

Case and Linking in Language Comprehension

Markus Bader and Josef Bayer

The German language, due to its verb-final nature, relatively free order of constituents and morphological Case system, poses challenges for models of human syntactic processing which have nearly been developed on the basis of head-initial languages with little or no morphological Case.

The verb-final order means that the parser has to make predictions about the input before receiving the verb. What are these predictions? What happens when the predictions turn out to be wrong? Furthermore, the German morphological Case system contains ambiguities. How are these ambiguities resolved under the normal time pressure in comprehension?

Based on theoretical as well as experimental work, the present monograph develops a detailed account of the processing steps that underly language comprehension. At its core is a model of linking noun phrases to arguments of the verb in the developing phrase structure and checking the result with respect to features such as person, number and Case.

This volume contains detailed introductions to human syntactic processing as well as to German syntax which will be helpful especially for readers less familiar with psycholinguistics and with Germanic.

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MARKUS BADER AND JOSEF BAYER
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Evidence from German

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Evidence from German

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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 Anschutz 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.

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Markus Bader
Josef Bayer

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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 auditory 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

¹We 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.

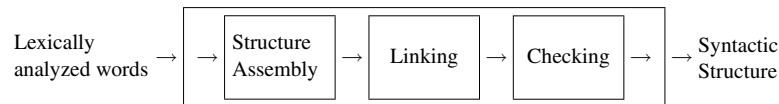


Figure 1.1. A model of the HSPM

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.

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

³Following 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

⁴For 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

	<i>Nominative</i>	<i>Accusative</i>	<i>Dative</i>
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

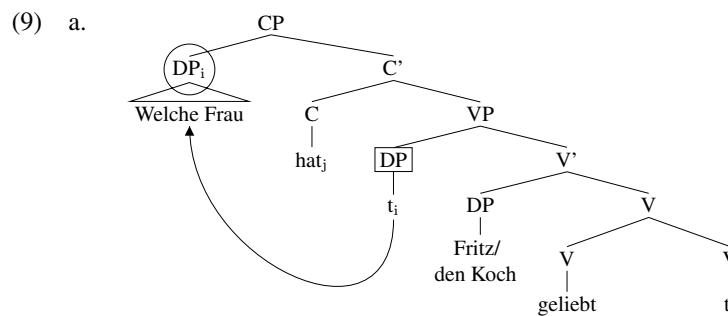
Unlike the proper name *Fritz* in (7), a definite masculine DP like *den Koch* ('the cook-ACC') or *der Koch* ('the cook-NOM') is unambiguous with respect to its Case. In contrast to the globally ambiguous sentence (7), the two sentences under (8) are therefore only locally ambiguous: The ambiguity of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

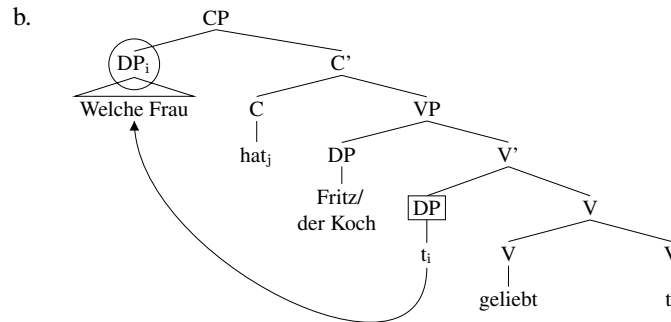
As with all syntactic ambiguities, syntactic function ambiguities raise questions concerning first- and second pass parsing. To these questions we turn now.

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.)



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



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

⁶We 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.

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

F i r s t P a s s	Structure Assembly Chapter 4 Explaining First-Pass Preferences in Syntactic-Function Ambiguities Chapter 5 The Mental Representation of Case	S e c o n d P a s s
	Linking and Checking Chapter 6 A Model of Linking and Checking Chapter 7 Case Checking and Lexical Reaccess Chapter 8 Case Checking and Working Memory	
Explaining Garden-path Recovery Chapter 9 In Defense of Serial Parsing		

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 Checking 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 Checking 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.

Chapter 2

INTRODUCING THE HUMAN SENTENCE PROCESSING MECHANISM

1. Introduction

The aim of this chapter is to give a short introduction to the Human Sentence Processing Mechanism (HSPM) for those readers who are not already familiar with it.¹

Before starting, two disclaimers are in order. First, reasons of space make it impossible to provide a complete or even near complete review of the pertinent literature concerned with the HSPM. Instead, we will focus on the basic mechanisms of the HSPM, and summarize the kind of questions any theory of the HSPM will ultimately have to answer. Second, the following introduction to the HSPM will be selective insofar as it concentrates on issues which are of particular relevance for serial models of human sentence processing. The reason for this selectiveness stems from the fact that the model we will propose in later chapters is a serial model itself. Alternative models (parallel models, minimal commitment models) will also be introduced in this chapter, but will be discussed only shortly. However, many of the points we will make from the perspective of serial parsing are relevant to models of the HSPM in general. Furthermore, we will come back to the issue of serial versus non-serial parsing at several points later in this book, most prominently in chapter 9 where we will provide a detailed defense of serial parsing against its contenders, based on the experimental results that we will provide in the course of this book.

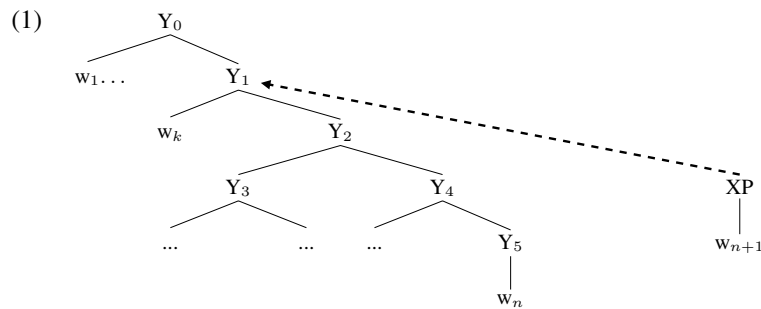
This chapter is structured as follows. Section 2 will review the two major sources of evidence on which theories of the HSPM are usually built. Section 3 will discuss several general properties of the HSPM, properties that one would

¹Longer introductions to the HSPM are Mitchell (1994) and Tanenhaus and Trueswell (1995). Several chapters reviewing the human parsing process can be found in Garrod and Pickering (1999).

have to account for even if syntactic ambiguities were absent from natural languages. Syntactic ambiguities and how to resolve them will be the topic of section 4. In this section, all major models of syntactic ambiguity resolution will be introduced. The following two sections will then take a closer look at the two major tasks of syntactic ambiguity resolution: Section 5 will be concerned with the preferences observed during syntactic ambiguity resolution, and section 6 with the processes responsible for garden-path recovery. Section 7 will summarize the questions that have been introduced in this chapter.

2. Data for a Theory of Human Parsing

In very general terms, the HSPM faces the task of integrating each word of a sentence into an unfolding syntactic structure. This task can be illustrated by the schema in (1) (adopted from Gibson, 2000).



(1) is to be understood as follows. The tree dominated by the topmost node “ Y_0 ” is the syntactic structure that the parser has computed for the sequence of words w_1, \dots, w_n . In the context of discussions of the human parsing mechanism, it is customary to call this structure the *CURRENT PARTIAL PHRASE MARKER*, or CPPM for short. “ w_{n+1} ” is the next word that the parser has to integrate into the CPPM. The task of theories of the HSPM is to explain how this integration is accomplished.

Two kinds of data have provided the major source of evidence for this endeavour: data on processing load and overload, and data on syntactic ambiguity resolution.² We will consider these two types of evidence in turn.

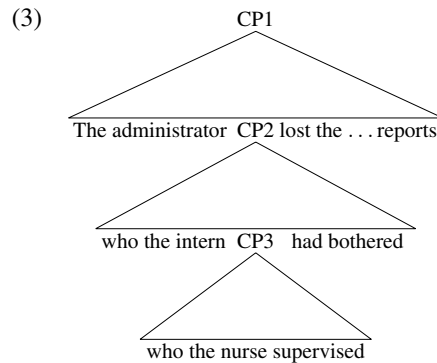
²Besides syntactic ambiguity resolution and processing (over)load, a range of other phenomena have contributed to a better understanding of the HSPM. For example, priming studies have tried to find evidence for trace reactivation during natural language comprehension (cf. e.g. Nicol and Swinney, 1989; MacDonald, 1989; Featherston, 2001).

2.1 Processing Load and Overload

Considerations concerning processing load and overload have had an influence on thinking about human parsing as early as Miller and Chomsky (1963). Consider first the sentences in (2) which illustrate the phenomenon of processing overload (these sentences, as well as the judgments—again indicated by “#”—are from Gibson, 1998: 4f.).

- (2) a. #The administrator who the intern who the nurse supervised had bothered lost the medical reports.
 b. #Because, if, when the baby is crying, the mother gets upset, the father will help, the grandmother can rest easily.

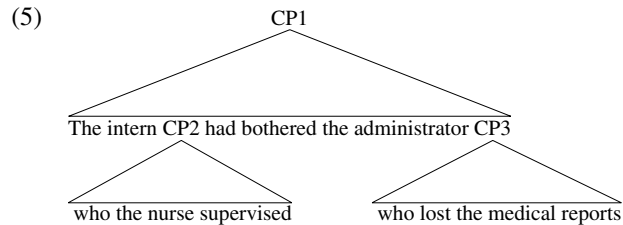
In schematic form, the syntactic structure of sentence (2-a) is shown in (3).



Structure (3) shows that the outermost clause CP1 of sentence (2-a) contains a second clause CP2 which in turn contains a third clause CP3. Sentence (2-a), as well as the even more complex sentence (2-b), is barely comprehensible. Compare now the sentences in (2) to the sentences in (4) (also from Gibson, 1998: 4f.).

- (4) a. The intern who the nurse supervised had bothered the administrator who lost the medical reports.
 b. If the mother gets upset when the baby is crying, the father will help so the grandmother can rest easily.

The structure of (4-a) is shown in (5), again in schematic form.



Structure (5) reveals that sentence (4-a) contains also two embedded clauses, but this time, both are direct descendants of CP1, and neither is nested inside the other. In contrast to the sentences in (2), the sentences in (4) are not particularly hard to understand. Since the only crucial difference between the sentences in (2) and (4) seems to lie in the higher degree of center-embedding, the conclusion seems warranted that sentences with two or more levels of center-embedding overtax the processing capacities of the HSPM.

As we have just shown, increasing the degree of center-embedding quickly leads to incomprehensibility. Sentences with repeated center-embedding thus illustrate the notion of processing load in a rather striking way. However, not all phenomena discussed under the heading of processing load are as severe as those illustrated by the examples above. A much-discussed difference in this connection is the one between subject-extracted relative clauses (cf. (6-a)) and object-extracted relative clauses (cf. (6-b)) (examples from King and Just, 1991: 582).

- (6) a. The reporter [that_i the senator attacked t_i] admitted the error.
 ↑—————↓
- b. The reporter [that_i t_i attacked the senator] admitted the error.
 ↑—↓

Numerous psycholinguistic investigations have shown that relative clauses with a relativized object are more difficult to comprehend than those with a relativized subject (e.g., Wanner and Maratsos, 1978; Just and Carpenter, 1992; Gordon et al., 2001; Gordon et al., 2002; Traxler et al., 2002).

In terms of integrating words into the developing CPPM, explanations of processing load differences in general, and of processing overload in particular, can make reference to two non-exclusive sources of complexity (cf. Gibson, 1998, for detailed discussion):

- *Maintaining the CPPM in working memory*

The CPPM has to be maintained in working memory in a useful way to allow subsequent integrations to succeed. Depending on the complexity of the CPPM, it might not be possible to retain enough information in memory for easy and successful parsing.

- *Making integrations*

Integrating a word into the CPPM can be more or less complex.

One popular type of processing-load explanation in terms of maintaining the CPPM in working memory postulates that there is only limited storage space available for the CPPM. For example, Principle Four “Two Sentences” of Kimball (1973) stated that the HSPM’s working memory has only space for two clauses which means that sentences with more than one degree of center-embedding can’t be processed. More refined versions of this idea have claimed that the HSPM can only keep track of a very small number of relations of the same type (cf. Stabler, 1994; Lewis, 1996).

An example of explaining processing load in terms of integrating words to the CPPM is provided by the Dependency Locality Theory (DLT) of Gibson (1998, 2000). In a nutshell, the DLT (which we will discuss in more detail in chapter 9) claims that object-extracted relative clauses are harder to process than subject-extracted relative clauses because the verb of the relative clause (*attacked* in (6)) has to be integrated across more intervening material in object-extracted relative clauses than in subject-extracted relative clauses. Intervening material is assumed by the DLT to make integrations more difficult because the information within the CPPM that has to be retrieved for successful integration of later input words (e.g., information about the complement of a verb, or information about moved elements like *who*) gets less accessible when the HSPM has to work hard when processing intervening material.³

While data on processing load and processing overload will not be the main focus of the theory that we will present in due course, some of the topics raised by processing (over-)load will show up repeatedly. This will be true in particular with regard to the question of how sentences are represented in working memory. This question will be discussed in chapter 6 and in chapter 8.

2.2 Syntactic Ambiguities

Data concerning the processing of ambiguous sentences have had an even greater influence on current conceptions of the HSPM than data on processing (over-)load. Some examples of syntactically ambiguous sentences were already given in the introductory chapter, and some additional examples are provided below ((7) from Frazier and Fodor, 1978; (8) and (9) from Kimball, 1973).

³Note that these sentences are also locally ambiguous, namely at the relative pronoun. Although this ambiguity is resolved quickly—already by the word immediately following the relative pronoun—it still might contribute to the increased processing load of object-relative clauses if there is a preference for analyzing the relative pronoun as the subject; an account along these lines has been proposed by Traxler et al. (2002).

- (7) Tom said that Bill had taken the cleaning out *yesterday*.
 (8) The woman took the job *that was attractive*.
 (9) Joe bought the book *for Susan*

The sentences in (7)-(9) are GLOBALLY AMBIGUOUS: In all three of them the italicized phrase can be analyzed in more than one way. In (7), for example, the adverbial *yesterday* can either modify the main clause (*Tom said*) or the embedded clause (*Bill had taken ...*). An important observation concerning globally ambiguous sentences is that usually one of the alternative analyses is preferred over the others. This seems intuitively obvious for the sentences above. In (7), for example, there is a strong preference of understanding *yesterday* as modifying the embedded clause, in (8) the relative clause is preferentially attached to the DP *job*, and in (9) the PP is preferentially understood as an argument of *bought*.

Globally ambiguous sentences can give important clues as to the structures preferred by the HSPM during on-line sentence comprehension. However, they are often not the best choice for experimental investigations of the HSPM, mainly because the observable preferences can only be investigated OFF-LINE, by asking people for their preferences after a sentence has been fully comprehended. In order to obtain ON-LINE data, that is, data that reflect the time-course of the ongoing comprehension processes more directly, students of the HSPM usually investigate sentences that are locally ambiguous but globally unambiguous.

We have already seen several examples of locally ambiguous sentences in the preceding chapters, and some more will be discussed now. Consider first the sentence pair in (10), a famous example from Bever (1970).

- (10) a. #The horse raced past the barn fell.
 b. The horse raced past the barn and fell.

Sentence pair (10) is an instance of the local ambiguity between reduced relative clause (10-a) and main-clause (10-b) that has been investigated quite intensively in the literature on the HSPM. Sentence (10-a) causes such a strong garden-path effect that people often fail to come up with the correct analysis.⁴

As our next examples (from Ferreira and Clifton, 1986) show, not all sentences exhibiting the reduced-relative/main-clause ambiguity lead to garden-path effects as strong as in Bever's sentence (10-a).

- (11) a. #The defendant examined by the lawyer turned out to be unreliable.

⁴This description presupposes that sentence (10-a) is indeed grammatical. While this has been assumed in most of the literature on reduced relative clauses, the opposite has recently been claimed by McKoon and Ratcliff (2003).

- b. The evidence examined by the lawyer turned out to be unreliable.

Two further examples of strong garden-path effects are the a-sentences in the following sentence pairs. (12) is taken from Frazier (1979); (13) is from Marcus (1980) (cf. Grodner et al., 2002, for recent experimental evidence on sentences like (13)).

- (12) a. #In order to help the little boy put down the package he was carrying.
 b. In order to help the little boy Jill put down the package she was carrying.
- (13) a. #The cotton clothing is made of grows in Mississippi.
 b. The cotton clothing is made of cotton from Mississippi.

As our final examples, we present two locally ambiguous sentences which give rise to only very mild garden-path effects—garden-path effects which are not strong enough to be perceived consciously. (14) is from Gibson (1991) (cf. Clifton et al., 1997, for experimental evidence on this kind of ambiguity) and (15) from Pritchett (1992) (cf. Boland, 1997, for experimental evidence).

- (14) a. The cop gave her earrings
 b. The cop gave her earrings to the dog.
- (15) a. I saw her duck fly away.
 b. I saw her duck into an alleyway.

The examples we have just reviewed as well as numerous other examples exhibiting all sorts of local syntactic ambiguity—comprehensive overviews of syntactic ambiguities present in the English language can be found in Gibson (1991) and Lewis (1993)—show two basic facts about what happens when the HSPM processes a syntactically ambiguous sentence:

- Usually, one of the possible structures is preferred to the other(s).
- Recovery from an initial misanalysis causes processing difficulties of varying degrees.

These are the kind of data that are crucial in developing models of the HSPM. Before proceeding to our discussion of such models, we have to note that the term *GARDEN-PATH EFFECT* is used in two different ways in the literature on syntactic ambiguity resolution. According to the first usage of this term, a garden-path effect is an increase in processing load that occurs at the point of disambiguation in locally ambiguous sentences, independent of whether the increased processing load can be perceived consciously or not. This is the usage that we adhered to in the discussion above as well as in the introductory chapter. According to the second usage, a garden-path sentence is a locally

ambiguous sentence which leads to conscious processing breakdown at the point of disambiguation. Locally ambiguous sentences which do not lead to conscious processing difficulties are accordingly not garden-path sentences.

In what follows, we will continue using the term garden-path effect in the first sense, calling all processing difficulties due to local ambiguity garden-path effects. As we will see, this sense is more in line with what one finds when experimentally investigating garden-path phenomena: garden-path strength comprises a very wide range, from barely detectable experimentally to very strong effects, where reanalysis is almost impossible for hearers or readers. Some of these strong effects are surely consciously detectable, and some of the weak ones are not, but drawing a firm line between conscious and unconscious effects seems only possible for cases near one of the endpoints on the spectrum of garden-path strength. A comprehensive theory of the HSPM has to be able to explain why certain garden-path sentences lead to conscious processing problems while others do not (for one particular proposal to this effect, cf. Bader, 1998), but we do not think that this distinction should be the starting point for our theories.

3. General Properties of the HSPM

Before going into the details of syntactic ambiguity resolution, this section will discuss two general properties of the HSPM that are independent of the fact that natural languages contain syntactic ambiguities: the MODULARITY of the HSPM and the property of INCREMENTAL PROCESSING.

3.1 Parsing and Modularity

One of the leading ideas in cognitive science has always been what Palmer and Kimchi (1986) have called the maxim of RECURSIVE DECOMPOSITION (for further discussion, cf. Palmer, 1999; Stillings et al., 1995). This maxim is given in (16).

(16) *Recursive Decomposition* (Palmer, 1999: 74)

Any complex (i.e., nonprimitive) informational event at one level of description can be specified more fully at a lower level by decomposing it into (1) a number of components, each of which is itself an informational event, and (2) the temporal ordering relations among them that specify how the information “flows” through the system of components.

A prominent and strong application of the maxim of Recursive Decomposition has been given by Fodor (1983) in terms of the MODULARITY HYPOTHESIS. According to this hypothesis, the human mind is made up of a set of INPUT MODULES which deliver information about the external environment to a CENTRAL PROCESSOR which is responsible for higher mental activities

like thinking and decision making. According to Fodor (1983), input modules share a range of properties that set them apart from the central processor. These properties include the domain specificity and informational encapsulation of input modules, their fast and mandatory mode of operation, and the association with a fixed neural architecture.

The Modularity Hypothesis has led to many controversies, within cognitive science in general and within psycholinguistics in particular (cf. the collection of papers in Garfield, 1987). As far as the HSPM is concerned, the question of modularity arises in two forms. First, we have to ask whether the HSPM as a whole forms a module of the human mind. If this question receives a positive answer, a second question then is whether the HSPM itself can be further fractionated into different subparts. As witnessed by the papers on language in Garfield (1987), these questions have been subject to intensive debates from the start. In recent discussions, the question of modularity has regained new impetus by the development of *CONSTRAINED-BASED THEORIES* of the HSPM. According to such theories (for recent overviews, cf. Seidenberg and MacDonald, 1999; Tabor and Tanenhaus, 1999), constraints from various sources of information are applied simultaneously to the input string. Furthermore, in these theories the distinction between lexical and syntactic processing—a basic distinction in modular theories of the HSPM—is blurred.

In summary, one of the most fundamental questions concerning the HSPM is the one in (Q1) (adopted from Clifton (2000)).

- (Q1) I Is the HSPM, considered as a whole, a module of the human mind?
 II Is the HSPM a single, uniform module, or is it composed of multiple modules?

3.2 The Incremental Nature of the Human Parsing Process

Among the properties of the HSPM, the one which is probably the least disputed is the property of *INCREMENTAL PARSING*. A parser which works in an incremental manner integrates each word into the ongoing CPPM immediately on encountering the word, without any delay, and without any buffering of words before integration.

Incremental parsing is supported by a variety of experimental results, among others by data concerning processing load and data concerning syntactic ambiguity resolution (for further discussion, cf. Pickering and Traxler, 2000).

- When reading garden-path sentences, readers show signs of disruption often at the earliest point possible, that is, immediately at the disambiguating word.
- In a similar vein, effects of increased processing load can often be observed immediately at the word at which the increase in processing load starts.

Despite the broad consensus that has been reached concerning the incremental nature of the HSPM, there is still an ongoing debate as to the precise scope of incremental parsing. This is in particular true for the parsing of head-final constructions, and is thus of some relevance for us given that German—the language which is in the focus of the current monograph—is an SOV-language.

Non-incremental parsing of head-final constructions is a property of HEAD-DRIVEN parsers, that is, parsers which can introduce a phrasal node into the CPPM only if the head of the phrase has been seen in the input. Strong forms of head-driven parsing have been proposed by Pritchett (1992) and Vosse and Kempen (2000).⁵ By way of illustration, consider example (17-a) which is a typical embedded clause in German.

- (17) a. . . . dass Peter Maria letzte Woche ein Buch brachte.
 that P. M. last week a book brought
 ‘. . . that Peter brought Maria a book last week.’
 b. [_{CP} dass], [_{DP} Peter], [_{DP} Maria], [_{DP} letzte Woche], [_{DP} ein Buch]

When processing a sentence like (17-a), a head-driven parser can assemble single pieces (cf. (17-b)), like a CP headed by *dass* (‘that’), or the various DPs that follow the complementizer, but these phrases cannot be integrated into a larger structure and instead have to be buffered until the clause-final verb is encountered. Only then can the parser postulate a VP-node (and perhaps nodes which extend the VP) and integrate the DPs into this structure.

There exists already quite a few evidence in favor of strictly incremental parsing, that is, incremental parsing independently of where heads are located within their phrases (e.g. Bader and Lasser, 1994; Kamide and Mitchell, 1999). Nevertheless, strict incrementality cannot be taken for granted, and we thus arrive at (Q2) as our second question concerning the HSPM.

- (Q2) Does the HSPM compute syntactic structures always in an incremental manner, or is incremental parsing restricted to certain types of syntactic structures?

4. Syntactic Ambiguity Resolution

Most theories of the HSPM that are currently under investigation are based to a large degree on findings concerning syntactic ambiguity resolution, and our own theory will be no exception. As the examples discussed in section 2.2 have shown, there are two basic facts about what happens when the HSPM encounters a syntactic ambiguity.

⁵There are several other strongly lexicalized theories of the HSPM (e.g., MacDonald et al., 1994a; Trueswell and Tanenhaus, 1994) which haven taken no definitive stance on whether additional structural knowledge is used for the purpose of parsing head-final constructions.

- Usually, one of the possible structures is preferred to the other(s).
- Recovery from an initial misanalysis causes processing difficulties of varying degrees.

When developing a model of the HSPM capable of accounting for these facts, the first decision to make concerns the questions in (Q3).

- (Q3) I Does the HSPM pursue only a single analysis at a time, or does it pursue more than a single analysis in parallel?
- II Does the HSPM compute fully specified syntactic structures, or does it compute structures that are to some extent underspecified?

Combining the two possible answers for (Q3-I) with the two for (Q3-II) gives rise to four combinations, but only three have made their way into discussions of the HSPM. Two of them assume that only a single analysis is computed, either a fully specified one or an underspecified one. The remaining combination is that the HSPM can compute more than a single structure, with each structure fully specified. These three ways to cope with syntactic ambiguities have become known under the names of SERIAL PARSING, MINIMAL COMMITMENT PARSING, and PARALLEL PARSING. The defining features of each parsing mode are summarized in (18) - (20) (from Gorrell, 1991: 279-280).

- (18) *Serial models: Single analysis, fully specified*
A single 'preferred' structure is computed for an ambiguous string. If this structure is incompatible with subsequent material, reanalysis is required.
- (19) *Parallel Models: More than a single analysis, fully specified*
Multiple structures are computed for an ambiguous string. At points of disambiguation in the parse, incompatible structures are abandoned.
- (20) *Minimal Commitment Models: Single analysis, underspecified*
Commitment to a particular analysis is postponed until the appearance of disambiguating information.

(18) - (20) define "pure" serial, parallel and minimal commitment parsing. Whereas many of the serial models which have been proposed in the literature are pure ones, closely adhering to the definition in (18), parallel and minimal commitment models are often hybrid models which combine parallel or minimal-commitment parsing with certain elements of serial parsing. The following discussion will concentrate on pure models as defined in (18) - (20).

Given that sentences may be unambiguous but may as well contain a local syntactic ambiguity, the parsing process can be in either of the four states listed below. For two of the garden-path examples from section 2.2, these four possible states are depicted in (21).

- ❶ Processing unambiguous parts of sentences
- ❷ Processing the word which starts the ambiguity
- ❸ Processing in the ambiguous region (The region that starts after the word at which the ambiguity began just prior to the point where the ambiguity is resolved)
- ❹ Processing the disambiguating word

(21) ❶ ❷ ❸ ❹ ❶

The horse	raced	past the barn	fell	in Mississippi.
The	cotton	clothing is made of	grows	

Serial, parallel, and minimal commitment models crucially differ in their claims about what goes on in the ambiguous region and at the point of disambiguation. This is true in particular with respect to the relationship between the processing of ambiguous and unambiguous sentences.

In a SERIAL MODEL, a single, fully specified syntactic structure is computed for both ambiguous and unambiguous sentences. When a serial parser encounters a word which can be integrated into the CPPM in more than one way, it decides on one of the possible structures (how this decision is made will be discussed in the next section). Processing in the ambiguous region works then the same way as processing an unambiguous sentence that has the same structure as the one chosen before, that is, an unambiguous sentence corresponding to the preferred structural analysis. At the point of disambiguation, there are two possibilities. If the sentence is disambiguated towards the preferred structure, parsing will continue in the same way as for corresponding unambiguous sentences. This means that the preferred syntactic structure is processed as if no ambiguity would have been present.

If, however, disambiguation is in favor of a non-preferred structure, a situation arises where the next word cannot be integrated into the CPPM. In a serial model, processes of reanalysis are invoked in this situation. The task of reanalysis is to transform the CPPM computed thus far into a structure compatible with the contradicting input word. There are several options how this might be achieved, as will be explained below.

For serial models of the HSPM, it has become customary to call all processes that go on up to the point of disambiguation as FIRST-PASS PARSING. As explained above, serial models make the claim that first-pass parsing is basically identical for ambiguous sentences and unambiguous sentences that correspond to the preferred analysis of the ambiguous sentence. The only processing difference that might occur concerns the processing of the word that starts the ambiguity. Since there are alternative ways to integrate this word into the CPPM, some decision has to be made; such decisions are not necessary for

corresponding unambiguous sentences. Sentences disambiguated towards the unpreferred analysis, in contrast, differ substantially from unambiguous sentences because they trigger processes of reanalysis at the point of disambiguation. These processes are also known as *SECOND-PASS PARSING*.

In a *PARALLEL MODEL*, unambiguous and ambiguous sentences are processed differentially as soon as the HSPM encounters the word that starts the ambiguity. From this point on, an ambiguous sentence calls for the computation of alternative structures in parallel whereas only a single structure needs to be computed for an unambiguous sentence throughout. The structures that are computed for an ambiguous sentence have to be elaborated during the ambiguous region until the point of disambiguation is reached. At this point, all structures that are excluded by the disambiguating input word can be pruned. Note that pruning of incompatible structures is necessary for all possible disambiguations. Thus, reanalysis in a parallel model pertains to all possible structural analyses of an ambiguous sentence, in contrast to serial models, where reanalysis is only necessary for non-preferred readings.

If a parallel parser computes all possible structures for an ambiguous sentence, how is it possible that preferences for certain structures arise, and garden-path effects for other structures? As will be discussed in more detail in chapter 9, parallel parsers usually make use of the concepts of *RANKING* and *PRUNING* in order to explain preferences and garden-path effects. *RANKING* means that the structures computed in parallel are not all on an equal footing, but that structures are ordered according to some criteria. The highest ordered structure is the preferred one. *PRUNING* means that structures that are ordered low are discarded from further analysis. If disambiguation is toward such a structure after all, a garden-path effect arises.

In a *MINIMAL COMMITMENT MODEL*, ambiguous and unambiguous sentences are also treated in different ways from the point onwards where the ambiguity starts. The HSPM can commit to a fully specified structure for unambiguous sentences but not for ambiguous sentences. As soon as a minimal commitment parser encounters a word at which an ambiguity starts, it has to compute a representation that is underspecified in such a way that all possible analyses of the ambiguous input string are compatible with it. In the extreme, this means delaying all further decisions until disambiguating material is encountered. However, there are also more refined schemata which allow the HSPM to commit on some aspects of the syntactic analysis while leaving other aspects open. Reanalysis in a minimal commitment model consists in filling-in the details that have been left open on first-pass parsing.

A particular incarnation of the minimal commitment approach to the HSPM is the *MONOTONICITY HYPOTHESIS* (for detailed discussion, cf. Sturt and Crocker, 1998). The monotonicity hypothesis claims that it is easy for the HSPM to add information to the CPPM but that it is difficult for the HSPM to

retract information once it has been added. This hypothesis relates to the notion of minimal commitment parsing as follows. According to minimal commitment parsing, the parsing mechanism leaves certain aspects of the syntactic analysis of a sentence unspecified until disambiguating information arrives. At this point, the details left unspecified so far will be fixed. Fixing unspecified details means adding additional information to the CPPM, and should therefore be easy according to the monotonicity hypothesis. Retracting information, which is claimed to be hard for the HSPM, in contrast, is normally not necessary if the HSPM is not forced to decide immediately on every aspect of the ongoing analysis.

This concludes our overview of the three main classes of parsing models that can be found in discussions of the HSPM. A summary of the main features of each model is provided in Table 2.1 on page 33.

5. First-Pass Parsing: Predicting Preferences

The first-pass parsing routines of the HSPM are responsible for the initial integration of each word into the developing CPPM. Given that natural languages give rise to syntactic ambiguities, and that a particular structure is normally preferred on the first-pass, an important task of the HSPM's first-pass parsing routines consists in deciding on which of several possible analyses to pursue. A major question that arises in connection with first-pass parsing is therefore the question in (Q4).

(Q4) What information does the HSPM use in establishing an initial syntactic analysis, and how?

Several types of information have been proposed to be used by the HSPM for assigning an initial structure. Below, we list the information types that have received most attention in the recent literature (this list is not exhaustive, but representative):

- (22) a. Phrase-structural configurations
 b. Subcategorization/argument structure information
 c. Morphological information (e.g. Case, number)
 d. Semantic/Pragmatic properties of syntactic structures
 e. Frequencies of various sorts (e.g., frequency of lexical items or particular properties of lexical items, frequency of particular syntactic structures)

Discussing all proposals which have been made regarding first-pass parsing is far beyond the scope of this chapter (for recent reviews, see Mitchell, 1994; Pickering, 1999; Tanenhaus and Trueswell, 1995). Given that our own project of developing a theory of the HSPM's linking and checking processes

Table 2.1. Serial, parallel, and minimal commitment models

	<i>Serial Model</i>	<i>Parallel Model</i>	<i>Minimal Commitment Model</i>
<i>Start of Ambiguity</i>	single structure computed	multiple structures computed	underspecified structure computed
<i>Ambiguous Region</i> - <i>preferred reading</i>	computed; same as unambiguous counterpart	computed; ranked highest	subsumed under underspecified structure
- <i>unpreferred reading</i>	not computed	computed; ranked lowest	subsumed under underspecified structure
<i>Point of disambiguation (Reanalysis)</i> - <i>preferred reading</i>	no reanalysis	pruning of lower ranked structure	full specification
- <i>unpreferred reading</i>	reanalysis	pruning of higher ranked structure	full specification

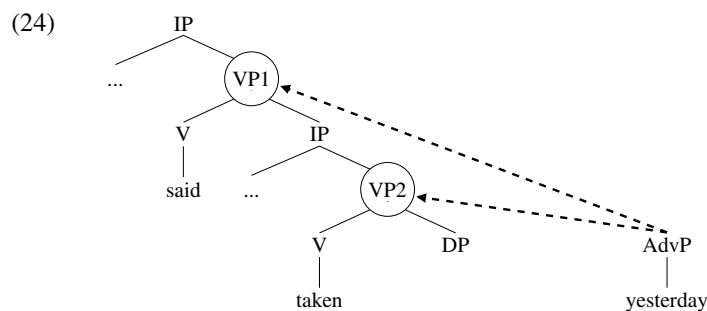
presupposes a theory of how the HSPM assembles phrase-structure representations, we will contend ourselves at this point to a review of some of the major parsing principles relevant for phrase-structure assembly, without going into any of the disputes that have revolved around this task.

In analogy to the two syntactic operations MERGE and MOVE, principles for phrase-structure parsing can be classified as either principles for PHRASE-STRUCTURE ATTACHMENT and principles for handling FILLER-GAP (ANTECEDENT-TRACE) DEPENDENCIES. Principles for phrase-structure attachment can be further subdivided into principles of LOCALITY and principles of PARSIMONY.

Locality principles state that the HSPM tries to minimize the distance between the word to be integrated and the integration site. A striking demonstration of the strength exerted by locality is sentence (23) (repeated from above).

(23) Tom said that Bill had taken the cleaning out *yesterday*.

The ambiguity that arises at the point of integrating *yesterday* into the CPPM is depicted in (24).



As shown in (24), there are two possible attachment sites for *yesterday*. When reading such a sentence, there is a strong propensity to attach the ambiguous word to the lower VP node, VP2 in (24). As is clearly visible in (24), VP2 is more local to *yesterday* than VP1: In linear terms, there is less distance between the head of VP2 and *yesterday*; in structural terms, less nodes have been postulated between inserting VP2 into the CPPM and encountering *yesterday*.

An early influential formulation of a parsing principle capturing the notion of locality is the RIGHT ASSOCIATION principle proposed in Kimball (1973).

(25) *Right Association*

Terminal symbols optimally associate to the lowest nonterminal node.
(Kimball, 1973: 24)

A preference for making local attachments seems to be a prevailing feature of the human parsing mechanism, and many theories include some variant of Kimball's Principle of Right Association, including LOCAL ATTACHMENT (Frazier and Fodor, 1978), LATE CLOSURE (Frazier and Rayner, 1982), and RECENCY (Gibson, 1991; Gibson et al., 1996). A comprehensive discussion of these principle can be found in Phillips (1995; 1996).

The second type of principle for resolving attachment ambiguities is the parsimony principles. Probably the best-known such principle is the MINIMAL ATTACHMENT principle proposed by Frazier (1979), which is given in (26) in the formulation of Frazier and Rayner (1982: 180).

(26) *Minimal Attachment*

Attach incoming material into the phrase-marker being constructed using the fewest nodes consistent with the well-formedness rules of the language.

A more recent variant of the Minimal Attachment principle is the SIMPLICITY principle of Gorrell (1995).

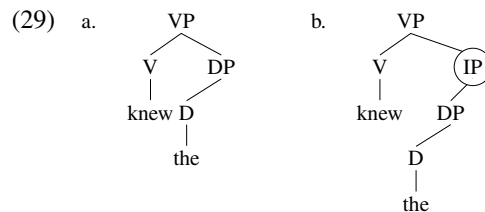
(27) *Simplicity*

No vacuous structure building.
(Gorrell, 1995: 100)

An example for illustrating parsimony at work is given in (28).

- (28) a. #Only the teacher knew *the solution to that problem* was easy.
b. Only the teacher knew *the solution to that problem*.


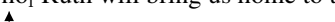
(29-a) and (29-b) are the two structures that the HSPM has to consider on encountering the determiner *the*.⁶



⁶Given that NP is an obligatory complement of D in English, and that IP necessarily dominates the nodes Γ , I, and VP, the CPPMs shown in (29) might as well contain these nodes, if the HSPM inserts predictable nodes into the CPPM. For the current discussion, nothing hinges on this point.

In both structures, the VP-node is the ultimate attachment site for *the*. Thus, locality is not at stake here. What differs between (29-a) and (29-b) instead is the number of nodes that have to be postulated in order to make the necessary attachment: In (29-a), the DP headed by *the* can be attached immediately to VP; in (29-b), an additional IP-node intervenes. The Minimal Attachment principle requires from the HSPM to use the smallest number of nodes when making attachments, and thus it correctly predicts a preference for structure (29-a). The Simplicity principle prohibits vacuous structure building. Since the IP-node in (29-b) is a piece of vacuous structure—in the input thus far there is no item licensing this node—the Simplicity principle also predicts a preference for structure (29-a). In the following, we will make reference to the principle SIMPLICITY when discussing preferences related to phrase-structure configurations because phrasing parsimony in terms of SIMPLICITY reflects certain differences in syntactic analysis (to be introduced in the next chapter) in a rather direct way.

In addition to parsing principles responsible for phrase-structure parsing in the sense of the syntactic operation MERGE, parsing principles are needed for handling ambiguous filler-gap dependencies, that is, dependencies brought about by the operation MOVE. A well-known example of such an ambiguity in English is the one in (30) (from Stowe, 1986).

- (30) 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.


In (30), there is a preference for postulating the trace associated with *who* immediately after the verb *bring*. This is compatible with the structure in (30-a), but leads to a surprise effect when encountering *us* in (30-b). This surprise effect is called the FILLED-GAP EFFECT because the location of the expected trace already contains phonetically spelled-out material.

An influential parsing principle accounting for the filled-gap effect—as well as numerous other findings from the area of filler-gap processing—is the ACTIVE FILLER HYPOTHESIS of Frazier (1987) which is presented here in the easier formulation of Clifton and Frazier (1989).

(31) *Active Filler Hypothesis*

When a filler of category XP has been identified in a non-argument position, such as COMP, rank the option of assigning its corresponding gap to the sentence over the option of identifying a lexical phrase of category XP.

(Clifton and Frazier, 1989: 292)

The phrase *who* is an active filler in the sense of the Active Filler Hypothesis because such a phrase is necessarily located in a non-argument position (SpecCP) in the sentences under consideration, and the parser therefore knows for sure when encountering *who* that it has to postulate a trace at some later point. A first possibility for postulating a trace is on encountering *bring*. This verb must be followed by a DP which can either be the trace of *who* or a lexical DP yet to be read. According to the Active Filler Hypothesis, the parser has to opt for the first option, and the preferred structure will therefore be the one of (30-a).

The Active Filler Hypothesis has been generalized by De Vincenzi (1991) to the MINIMAL CHAIN PRINCIPLE. This principle, which was already introduced in the preceding chapter, is repeated in (32).

(32) *Minimal Chain Principle*

Avoid postulating unnecessary chain members at S-structure, but do not delay required chain members.

(De Vincenzi 1991: 13)

The filled-gap effect follows from the second clause of the Minimal Chain Principle which requires from the HSPM to insert a required trace into the CPPM as soon as possible. In (30), the first opportunity to insert a trace is immediately after *bring*. This is the location where the trace is preferentially inserted, and thus the Minimal Chain Principle also readily explains the filled-gap effect. As we will see later, the Minimal Chain Principle plays an important role in explaining first-pass preferences observed in subject-object ambiguities.

The parsing principles introduced so far have in common that they make use of a very narrow range of information: With respect to the input seen thus far, the only information used is the phrase-structure configuration given by the CPPM; with respect to the word that is to be integrated next, only the syntactic category label is used. That first-pass parsing is a process which is informationally encapsulated in this way is a strong hypothesis about the HSPM which is closely connected to the so-called GARDEN-PATH THEORY of Frazier and colleagues (e.g. Frazier and Rayner, 1982; Frazier, 1987a). However, this hypothesis is by no means uncontroversial. As already pointed out at the beginning of this section, there are many kinds of information that have been proposed to guide the parser's decisions when confronted with a syntactically ambiguous input string (cf. the listing in (22)).

To give just one example, consider again sentence pair (28). We have shown above how the preference for analyzing the ambiguous DP *the solution* as an object of the verb *knew*—instead of taking it as the subject of a clause embedded under *knew*—follows from parsimony principles like MINIMAL ATTACHMENT or SIMPLICITY. As an alternative to such a parsimony explanation, it has been proposed that the true reason for this preference lies in the subcategorization

properties of the matrix verbs used in examples of this kind (e.g., Ford et al., 1982). If the lexicon informs the parser about the frequency of use of different complement types of a verb like *knew*, the parser might compute the structure that corresponds to the most frequently used complement. This would make reference to the exact phrase-structural configurations of the competing analysis superfluous. In the experimental literature concerned with the HSPM, one can find both evidence for and against the immediate use of subcategorization information for purposes of first-pass parsing (for extensive discussion, cf. Mitchell, 1994; Tanenhaus and Trueswell, 1995).

Despite the controversies surrounding the HSPM's first-pass parsing routines, we have to stop our discussion of this topic at this point (for comprehensive discussion, cf. the literature cited in footnote 1 on page 19). However, we will return to it when discussing the preferences that have been observed for sentences with syntactic function ambiguities. As discussed in this section, one of the major questions will then be what kind of information the parser uses in making its decisions.

6. Second-Pass Parsing: Predicting Garden-Path Strength

Processes of second-pass parsing have recently become a topic of intensive research (as witnessed, for example, by the collection of papers in Fodor and Ferreira, 1998). This research has greatly sharpened our understanding of the theoretical options we have when trying to develop explicit models of garden-path recovery. In this section, we will review a number of important dimensions along which existing theories of reanalysis differ (cf. Lewis, 1998, and Sturt and Crocker, 1998, for related reviews). Although we will phrase the discussion in terms of serial models, many of the distinctions are also relevant for parallel and minimal commitment models. As our reference examples for the discussion in this section, we will use the sentence pairs in (33) and (34) (from Frazier and Rayner, 1982).⁷

- (33) a. #Only the teacher knew *the solution* WAS easy.
 b. Only the teacher knew *the solution*.
- (34) a. #Since Jay always jogs *a mile* SEEMS like a short distance to him.
 b. Since Jay always jogs *a mile* THIS seems like a short distance to him.

In both (33) and (34), the italicized DP is locally ambiguous because, until following material leads to disambiguation, it can be either a subject ((33-a) and (34-a)) or an object ((33-b) and (34-b)). Intuitions as well as experimental results (e.g. Frazier and Rayner, 1982; Sturt et al., 1999) show two things:

⁷With respect to type of ambiguity, sentence pair (34) is on a par with sentence pair (12).

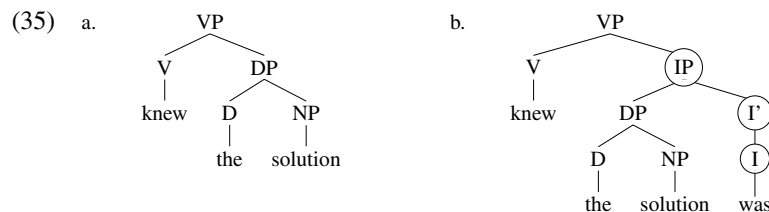
- In both (33) and (34), the ambiguous DP is preferentially analyzed as an object of the preceding verb.
- Switching from the preferred to the unpreferred reading is rather effortless for (33-a) but not for (34-a), where it indeed might lead to consciously detectable processing difficulties.

What is the reason for (33-a) leading to a mild and (34-a) leading to a strong garden-path effect? The first dimension in addressing this question concerns the fate of the original CPPM, that is, the CPPM that was assembled up to the point of disambiguation. At this point, we have to ask the question in (Q5).

- (Q5) Is (part of) the original CPPM simply discarded after encountering the disambiguating word, such that new structure has to be built up from scratch, or is it kept as far as possible and only altered where necessary in order to overcome the garden-path?

Following Fodor and Inoue (1994), we will call the first option of garden-path recovery given in (Q5) *REPARSING* and the second option *REPAIR*.

By way of illustration, consider the tree structures in (35).



(35-a) shows the CPPM computed for (33-a) up to the ambiguous DP *the solution* (for reasons of space, the structure above VP is not shown). This DP has been attached as the direct object in (35), in accordance with one of the parsimony principles mentioned above (Minimal Attachment, Simplicity). (35-b) shows the CPPM that is necessary in order to integrate the auxiliary that follows the ambiguous DP in (33-a). In (35-b), this DP is no longer a direct object of the verb *knew* but instead the subject of an embedded clause.

The crucial question now is how the HSPM gets from (35-a) to (35-b) on encountering *was*. According to a reparsing model, (part of) the original CPPM would be deleted and parsing would then start anew. According to a repair model, the original CPPM would not be discarded but withheld. Repair would consist in inserting the circled nodes in (35-b) between VP and the ambiguous DP *the solution*.

Independently of whether reanalysis proceeds by repair or by reparsing, a further question arises immediately: How can the HSPM know which repair

or reparsing operation(s) to apply? For example, when reparsing part or the entirety of an input sentence, what prevents the HSPM from making the same error again and again? Or, in terms of repair, what tells the parser that the circled nodes in (35-b) have to be added to the original tree (35-a) between VP and DP in order to arrive at a successful reanalysis? One possibility, well-known from books on computational linguistics (e.g. Winograd, 1983; Allen, 1995), is that the parser keeps a record of prior choice points, including with each choice point information about which alternative analyses have not been pursued yet. In case the initial structure runs into a dead end at some point during the ongoing analysis, the HSPM can then return to one of the choice points, delete all structure up to this point, and compute a new structure using the information about unexplored alternatives to avoid making the same error time and again. A psycholinguistic model that works along these lines by integrating the storage of prior choice points, has been proposed by Inoue and Fodor (1995).

If we do not want to make the assumption that the HSPM keeps a record of prior parsing actions in addition to the CPPM, we have to stick to a pure serial parsing mechanism which has only the CPPM to operate on at the point of disambiguation. The operations leading to successful garden-path recovery will then have double duty. First, they have to figure out what changes are necessary to correct the CPPM built up by the first-pass parsing routines. Second, they have to actually carry out the changes which have been determined necessary to correct the error. Again following Fodor and Inoue (1994 and *passim*), who have made this distinction a central one in discussions of garden-path recovery, the former task has become known under the name of *DIAGNOSIS* whereas the second one goes under the name of *CURE*.⁸

To illustrate what is meant by diagnosis, let us consider how the *DIAGNOSIS MODEL* proposed in Fodor and Inoue (1994, 1998) handles the contrast between (33) and (34). The diagnosis model of Fodor and Inoue is a pure serial model in the sense defined above. Furthermore, it is a repair model and not a reparsing model, which is a necessary assumption if the HSPM does not store prior choice points. The diagnosis process is set into motion at the point of disambiguation. By definition, at this point the HSPM encounters a word for which it cannot find a legitimate attachment site within the CPPM. Such a word is attached to the CPPM nevertheless, according to the *ATTACH ANYWAY* principle shown in (36).

⁸The notion of diagnosis already figured in the *SELECTIVE REANALYSIS HYPOTHESIS* of Frazier and Rayner (1982). According to this hypothesis, “. . . the parser does not stupidly and automatically proceed through the sentence in one direction or the other regardless of the type of error involved; rather, the parser will use whatever information indicates that its initial analysis is inappropriate to attempt to diagnose the source of its error” (op.cit.: 182).

(36) *Attach Anyway*

Having established that there is no legitimate attachment site in the CPPM for the current input word, attach the input word into the CPPM wherever it least severely violates the grammar, and subject to the usual preference principles that govern *Attach*.

Attaching a word by *Attach Anyway* will create an ill-formed phrase marker. The next task of the HSPM therefore is to find a way for repairing the ill-formed CPPM in such a way that a well-formed phrase marker results. This is the task of the operation *ADJUST* in (37), whose working is constrained by the *GRAMMATICAL DEPENDENCY PRINCIPLE* in (38).

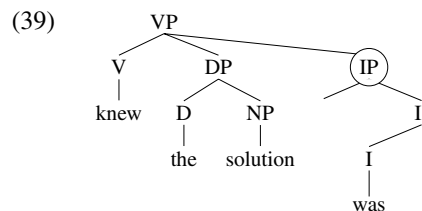
(37) *Adjust*

When a grammatical conflict has been created between two nodes or features X and Y in the CPPM, by either *Attach Anyway* or *Adjust*, eliminate the problem by altering minimally (i.e. no more than is necessary for conflict resolution) whichever of X and Y was less recently acted on, without regard for grammatical conflicts thereby created between that node and other elements in the CPPM.

(38) *The Grammatical Dependency Principle (GDP)*

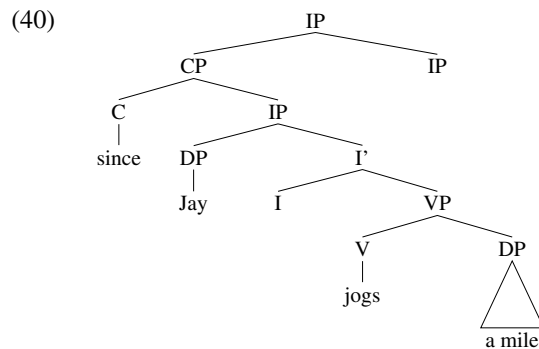
When a grammar violation has been created in the CPPM by an action on node *n* in accord with *Attach Anyway* or *Adjust*, attempt to eliminate the problem by acting on a node that is grammatically incompatible with *n*.

Let us illustrate the interplay between *ATTACH ANYWAY*, *ADJUST*, and the *GRAMMATICAL DEPENDENCY PRINCIPLE* by showing how a parser abiding by these principles would transform the phrase-marker (35-a) into the phrase-marker (35-b). When the HSPM encounters the word *was* during processing of sentence (33-a), it will have no legitimate attachment site in the initial structure (35-a). By *Attach Anyway*, *was* will nevertheless be attached to (35-a), in the manner depicted in (39).



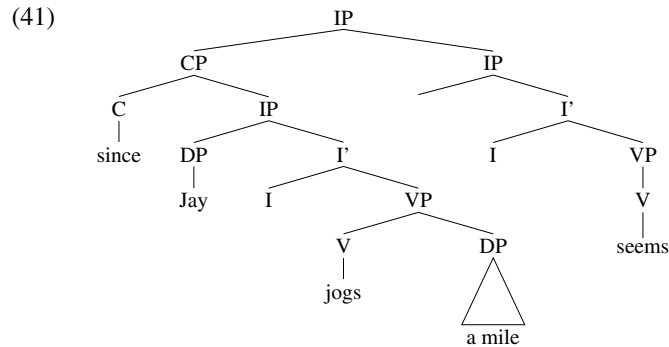
In (39), the IP headed by *was* has been attached as a further daughter of the VP node headed by the main verb *knew*.⁹ There are two problems with the resulting structure: First, *knew* now has two arguments while only one is allowed, and second, *was* is missing its subject. What the HSPM therefore has to diagnose is that the DP *the solution* has to be lowered to the subject position of *was*. This will remove both problems at once. Given the Grammatical Dependency Principle, making the necessary deductions will be easy. If we take node *n* in the definition of the Grammatical Dependency Principle as the IP attached by Attach Anyway, the HSPM now has to work on a node grammatically incompatible with *n*. Incompatible with *n* is the DP on its left because this DP competes with *n* for the object role of the verb *knew*. One way to resolve this competition is by removing the DP from its original position. Then a new position for it will be needed, but such a position is already present in the CPPM, namely the empty subject position within *n* (= IP). By attaching DP to this position, the initial (35-a) will have been transformed to (35-b), and normal processing can resume.

We have to show next why reanalysis should be difficult for sentence (34-a). The structure computed for the sentences in (34) up to the ambiguous DP is shown in (40).



The next word to attach to the CPPM is the verb *seems*. There is no legitimate attachment site for this word in (40), so it has to be attached by Attach Anyway. Fodor and Inoue assume that *seems* will be attached as in (41) because this leads to a less severe violation of the principles of grammar than attachment to the VP of the embedded clause.

⁹For the present discussion, it is immaterial whether only binary branching is allowed or not. For ease of exposition, we show a ternary structure in (39).



(41) is not a well-formed syntactic structure because the verb *seems* is missing its subject. Therefore, Adjust is set into motion. According to the Grammatical Dependency Principle—the principle which guides the working of Adjust—the HSPM's next move is to act on a node which is incompatible with the node attached by Attach Anyway, that is, the VP headed by *seems*. The only node which is incompatible with this VP is the subject position of the IP node dominating the VP because this position is empty and thus does not provide the subject required by the finite verb *seems*. So Adjust is invoked a second time, this time on the empty subject node. With which node is this node incompatible? The only candidate is the VP headed by *seems*. This VP is incompatible with an empty subject position because a finite VP requires an overt subject in English. Since this VP is also the node from which diagnosis started, ADJUST has returned to its starting point, and no progress has been made. Thus, automatic reanalysis is not possible in this case, and only processes of a conscious, problem-solving nature might lead to garden-path recovery.

In summary, Adjust constrained in the manner of the Grammatical Dependency Principle is unable to detect that what really went wrong in the example under consideration is that the DP *a mile* was attached at the wrong place on initial pass-parsing.¹⁰ By assuming that reanalysis is easy only in case the error can be straightforwardly deduced the diagnosis model therefore correctly predicts that reanalysis for sentences like (34-a) is not easy.

After this short illustration of diagnosis at work, we are now ready to return to the theoretical distinctions that have to be drawn regarding second-pass parsing. Given the preceding opposition between diagnosis and cure, the question in (Q6) naturally arises.

¹⁰The same result would follow if the IP dominating *seems* would be taken as node *n* in the definition of the Grammatical Dependency Principle.

(Q6) Do differences in garden-path strength follow from constraints on diagnosis or from constraints on cure?

Three types of reanalysis models have been proposed as an answer to this question: DIAGNOSIS-CONSTRAINED models, CURE-CONSTRAINED models, and MIXTURE models (cf. Sturt and Crocker, 1998). According to diagnosis-constrained models, the strength of a given garden-path effect is a function of how difficult it is for the HSPM to deduce the necessary revision operations. In our discussion of the diagnosis model of Fodor and Inoue above, we have already seen one particular way of spelling out this idea.

In contrast to diagnosis constrained models, cure constrained models ascribe differences in garden-path strength to inherent costs associated with particular revision operations. A prime example for this kind of explanation is provided by MINIMAL COMMITMENT MODELS of the HSPM which claim that adding additional information on reanalysis is an easy task for the HSPM but retracting already existing information is difficult. This idea goes back to work by Marcus, Hindle and Fleck (1983) and Berwick and Weinberg (1985). In a more recent study, Sturt et al. (1999) have provided new experimental evidence that sentence (34-a) results in a stronger garden-path effect than sentence (33-a), and have explained this finding in terms of the difficulty of the necessary repair operations. For the easy (33-a), information in form of an IP-node has to be added. For the difficult (33), in contrast, the initial statement of a dominance relation between the VP headed by *jogs* and the NP *a mile* has to be withdrawn.

A model of reanalysis should not only state whether reanalysis is constrained in terms of diagnosis and/or in terms of cure, but should also offer an answer to the question in (Q7).

(Q7) What are the reasons for the constraints on reanalysis?

Several, again non-exclusive, motivations for constraints on reanalysis have been proposed in the recent literature. First, there might be limitations on the computational resources that the HSPM has at its disposal for garden-path recovery. In the diagnosis model of Fodor and Inoue, for example, computational limitations on the diagnosis operations are the ultimate reason why reanalysis sometimes succeeds but at other times fails. These limitations arise from the assumption that the HSPM is not a powerful mechanism which can look at the CPPM as a whole. Instead, diagnosis is a process that works in small steps, and access to the CPPM is limited by the Grammatical Dependency Principle given in (38). Whether reanalysis is effortless or not will therefore depend on whether or not a chain of local corrections will lead from the symptom to the error, and from there to the needed repair operations.

A rather different type of motivation for why some reanalysis operations might be more costly than others comes from considerations of the different

types of information involved in sentence comprehension. The HSPM does not work in a vacuum. This has two consequences for garden-path recovery.

On the one hand, the decisions of the HSPM will often depend on prior decisions, in particular lexical decisions; on the other hand, the decisions of the HSPM will affect later decisions, for example decisions regarding the semantic/pragmatic interpretation of a sentence. Revising a syntactic structure during reanalysis will therefore often have the consequence that other structures will have to be revised too. For example, when the initial syntactic structure has to be given up, the semantic structure that was computed on the basis of the initial syntactic structure almost always needs to be given up, too.¹¹ This opens up the possibility that—even if it should be easy to revise the syntactic structure as such—it might be difficult to revise structures outside of the HSPM. There are several proposals in the literature on the HSPM which claim that this is indeed the case. Among the non-syntactic types of information which have been claimed to hinder successful syntactic reanalysis are semantic representations (e.g., the SEMANTIC COST PRINCIPLE of Frazier and Clifton, 1998), prosodic representations (e.g., the PROSODIC CONSTRAINT ON REANALYSIS of Bader, 1998), as well as various aspects of lexical information (e.g., Ferreira and Henderson, 1991). According to these proposals—which do not exclude each other—apparent constraints on the HSPM’s reanalysis procedures might turn out to be illusory because the syntactic reanalysis procedures itself might not be constrained. What is constrained instead is the capability of adjusting non-syntactic structures in accordance with the syntactic revisions.

The last, but surely not the least, dimension of variation among reanalysis models that we will consider is given by the question in (Q8) (cf. Stevenson, 1998, for further discussion).

(Q8) What is the relationship between the mechanisms responsible for first-pass parsing and the mechanisms responsible for reanalysis?

At one extreme, there might be two completely distinct sets of mechanisms, one set devoted to the initial structuring of the input string, and a second one which only comes into play if the syntactic representation computed by the former set of mechanisms turns out to be false. At another extreme, there might be no difference at all between the parsing routines that are responsible for initial structuring and later repair. In between these two extremes, numerous parsing models are conceivable.

Question (Q8) is a particularly pressing one for the more general question as to what we can learn about the normal course of language comprehension from detailed investigations of how the HSPM recovers from garden-path analyses.

¹¹Sometimes, there are exceptions to this rule, like the famous *They are visiting relatives*.

Without going into any deeper discussion of this question, it seems fair to claim that the more reanalysis procedures draw from procedures needed anyhow for successful sentence parsing, the more we will be able to learn about normal syntactic analysis from investigations of how reanalysis works. While the relationship between first-pass parsing and second-pass parsing is ultimately a completely empirical matter, at the present stage of our knowledge we take it to be a useful guideline to be as parsimonious as possible when postulating special machinery for garden-path recovery.

7. Summary

This section has introduced a set of questions that should be answered by any comprehensive model of the HSPM. These questions are repeated below.

- (Q1) I Is the HSPM, considered as a whole, a module of the human mind?
- II Is the HSPM a single, uniform module, or is it composed of multiple modules?
- (Q2) Does the HSPM compute syntactic structures always in an incremental manner, or is incremental parsing restricted to certain types of syntactic structures?
- (Q3) I Does the HSPM pursue only a single analysis at a time, or does it pursue more than a single analysis in parallel?
- II Does the HSPM compute fully specified syntactic structures, or does it compute structures that are to some extent underspecified?
- (Q4) What information does the HSPM use in establishing an initial syntactic analysis, and how?
- (Q5) Is (part of) the original CPPM simply discarded after encountering the disambiguating word, such that new structure has to be built up from scratch, or is it kept as far as possible and only altered where necessary in order to overcome the garden-path?
- (Q6) Do differences in garden-path strength follow from constraints on diagnosis or from constraints on cure?
- (Q7) What are the reasons for the constraints on reanalysis?
- (Q8) What is the relationship between the mechanisms responsible for first-pass parsing and the mechanisms responsible for reanalysis?

A survey of the questions listed above might suggest that we have given unduly weight to the processes of second-pass parsing. Whether this is so or not, we believe, will ultimately depend on the answer given to question (Q8). If there is

a substantial overlap of processes involved in first-pass parsing and processes involved in second-pass parsing, examining processes of second-pass parsing will also further our understanding of processes of first-pass parsing, and the imbalance present in the list of questions given above will turn out to be only an apparent one.

In the chapters to follow, we will develop a model of the linking and checking procedures within the HSPM, with syntactic function ambiguities as they are found in German as our domain of investigation. The success of this model will depend on whether it will be able to answer the above questions in a satisfactory way.

Chapter 3

WORD ORDER AND CASE IN GERMAN

1. Introduction

This chapter presents the syntactic background for the chapters to come. We will concentrate on those aspects of German syntax that play a role in the experiments as well as in the theoretical argumentation about sentence parsing. The chapter will first develop a sketch of German clause structure and its rather free word order (in comparison with English). The chapter will then capitalize on two important aspects of the licensing of Case which build on the classical distinction between structural and inherent (or lexical) Case, but will take a closer look at Case morphology than is usually done. We will argue that the so-called “structural” Cases nominative and accusative are not positionally licensed by functional heads such as AgrS (for subject agreement) and AgrO (for object agreement), but agree with corresponding features of the inflected transitive verb under a local agreement relation. The so-called “inherent” Cases dative and (verbally selected) genitive cannot enjoy a similar formal agreement relation. They have to import their own functional structure into the derivation. We will show that Case morphology is the morphological exponent of this licensing, and that its syntactic side is a Kase Phrase (KP) which dominates DP/NP.

The chapter is organized as follows: Section 2 presents some key features of German clause structure. In section 3 we take a closer look at word order below the CP-level and the factors by which it is determined. In section 4 we turn to an examination of the morphological side of Case and the syntactic consequences which follow. This last section contains various morphosyntactic arguments in favor of the KP-hypothesis. Section 5 contains a conclusion.

2. Key Features of German Clause Structure

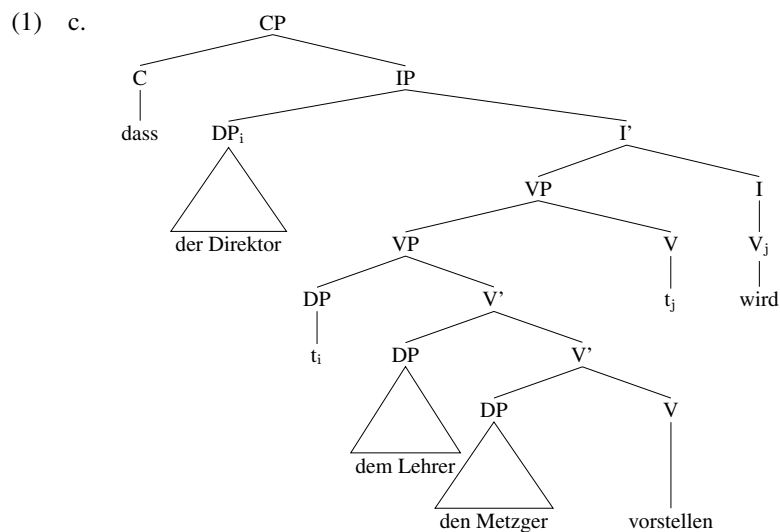
To start, we will discuss certain central syntactic properties of German which highlight differences with the language that has received most attention in both syntactic theory and psycholinguistics: English. These properties are: Basic word order, morphologically signaled Case, linearization of arguments, the absence of a formal subject requirement, and radical verb-second in root clauses.

2.1 Verb-Final Order

Consider first the difference between (1-a) and (1-b):

- (1) a. that the director **will**₁ **introduce**₂ the butcher to the teacher.
 b. dass der Direktor dem Lehrer den Metzger **vorstellen**₂ **wird**₁.

While English follows a strict head-complement order, German has—at least partially—complement-head order, as one can see in (1-b) where the complements precede the verb, and the VP precedes the auxiliary. Following earlier standard assumptions about clause structure for expository reasons, the phrase structure of (1-b) will then be as in (1-c).



This structure is maximally similar with what one can assume about (1-a), but it is—apart from the complementizer (C) and the subject (the specifier of I)—its mirror image. Similar differences in the basic order of constituents also appear in other constructions, e.g. in APs and certain PPs, but German is far from being

a radical head-final language like, for instance, Japanese; for instance, CP is invariably head-initial.

2.2 Morphological Case

One can observe in (1) that German has morphological Case marking on each of the DPs, while English lacks such signals (with the exception of pronouns where nominatives and non-nominatives are still distinct). Morphological Case allows the assignment of grammatical functions like SUBJECT, DIRECT OBJECT, INDIRECT OBJECT without reference to a specific position in the phrase marker. Its presence seems to be tightly connected to the variable linearization of arguments found in German. Before turning to this property in the next section, we want to draw attention to the fact that the Case paradigm is deficient in German too. Tables 3.1 and 3.2 for the paradigms of masculine (*Mann* ('man'), *Professor* ('professor')), neuter (*Kind* ('child'), *Mädchen* ('girl')) and feminine (*Frau* ('woman')) DPs give an impression to what extent this is true:

Table 3.1. Case paradigm of singular definite DPs

	<i>Masculine</i>	<i>Neuter</i>	<i>Feminine</i>
Nominative	der Mann / Professor	das Kind / Mädchen	die Frau
Genitive	des Mannes / Professors	des Kindes / Mädchens	der Frau
Dative	dem Mann(e) / Professor	dem Kind(e) / Mädchen	der Frau
Accusative	den Mann / Professor	das Kind / Mädchen	die Frau

Table 3.2. Case paradigm of plural definite DPs

	<i>Masculine</i>	<i>Neuter</i>	<i>Feminine</i>
Nominative	die Männer / Professoren	die Kinder / Mädchen	die Frauen
Genitive	der Männer / Professoren	der Kinder / Mädchen	der Frauen
Dative	den Männern / Professoren	den Kindern / Mädchen	den Frauen
Accusative	die Männer / Professoren	die Kinder / Mädchen	die Frauen

The N-paradigm is clearly deficient. With the dative *-e* having disappeared in most varieties, only masculine and neuter singular nouns retain the genitive *-(e)s*. In the plural it is the *-n* which, in the masculine and neuter paradigm, distinguishes datives from the rest, but even this is not visibly/audibly the case in all the paradigms as shown by *Professoren* and *Mädchen*. As one can see, morphological Case is spelled out at the determiner. But even there, only

the masculine singular has a perfectly distinct series. In all the other cells, nominative and accusative have collapsed into one form, and in the feminine singular genitive and dative have collapsed too. The ambiguity that emanates from this system leaves remarkable traces in German syntax as we will show later on. The existing Cases are the result of a long history which may have imposed a small amount of idiosyncrasy. One can show, however, that the existing morphological Cases match the system of syntactic Case licensing quite perfectly in an expected direction, as will become clear in the course of this chapter.

2.3 Linearization of Arguments

While permutation of the DPs in an English sentence like (1-a) leads to changes in the sentence's truth conditions, this is not true in German. This is clearly due to the fact that the overt Cases allow the determination of the DPs' grammatical function without reference to its exact position in the phrase marker.

- (2) that the butcher will introduce the director to the teacher. (\neq (1-a))
- (3) a. dass den Metzger_{ACC} der Direktor_{NOM} dem Lehrer_{DAT}
vorstellen wird.
b. dass dem Lehrer_{DAT} der Direktor_{NOM} den Metzger_{ACC}
vorstellen wird.
c. dass dem Lehrer_{DAT} den Metzger_{ACC} der Direktor_{NOM}
vorstellen wird.
d. dass den Metzger_{ACC} dem Lehrer_{DAT} der Direktor_{NOM}
vorstellen wird.

Although (3a-d) deviate from (1-b) in information structure and thus in the pragmatic applicability of the sentences in discourse, they all share with the "normal" order in (1-b) the grammatical functions of their arguments and therefore elementary truth conditions ("who did what to whom"). Thus, German allows for reorderings of arguments which have become known as SCRAMBLING since Ross (1967). We assume (without argumentation) that scrambling is achieved by leftward movement within the (extended) verbal projection, that this movement has characteristics of A-movement ("NP-movement"), but is not Case-driven. Since the grammar of German permits the realization of Case in arbitrary positions of the verbal projection (unlike suggested by the tree in (1-c), which will be revised), scrambling can be used by the grammar to serve information packaging. According to Haider and Rosengren (2003), scrambling is not triggered in the sense of feature checking. The trigger for scrambling lies outside of grammar proper. Perhaps due to its head-final VP and its (still operative) morphological Case system, the grammar permits seemingly optional

leftward movement in the bonds of the verbal projection.¹ This movement option is quite obviously exploited by the system to evacuate the focus domain which places the pitch accent as late as possible to the left of the verb. We will discuss the interaction of word order and focus in section 3.4.

We will not discuss indefinite DPs, but since Diesing (1992) and related work it is widely known that scrambling of indefinites yields semantic distinctions too. Thus, the conclusion seems to be justified that scrambling is an option of German grammar that is used by the semantic/pragmatic interface but which itself does not follow independent, grammar immanent mechanisms of feature checking.

2.4 Non-existence of a Formal Subject Requirement

Another important feature of German that seems to be connected to the head-final organization of its VP is its non-insistence on a formal subject. English (being a “non-pro-drop language”) insists on a phonetically expressed subject which is the highest argument in the clause, definable in phrase structural terms like “the DP which is a left sister of VP” or “argument which is immediately dominated by S”. If the referential subject is missing, English has to use an expletive as shown in (4-b).

- (4) a. A man was in the garden.
b. There was a man in the garden.

Although German clauses usually show an overt (nominative) subject too, there is no formal requirement for the presence of a subject. (5) shows sentences in which no subject is present:

- (5) a. dass dem Mann schlecht wurde.
that the man-DAT bad became
'that the man started feeling nauseated.'
b. dass den Mann friert.
that the man-ACC freezes
'that the man is cold.'
c. dass getanzt wurde.
that danced was
'that there was dancing going on.'

While for many speakers (5-a) and (5-b) can also be articulated with the pronoun *es* ('it') after *dass*, this option is not allowed in the impersonal passive clause in

¹One should notice that scrambling in terms of leftward movement is not uncontroversial. Especially within the Minimalist Program it is unclear which features should trigger displacement (cf. Fanselow, 2002), but empirical problems have already been uncovered within the GB-framework (cf. Bayer and Kornfilt, 1994).

(5-c). Furthermore, there is no evidence that *es* would function as an expletive like English *there*. While linguists have occasionally argued for the presence of an “empty expletive” in German, the present assumption is that the requirement of an overt subject is not part of Universal Grammar, and that languages have the choice of not insisting on a formally designated subject position.

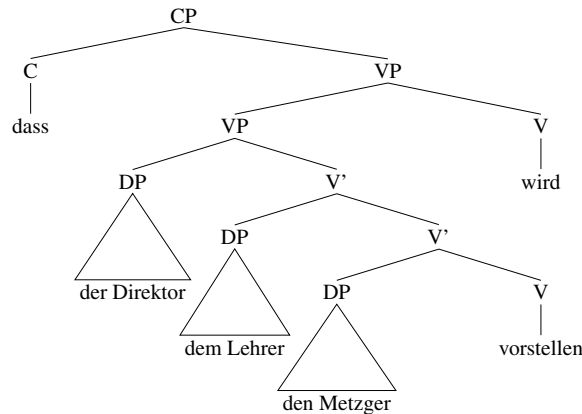
The fact that there is no formally defined subject position is related to the fact that German allows nominative subjects “out of place” even in unscrambled sentences. All other things being equal, sentences with experiencer objects often show the order object < subject as the unmarked order. This is especially true if the non-nominative experiencer argument is +human, and the nominative stimulus argument is –animate:

- (6) a. dass die Kritiker der Film gelangweilt hat.
 that the critics-ACC the movie-NOM bored has
 ‘that the movie has bored the critics.’
 b. dass den Kritikern der Film gefallen hat.
 that the critics-DAT the movie-NOM pleased has
 ‘that the movie has pleased the critics.’

Although the nominative DP is a formal subject as shown by singular agreement with the finite verb, this subject is not the highest argument in the clause as its nearness to the verb indicates. Sentences like (6-a) and (6-b) display basic order and must be distinguished from sentences in which the arguments have been re-arranged by scrambling. This shows that the German subject is independent of a certain position, a fact that German shares with many other SOV-languages.

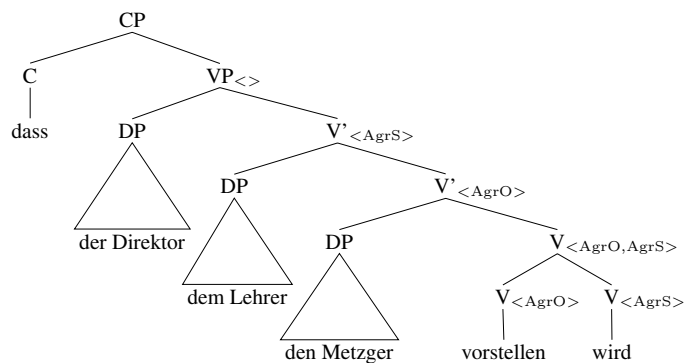
While English has a specifier position associated with I^0 which contains the subject or an expletive, or in certain marked cases a locative PP (e.g. *Into the room danced a beautiful girl*), German seems to lack such a position altogether. This is but one indication among various others which we cannot reproduce here that German (and perhaps OV-languages in general) does not project I^0 in the sense of a syntactic \bar{X} -projection. In this case, no designated SpecIP-position will be created, and the nominative subject can be attached anywhere to the left of V. The correspondent of I is then not a category which projects the familiar \bar{X} -projection, but rather something like a feature on the verb which can be checked anywhere within the projection of V (cf. Bayer, 2004, for more details and further references). The tree in (1-c) should therefore be abandoned in favor of the tree in (1-d), a representation in which there is no IP in the sense of \bar{X} -theory but just a finite VP which includes the subject (the “external argument”) as well as the objects (“internal arguments”):

(1) d.



In (1-d), the structural Case of the objects is licensed by being in the projection of a transitive verb. For the subject to be Case-licensed, the nominative DP (*der Direktor*) would have to raise into the domain of the finite verb. Notice, however, that next to (1-d) there is another analysis in which the two verbs form a verbal complex: [*vorstellen wird*]. There is evidence that the order shown in (1-d) surfaces such that the two verbs are reanalyzed as a verbal complex. A verb cluster of this sort can be generated by head recursion or derived by head-movement from a structure such as (1-d). Quantitative and behavioral data (cf. Schmid et al. (in press) and Bayer et al. (2005)) suggest that the formation of a verb cluster does not involve computational steps that map a structure such as (1-d) onto a simpler structure such as (1-e) where the two verbs form a complex (for a defense of base-generating the verbal complex cf. Haider (1993)).

(1) e.



In (1-e), Case checking is symbolized as removal from a list of features associated with the V-cluster $V_{\langle \text{AgrO}, \text{AgrS} \rangle}$ as the Case-bearing DPs are attached. $\text{DP}_{\langle \text{ACC} \rangle}$ removes the feature $\langle \text{AgrO} \rangle$, and $\text{DP}_{\langle \text{NOM} \rangle}$ removes the feature $\langle \text{AgrS} \rangle$. The subject-DP is in the projection of the V-cluster. Technically it is m-commanded by the feature $\langle \text{AgrS} \rangle$ with which it undergoes agreement. The definition of M-COMMAND is given in (7).²

(7) *M-Command*

X m-commands YP iff the m(aximal) projection of X dominates XP

It is also important to see that the attachment of $\text{DP}_{\langle \text{DAT} \rangle}$ leaves the formal features of the verb(-cluster) unaffected, although the argument structure of the verb *vorstellen* is satisfied at this point. There is no “indirect object”-feature $\langle \text{AgrIO} \rangle$ associated with the verb, as various researchers have suggested. Thus, the indirect object is formally speaking like an adjunct, whereas it is argumental with regard to the argument structure of *vorstellen*. The reason for this rather important aspect of the analysis will become clear in section 4 when we turn to the Case properties of German DPs.

(1-e) is not the only tree that can be generated. As one will see in the next section, V-projections of different size like *den Metzger vorstellen* (‘the butcher-ACC introduce’) or *dem Lehrer den Metzger vorstellen* (‘the teacher-DAT the butcher-ACC introduce’) must be possible constituents. (1-e) does not express this. But there is no reason why the infinitival verb could not project verbal projections of this kind. Thus, the possibility of projecting (1-e) should not be seen as blocking a projection like (1-d) in which the lexical verb is allowed to form V-projections of different sizes.

2.5 Verb Second

So far we have looked at German embedded clauses. Root clauses show the “verb second” (V2) phenomenon, which also exists in English, but only in limited constructions such as non-subject questions and certain other contexts which have initially become known as “subject-aux-inversion” constructions. German V2 appears with high regularity, i.e. it is independent of special constructions. The finite verb undergoes movement to the position which is otherwise filled with the complementizer. In declaratives and wh-questions a constituent, not necessarily the subject, moves to the left of the verb. Sentence (1-b), which is repeated as the first line in Table 3.3, can be permuted as shown in the (non-exhaustive) Table 3.3; Table 3.4 shows wh-clauses.³

²Further empirical motivation for m-command comes from, e.g., negative polarity licensing; cf. Bayer (2001).

³We represent the examples as suggested by the model of topological fields since Erdmann (1886), Drach (1937), and Boost (1964). A more recent evaluation of this model can be found in Hölle (1986).

Table 3.3. Selected permutations within a declarative clause

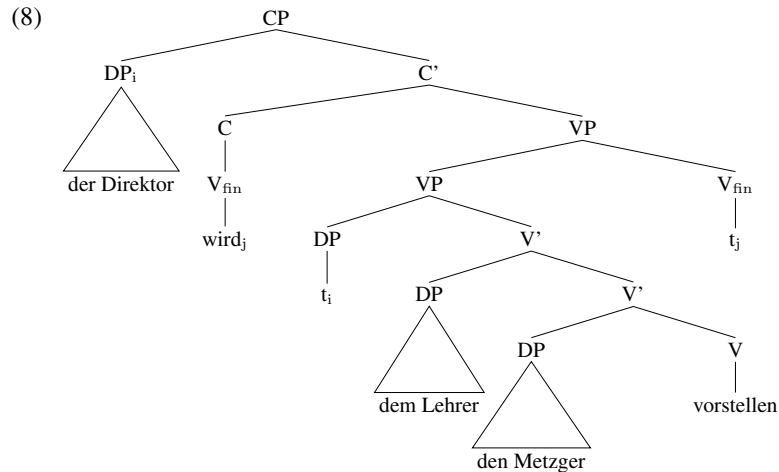
SpecCP	C ⁰	Middlefield			V
	dass	der Direktor	dem Lehrer	den Metzger	vorstellen wird
	Wird	der Direktor	dem Lehrer	den Metzger	vorstellen
Der Direktor	wird	—	dem Lehrer	den Metzger	vorstellen
Dem Lehrer	wird	der Direktor	—	den Metzger	vorstellen
Den Metzger	wird	der Direktor	dem Lehrer	—	vorstellen
Den Metzger	wird	der Direktor	dem Lehrer	—	—
vorstellen					
Dem L. den M.	wird	der Direktor	—	—	—
vorstellen					
Vorstellen	wird	der Direktor	dem Lehrer	den Metzger	—

Table 3.4. Selected permutations within a Wh-clause

SpecCP	C ⁰	Middlefield			V
Wer	wird	—	dem Lehrer	den Metzger	vorstellen
Wem	wird	der Direktor	dem Lehrer	den Metzger	vorstellen
Wen	wird	der Direktor	dem Lehrer	—	vorstellen

As shown in these tables, not only non-subjects move in front of the finite verb but also subjects. This is another indication that the German subject lacks a designated VP-external position—as it does in English—and is more on a par with objects in terms of phrase-structure positions. Thus, we will follow the traditional assumption of a uniform CP-structure for root clauses and embedded V2-clauses. For a sentence with a fronted subject (third line in Table 3.3), we will then have the structure in (8) shown on page 58.

The structure in (8) suggests that V_{fin} is substituted for C. There is some evidence that this is indeed true. The labels C, C' and CP are conventional shorthands for a more elaborate feature structure according to which the fronted finite verb activates illocutionary force and as such is able to turn the clause into an utterance that can be semantically linked to the surrounding context and discourse (cf. Wechsler, 1991, and various contributions in Lohnstein and Trissler, 2004).



3. Word Order below CP

3.1 The Verbal Projection

In an OV-language like German the verbal projection is usually expanded by merging to the left of the verb which leads to a hierarchical right-branching tree. The core assumption is that VP contains the subject, but also that the subject is not separated from the other arguments by a specific position as it is the case in English. Thus, while being in an agreement relation with the finite verb, the subject does not have positionally rooted privileges. What then is responsible for the fact that in German—as in English—the subject is nevertheless very often the highest or “external” argument?

3.2 Argument Structure and Unmarked Word Order

We follow the standard assumption that the lexical-semantic structure of the verb determines its argument structure, and that the argument structure must be projected in syntax (cf. Grimshaw, 1990; Levin and Rappaport Hovav, 1995; Levin and Rappaport Hovav, 2005). To begin with the simplest cases, let us first consider intransitive and transitive agentive verbs such as *tanzen* (‘to dance’) and *besuchen* (‘to visit’). These have an external nominative argument with an

agentive thematic role. Ignoring aspectual properties, their argument structures are as in (9-a) and (9-b) respectively:⁴

- (9) a. tanzen: DANCE (x)
 b. besuchen: VISIT (x, y)

Linking the only DP that is licensed by (9-a) is trivial. Since there is no second argument, and since no Case diacritics appear, the DP will be projected as the external argument, will undergo agreement with the finite verb and thus be realized as a nominative subject. If we consider (9-b) to be a semantic representation with two unsaturated arguments, i.e. $\lambda y \lambda x \text{ VISIT } (x, y)$, linking the two DP arguments proceeds “from inside to outside”, i.e. there must first be an inner argument that replaces the y-variable. Since no diacritic appears in (9-b) either, this DP must bear structural object Case, the structural Case for objects being the accusative in German. The semantics of *besuchen* declares the object to be something like a goal. The x-variable is replaced by a DP which receives the remaining structural Case, which is the nominative. This argument must be a volitional agent.⁵

Given that German, unlike English, does not have a configurational (nominative) subject position, what determines the linearization of the verb’s arguments? Recall the examples in (6) which showed DAT/ACC < NOM as the unmarked, i.e. non-scrambled, ordering of arguments. There are two factors which play a decisive role, and which are not entirely distinct. One consists of a number of semantic constraints according to which, all other things being equal, animate arguments precede inanimate arguments, human arguments precede non-human arguments, and volitional arguments precede non-volitional arguments.⁶ The other is given by the θ -hierarchy.

- (10) Conceptual semantic constraints on word order
 a. +animate \ll –animate
 b. +human \ll –human
 c. +volitional \ll –volitional
- (11) θ -Hierarchy (according to Jackendoff, 1990: 258)
 actor \ll patient/beneficiary \ll theme \ll location/source/goal

⁴For reasons of space, we cannot enter into a serious discussion of the vast literature on the mapping from (verb) semantics to argument structures; for a thorough overview of this topic, see Levin and Rappaport Hovav (2005).

⁵Sentences like *Die Pest besuchte Paris* (‘The plague visited Paris’) are highly deviant, but sentences like *Die Katze meines Nachbarn besuchte meinen Garten* (‘My neighbour’s cat visited my garden’) are only slightly less awkward.

⁶Important works discussing such constraints in detail are Lenerz (1977), Hoberg (1981), Uszkoreit (1987), among others. A recent discussion of the relevant regularities in the framework of Optimality Theory can be found in Müller (1999).

Consider now the two examples in (12).

- (12) a. Der Arzt besucht das Museum.
 the doctor-NOM visits the museum-ACC
 b. Der Arzt besucht den Kranken.
 the doctor-NOM visits the patient-ACC

Given the semantics of the verb *besuchen* (“x acts such that y enjoys x’s company”) and the two DPs in (12-a), it is predicted by (10-a) that the inanimate DP has to be linked to the inner or “lower” position, while the animate DP has to be linked to the external or “higher” position. The other conditions are vacuously satisfied. The θ -hierarchy does not have to be referred to at all. In (12-b) there are two arguments which are equally animate, human and potentially volitional. The θ -hierarchy determines, however, that the goal-role should be linked to the inner argument and the actor-role should be linked to the external argument. Sentences like *dass den Kranken der Arzt besucht* (“that the patient-ACC the doctor-NOM visits”), which are fully grammatical in German, do not represent the order of constituents that is directly projected from argument structure. In this case, the arguments must have been reordered by a movement operation.

Consider next experiencer verbs with only one argument such as those in (5): *frieren* (“to feel cold”), *schlecht sein* (“to feel nauseated”), *grauen* (“to be disgusted”), etc. Linking is trivialized by the fact that these verbs take only one argument, but this argument needs to be marked with a Case diacritic because it does not bear nominative.

- (13) a. frieren: FEEL-COLD (x)
 |
 ACC
 b. grauen: BE-DISGUSTED (x)
 |
 DAT

Similarly, there are agentive verbs like *helfen* (“to help”) and *gedenken* (“to remember”) which closely resemble verbs like *besuchen* (“to visit”), but require a diacritic for the Case of their object. These verbs are transitive in the sense that they license a nominal object, but this object is a dative or genitive object instead of a direct accusative object:

- (14) a. helfen: HELP (x, y)
 |
 DAT
 b. gedenken: REMEMBER (x, y)
 |
 GEN

The Case of the object argument is not predictable and must be mentioned in the lexical entry. *Helfen* is normally associated with a human actor role for *x*, but this is not necessarily the case. In *Das Medikament hat dem Kranken geholfen* ('The medicine_{NOM} helped the patient_{DAT}') the subject is a non-human agent. The dative-DP bearing a beneficiary role, the θ -hierarchy predicts NOM < DAT order. This is in conflict with the constraints expressed by (10-a) and (10-b). Given this conflict, it is not surprising to observe that reversal of the two DPs as in *Dem Kranken hat das Medikament geholfen* is not only possible, but does not seem to induce a difference in markedness. We will see similar effects shortly in experiencer constructions.

Consider next ditransitive verbs like *geben* ('to give'), *schicken* ('to send') etc. These verbs show the order NOM < DAT < ACC. As Wegener (1985), Czepluch (1996), Wunderlich (1997) and others have shown, the appearance of the dative in ditransitives is to a large extent predictable. They have argued that dative is a structural Case on a par with the accusative.⁷ For reasons of simplicity we will not elaborate on this and simply assume here that the dative is nevertheless marked on the beneficiary argument. Thus the argument structure of *schicken* would be as in (15-a). If *schicken* is confined to direct physical transfer, the beneficiary argument can be replaced by PP (headed by *zu* or *an*) with a goal interpretation. This is expressed in (15-b).

(15) a. *schicken*: SEND (*x*, *y*, *z*)

|
DAT

b. *schicken*: SEND (*x*, *y*, *z*)

|
PP_{zu/an}

The order NOM < DAT is predicted by the θ -hierarchy. Since the indirect object is always a person (or at least an institution which is run by humans), and the direct argument is often –animate, the order DAT < ACC is expected. If the direct argument is +human as in *Wir schickten dem Chirurgen die Kranken-*

⁷The key argument is the existence of the so-called *bekommen/kriegen* ('to get') passive which seems to involve dative absorption and promotion of the indirect argument to subject.

(i) Wir haben dem Opa ein Buch geschickt
we-NOM have the grandfather-DAT a book-ACC sent
'We sent grandfather a book'

(ii) Der Opa bekam/kriegte ein Buch geschickt
the grandfather-NOM got a book-ACC sent
'Grandfather was sent a book'

For arguments against (ii) being a genuine passive construction and against dative being a structural Case in general, cf. Bayer et al. (2001) and Vogel and Steinbach (1995).

schwester ('we sent the surgeon_{DAT} the nurse_{ACC}'), the θ -hierarchy predicts that the beneficiary argument is merged after the theme argument has been merged.

German has a small number of ditransitives whose basic order deviates from this in the sense that the two inner arguments are reversed.

- (16) a. Man hat die Pflanzen / die Kinder der Kälte
 one-NOM has the plants-ACC / the children-ACC the cold-DAT
 ausgesetzt.
 exposed
 'One has exposed the plants/the children to the cold.'
- b. Man darf die Kinder nicht der eigenen Panik
 one-NOM must the children-ACC not the own panic-DAT
 ausliefern.
 relinquish
 'One must not relinquish the children to their own panic.'
- c. Ich werde sie den beiden nicht ausliefern.
 I-NOM will her-ACC the both-DAT not relinquish
 'I will not relinquish her to the two of them.'

In each of these cases, the dative argument, be it animate or not, bears the role of a goal, while the accusative argument has a theme role. These examples show that there cannot be an automatic identification of dative with a beneficiary role. The difference with (15) is that the Case diacritic appears on the hierarchically lowest argument as shown in (17).

- (17) aussetzen: EXPOSE (x, y, z)
 |
 DAT

Let us finally consider experiencer verbs. According to Grimshaw (1990: 41) there are three kinds: (i) psychological state verbs like *gefallen* ('to please'), *interessieren* ('to interest'); (ii) psychological causative verbs; (iii) psychological agentive verbs. The latter two classes are represented by verbs like *erschrecken* ('to frighten'), *stören* ('to disturb/annoy'), *nerven* ('to get on one's nerves') *langweilen* ('to bore') etc. Their English correspondents can be construed with a theme subject or an agentive subject. (*The building frightened the tourists* or *John frightened the tourists*). Let us here follow Jackendoff (1990) who would distinguish (ii) and (iii) simply by speaking of human and non-human actors. For Jackendoff, the experiencer is something like a goal or location. Following the majority of researchers, we assume a separate experiencer role which is ordered below the actor and above the theme role. This replaces (11) by (18).

- (18) *θ*-Hierarchy (revised version)
 actor ≪ patient/beneficiary/experiencer ≪ theme
 ≪ location/source/goal

Considering state verbs first, we observe that they may require a Case diacritic, as in (19-a), or not, as in (19-b).

- (19) a. gefallen: PLEASE (x, y)
 |
 DAT
 b. interessieren: INTEREST (x,y)

We would like to stress that there is no principled reason to align DAT with the external argument. In sentences like *Dem Opa hat das Buch gefallen* ('the grandfather_{DAT} pleased the book_{NOM}') the +human experiencer would be ordered before the –animate theme (or rather stimulus) argument. Once a +human theme/stimulus argument is chosen, as in *Dem Opa hat die Besucherin gefallen* ('the grandfather_{DAT} pleased the visitor_{NOM}'), things become less clear. Both orderings appear to be possible as unmarked orderings. Thus, *Die Besucherin hat dem Opa gefallen* does not seem to be based on an analysis in which topicalization to SpecCP would necessarily be preceded by a scrambling operation. If correct, this means that the experiencer and theme/stimulus are not far apart from each other in the thematic hierarchy such that both orders can be projected from the argument structure directly. The same holds for *interessieren*. The human experiencer, which is here represented by a DP with accusative Case, precedes a non-human theme/stimulus which bears nominative Case. No particular ordering preference results in cases where the theme/stimulus role is likewise +human.

Consider finally the class of psych-verbs which allow for both a human and a non-human agent. If the subject is associated with a human and therefore volitional agent, the unmarked order is rather clearly NOM < ACC. If the agent is non-volitional, the experiencer tends to be ranked higher, which means that the notion 'actor' in (11)/(18) should be understood as 'volitional actor'. If the agent is inanimate, i.e. if it is a mere stimulus, the +human experiencer is ranked higher more clearly. These facts are illustrated in the following examples.

- (20) a. dass die Kinder den Opa gestört / genervt
 that the children-NOM the grandfather-ACC annoyed / nerved
 haben.
 have
 'that the children annoyed grandfather / got on grandfather's nerves.'

- b. dass den Opa die Kinder gestört / genervt
 that the grandfather-ACC the children-NOM annoyed / nerved
 haben.
 have

Although both sentences are equally unmarked, there is a subtle but clear difference: The nominative subject is interpreted as volitional in (20-a), whereas it tends to be interpreted as non-volitional in (20-b). The children tend to be perceived as evil-doers in (20-a) and as involuntary trouble-makers in (20-b). This impression is supported by the pair in (21).

- (21) a. dass die Fliegen den Opa gestört / genervt haben.
 that the flies-NOM the grandfather-ACC annoyed / nerved have
 'that the flies annoyed grandfather / got on grandfather's nerves.'
 b. dass den Opa die Fliegen gestört / genervt haben
 that the grandfather-ACC the flies-NOM annoyed / nerved have

Since normally flies are non-volitional agents, the order in (21-b) tends to be perceived as basic. This tendency is strengthened, if the agent is inanimate as in (22).

- (22) a. dass die Gemälde den Opa gestört / genervt
 that the paintings-NOM the grandfather-ACC annoyed / nerved
 haben.
 have
 'that the paintings annoyed grandfather / got on grandfather's nerves.'
 b. dass den Opa die Gemälde gestört / genervt
 that the grandfather-ACC the paintings-NOM annoyed / nerved
 haben.
 have

These interpretations have a reflex in passive constructions. Only the volitional agentive use of these verbs is fully normal. Animate but non-volitional agents lead to a slight degradation. Inanimates are extremely awkward.⁸

- (23) a. dass der Opa von den Kindern gestört / genervt
 that the grandfather-NOM by the children annoyed / nerved
 wurde.
 was
 'that grandfather got annoyed / disturbed by the children.'
 b. ?dass der Opa von den Fliegen gestört / genervt wurde.

⁸Thanks to Ellen Brandner for discussion of these facts.

- c. *dass der Opa von den Gemälden gestört / genervt wurde.

The reason for this cline in grammaticality is unlikely to rest on the particular choice of the non-experiencer argument, but rather on aspectual properties. (23-a) is clearly eventive, and (23-c) is clearly non-eventive. (23-b) is somehow “in-between”, perhaps with a tendency to be viewed as non-eventive.

Given these facts, there seems to be no reason to accept the distinction between “psychological causative verbs” and “psychological agentive verbs” as suggested by Grimshaw (1990) for German. They share the same argument structure which is simply as shown in (24).

- (24) a. stören: ANNOY (x,y)
 b. nerven: GET-ON-THE-NERVES-OF (x, y)

The burden of linking DPs to these argument structures rests on the variable interpretation of the non-experiencer. The non-experiencer can be a volitional human actor or a non-volitional human or non-human actor or simply an inanimate stimulus. This choice has consequences for the semantic constraints in (10) and perhaps further consequences for the aspectual interpretation but has nothing to do with argument structure per se.

As work like Lenerz (1977), Hoberg (1981), Uszkoreit (1987) and others has made clear, there are pervasive influences of semantic constraints on word order in German. Since German does not rely on a fixed position for the nominative subject as English does, the effect of these constraints can be observed rather directly. Interestingly, even purely agentive verbs like *stechen* (‘to pinch/sting’) may differ in their ordering preferences according to the choice of arguments, depending on volitionality. Lenerz (1977) has observed that even though German is a free word order or scrambling language, a non-specific indefinite object cannot usually scramble over a definite subject as shown in (25-b). The contrast seen in (25) disappears in (26).

- (25) a. dass die Lehrer ein Kind gelobt haben.
 that the teachers-NOM a child-ACC lauded have
 ‘that the teachers lauded a child.’
 b. *dass ein Kind_i die Lehrer t_i gelobt haben.
- (26) a. dass die Bienen ein Kind gestochen haben.
 that the bees-NOM a child-ACC stung have
 ‘that the bees stung a child.’
 b. dass ein Kind die Bienen gestochen haben.

Sentence (26-b) is grammatical under the interpretation that the subject is a non-volitional agent. Given that bees are normally not considered volitional agents, this condition is fulfilled. The absence of a scrambling effect as in

(25-b) suggests that the order in (26-b) is a possible base order.⁹ A number of tests which cannot be presented here provide independent support for this conclusion.

To sum up, what counts as “unmarked order” in German is the result of the verb’s argument structure in interaction with the nature of the selected arguments. These are ranked in hierarchies which are partially captured by the θ -hierarchy and partially by semantic constraints concerning animacy, humanness and volitionality. If in German the nominative subject often happens to be the highest or “external” argument, this is a consequence of the frequency of certain verbs and the semantic nature of the arguments which are licensed by it. Unlike in English, the Case system is clearly not responsible for the observed order.¹⁰

Our observations about argument structure and word order agree straightforwardly with the evidence that in German Case can be licensed/checked anywhere in the local domain of the projection of the verb. This also has important consequences for argument changing operations such as passivization. The classical GB-explanation assumes an oppression of accusative assignment which goes hand in hand with an oppression of the subject’s theta-role (“Burzio’s generalization”). In order to escape the Case-filter, the object DP has to raise to the (non-theta) subject position where it is assigned nominative Case. Given that nominative Case can only be realized positionally in English, whereas it can be realized anywhere in German, we expect differences between these two languages. In fact, there is no evidence for Case-driven NP-movement in German. Although passive shows the same reduction of argument structure and the same object-to-subject promotion as in English, there is no evidence that the object-DP leaves its place for this very reason. As a matter of fact, the relative word order of the active sentence is retained in the passive. Considering (1-b), which is repeated here as (27-a), we see that the verb changed from the bare infinitive to the past participle which is selected by the passive auxiliary *werden*. After the suppression of the subject role, there are two ways in which the passive sentence can surface. These are given in (27-b).

⁹The semantic properties that in a particular language may constitute a volitional agent or not seem to rest on folk ontology and folk psychology. In German, for example, dogs would be more prototypical and therefore more volitional agents than bees. Thus, replacing in (26) *die Bienen* with *die Hunde* (‘the dogs’) and *stechen* with *beißen* (‘to bite’) will lead to the expected scrambling effect (**dass ein Kind die Hunde gebissen haben* (‘that a child_{ACC} the dogs_{NOM} bitten have’). Cf. Fanselow (2002) for related observations and discussion of differences between experiencer and agentive constructions with respect to human and non-human agents.

¹⁰We assume that the hierarchies which play a role in our discussion are universal. If so, they have to be active in English as well. Due to its impoverished Case system, English is forced to externalize the nominative in violation of these universal constraints. Since there is no morphological reflex of nominative Case, it must be signaled positionally.

- (27) a. ACTIVE:
 dass der Direktor dem Lehrer den Metzger vorstellen wird.
 b. PASSIVE:
 (i) dass dem Lehrer-DAT der Metzger-NOM vorgestellt wird.
 (ii) dass der Metzger-NOM dem Lehrer-DAT vorgestellt wird.

If German followed the requirement of a positionally licensed subject (in SpecIP) as English does, we would expect only (27-b-ii) to be grammatical. This is not true, however. If there is a difference in markedness at all, the unmarked order of the passive version is the one in (27-b-i). We can assume that the DP *der Metzger* has not been moved at all and can check nominative Case exactly where it may check accusative Case in (27-a). The movement seen in (27-b-ii) is perhaps the result of scrambling, not the result of Case-driven NP-movement.

Given that both arguments in (27-b) are +human, and the difference between the roles of beneficiary and theme are not particularly strong, one may not easily detect a difference in markedness (effect of scrambling) between (27-b-i) and (27-b-ii). Such a difference can, however, be made visible rather easily, if the theme argument is –animate. A relevant example is shown in (28).

- (28) a. ACTIVE:
 dass der Direktor dem Lehrer das Buch zeigen wird.
 that the director the teacher the book show will
 ‘that the director will show the teacher the book.’
 b. PASSIVE:
 (i) dass dem Lehrer-DAT das Buch-NOM gezeigt wird.
 (ii) dass das Buch-NOM dem Lehrer-DAT gezeigt wird.

(28-a) shows the expected ordering with a difference between beneficiary- and theme-role which has been amplified by the animacy effect. This ordering is retained in (28-b-i) but is violated in (28-b-ii). Not surprisingly, the latter is a marked construction which typically results from scrambling.

Since verbs with different types of argument constructions as well as passive constructions will play a major role in the experiments to be reported later, it is important to keep these facts in mind.

3.3 Types of Arguments

The factually observed word order is, of course, not only the result of argument structure. Argument structure as given by the pure selection of lexical items may be changed according to requirements that are rooted in the discourse semantic system. We have already mentioned that definite DPs can scramble out of VP. This is even more true of weak or clitic pronouns. For most speakers, weak or clitic pronouns must be moved up to the C-position which is either filled by C itself or—in V2-clauses—by the finite verb. Consider as a reference model

the sentence *dass der Direktor dem Lehrer den Metzger vorstellen wird* and different replacements by a pronoun. Assuming that the pronoun is unstressed, the only permissible—or at least strongly preferred—orders are those shown in (29).

- (29) a. *dass er_i t_i dem Lehrer den Metzger vorstellen wird.*
 Wird er_i t_i dem Lehrer den Metzger vorstellen?
 b. *dass ihm_i der Direktor t_i den Metzger vorstellen wird.*
 Wird ihm_i der Direktor t_i den Metzger vorstellen?
 c. *dass ihn_i der Direktor dem Lehrer t_i vorstellen wird.*
 Wird ihn_i der Direktor dem Lehrer t_i vorstellen?

If the pronoun has head properties, the natural explanation for this movement (which is also known as “Wackernagel” movement according to Jacob Wackernagel’s generalization about atonic elements in Indo-European), would be that it moves to C, and that we are dealing here with an instance of head-to-head movement. On the other hand, pronouns refer to individuals whose existence and identity is known from the preceding discourse. As such they share certain discourse semantic properties with definite DPs for which there is evidence that they also move out of VP.

Definite DPs are positionally distinguished from non-specific indefinites. This can most easily be seen in examples with indefinites such as *was* or *etwas* (‘something’) or *wer / wen / wem* or *irgendwer / irgendwen / irgendwem* (‘someone’) which cannot receive a specific interpretation. Such indefinites must not scramble.

- (30) a. *dass der Direktor dem Lehrer (et)was gezeigt hat.*
 b. **dass der Direktor (et)was_i dem Lehrer t_i gezeigt hat.*
 c. **dass (et)was_i der Direktor dem Lehrer t_i gezeigt hat.*
- (31) a. *dass dem Lehrer (et)was aufgefallen ist.*
 b. **dass (et)was_i dem Lehrer t_i aufgefallen ist.*

If an indefinite precedes a definite DP according to the requirements of argument structure, the result is acceptable. Nevertheless, there is a tendency for the definite DP to scramble over the indefinite. This is shown in (32):

- (32) a. *?dass (irgend)wem das Buch aufgefallen ist.*
 b. *dass das Buch_i (irgend)wem t_i aufgefallen ist.*

Due to animacy, the order in (32-a) would be predicted, but in comparison with (32-b), (32-a) seems to be less preferred. The indefinite prefers to stay inside VP whereas the definite DP may scramble to some higher position.

The data suggest the existence of the following regions of which A is clearly outside VP and B and C may either be part of a layered VP or only C is in VP while B is a distinct topic region above VP:¹¹

(33)	A	B	C
	Clitic pronouns	definite DPs	Indefinites

Indefinites may be scrambled out of C, but then they receive either a specific interpretation or—under certain circumstances—a generic interpretation:

- (34) a. dass eine Strasse in München_i der Bauer nicht t_i finden konnte.
 that a street in Munich the farmer not find could
 ‘that the farmer could not find a certain street in Munich.’ (specific)
- b. dass eine Strasse in München_i der Bauer nicht t_i finden würde.
 that a street in Munich the farmer not finden would
 ‘that the farmer would not find any street in Munich.’ (generic)

Since semantic differences between definites and indefinites will not play an important role in the rest of our work, we will not provide any further details. For the semantic effects which are yielded by the placement of indefinites, cf. Carlson (1977), Diesing (1992), and following work.

Our brief consideration of pronominal, definite and indefinite arguments re-confirms the impression that the order of constituents is not guided by Case, but rather by (discourse-)semantic mechanisms which overlay the ordering imposed by argument structure. The Cases are in principle available anywhere along the verbal projection. Variation in the order of constituents is determined by argument structure and the semantics of information packaging.

3.4 Focus and Focus Projection

It was mentioned in section 3.3 that normal or unmarked word order as compared to scrambling or marked order has consequences for focus assignment. As expected, the pitch accent in German is assigned to the predicate. If the predicate is not as simple as in (35-a) below, the question is on which sub-constituent of the predicate the pitch accent falls. Consider the data in (35-b) and (35-c) where accent is symbolized by capital letters.

- (35) a. Ich glaube, dass der Direktor SCHLÄFT.
 I believe that the director sleeps
- b. Ich glaube, dass der Direktor den METZGER holt.
 I believe that the director the butcher fetches

¹¹Frey (2000) suggests a functionally defined topic position for German, but positional licensing in addition to the usual discourse requirements remains controversial; cf. Fanselow (2002).

- c. Ich glaube, dass der Direktor dem Lehrer den METZGER
 I believe that the director the teacher the butcher
 vorstellt.
 introduces

If there is a DP which can be focused (i.e. a DP unlike for example *etwas* ('something') which can never be focused), this DP will attract a pitch accent. If there is more than one such DP, as in (35-c), it will be the rightmost DP (or PP) which attracts pitch accent. We will not make any suggestion as to how stress is assigned in German and rather concentrate on its function.¹² The examples can be interpreted with narrow focus, but also with wide focus. With narrow focus, the semantic focus is essentially identical with the XP whose lexical head carries the pitch accent. With wider focus, the pitch accent is on the rightmost lexical exponent of a larger phrase, which, as we have said, is either the substantive verb, in case there is no preceding DP (or PP), or the rightmost object-DP (or PP) preceding the verb. The narrow focus construction can be tested by considering constituent questions which trigger one of (35) as suitable answers. The focus constituent corresponds to the variable which is bound by the *wh*-operator, i.e. the residual proposition counts as the background (the presupposition in the terminology of Chomsky, 1971, and Jackendoff, 1972; cf. Selkirk, 1994, for recent discussion).

- (36) a. Was tut der Direktor? - (35-a)
 what does the director
 b. Wen holt der Direktor? - (35-b)
 Who fetches the director
 c. Wen stellt der Direktor dem Lehrer vor? - (35-c)
 Who introduces the director (to) the teacher

Since the pitch accent can also be interpreted as the focus of a more inclusive phrase, the sentences in (35) can also count as answers to questions which presuppose less:

- (37) Was tut der Direktor? - (35-a), (35-b), (35-c)

Here the pitch accents in (35) correspond to foci which embrace the entire predicate. If the referents of the DPs are already familiar from the preceding discourse, sentences of this type can also answer questions with even less specific presuppositions:

¹²For earlier accounts, cf. Kiparsky (1966) and Höhle (1982). Different suggestions concerning the assignment algorithm have been made by Cinque (1993), Jacobs (1982), Selkirk (1984), von Stechow and Uhmann (1986), and others. Notice that not all SOV-languages seem to function alike. Hayes and Lahiri (1991) show that in Bengali it is the verb rather than the preceding DP which serves as the exponent of phrasal accent.

- (38) a. Was geschieht hier?
 what happens here
 b. Was geht hier vor?
 what goes here on
 c. Was ist hier los?
 What is here on

In this case, the entire answer presents novel information. We can assume that the focus projects up to the entire (extended) verbal projection which, as we have argued, includes the subject. As Höhle (1982) has pointed out, and as we have shown with the examples above, this is the structure that can be used in the maximum number of context types. It corresponds with what speakers in general perceive as the “unmarked” word order. This finding is, of course, not confined to nominative-first sentences. Experiencer and psych-verb constructions in which a non-nominative appears as the highest-ranked argument behave exactly alike. The following examples should serve as a demonstration that unmarked word order and focus projection work independently of Case and grammatical function:

- (39) Ich glaube, dass den Opa die FLIEGEN ärgern.
 I believe that the granddad the flies molest

(39) can again be interpreted with wide and narrow focus. With narrow focus, the semantic focus is confined to the DP *die Fliegen*. This interpretation is consistent with the question:

- (40) Wer/was hat den Opa geärgert? - (39)
 Who/what has the granddad molested

However, (39) is also a perfect answer to the following two questions of which (41-a) presupposes more than (41-b):

- (41) a. Was ist mit dem Opa los? - (39)
 b. Was ist hier los? - (39)

Notice in this connection that German passives behave like any other clause type with unmarked word order. (42) is a natural answer to (43-a), to the less presuppositional (43-b), and to the even less presuppositional (43-c), provided, of course, that the referent of *dem Lehrer* is familiar from the discourse:

- (42) Ich glaube, dass dem Lehrer der METZGER vorgestellt wurde.
 (43) a. Wer wurde dem Lehrer vorgestellt? - (42)
 b. Was war mit dem Lehrer los? - (42)
 c. Was war los? - (42)

We can conclude that marked order must be independent of the argument changing operations that play a role in passive constructions and the like.

Things are different when we turn to scrambling. If scrambling affects the relative linear order of arguments, the result will normally be a marked construction which is only applicable in a limited set of context types. Compare (35-b) with the scrambled version in (44). As expected, the pitch accent falls on the DP closest to the verb.

- (44) Ich glaube, dass den Metzger_i der DIREKTOR t_i holt.
 I believe that the butcher the director fetches
 'I believe that the person who calls the butcher is the director.'

In (44), the focus is on *der Direktor*, and it does not project any further. Thus (44) is a natural answer to the questions in (45-a) and (45-b), but not to the questions in (45-c) and (45-d):

- (45) a. Wer holt den Metzger? - (44)
 who fetches the butcher
 b. Was geschieht mit dem Metzger? - (44)
 what happens with the butcher
 c. Was tut der Direktor? - *(44)
 what does the director
 What is the director doing?
 d. Was geht hier vor? - *(44)
 what goes here along
 What goes on here?

(45-a) requires that the focus is confined to *der Direktor*. Since the object-DP is scrambled to some topic field of the clause, this is consistent with the phonology of (44). (45-b) requires that the focus is on the entire VP minus the scrambled object. Since German permits scrambling, and since traces lack a phonological matrix and can therefore not bear phonological weight, focus may be on the remnant verbal projection. This is consistent with the question in (45-b). The question in (45-c) employs the presupposition λx [the director does x]. This is inconsistent with (44) according to which *der Direktor* must be part of the focus projection. Why is it that (45-d) also fails? We know that in the least marked case focus must project up the entire verbal projection. Scrambling, however, is an operation that moves a constituent out of this projection, say, into a higher topic field. As a result, the constituent *den Metzger* cannot be part of the focus any longer. This is in fatal conflict with the requirement of (45-d) that the entire information provided by the answer should count as novel information.

German is a language which allows scrambling for (as yet poorly understood) formal reasons that—we believe—have nothing to do with information packaging. Nevertheless, this subsystem which is offered by the grammar is being used by requirements of information packaging. The expressive range of infor-

mation structure that English yields with the exploitation of passive and cleft constructions seems to be expanded in German by the option of scrambling. Provided that this line of analysis is on the right track, we expect that scrambled sentences are “disfavored” in the sense that they require comparatively narrow contextual determination.

3.5 Functional Heads

Certain considerations in section 3.1 have led to the conclusion that for German the formal licensing of arguments, in particular Case checking, is unlikely to be driven by movement to designated specifier positions which are associated with functional heads. The overall impression is that only phrase-initial functional heads give rise to formally licensed specifiers, while phrase-final heads license their dependents in a different way. Widely recognized evidence in support of this view is that the English AUX-vocabulary is separated from the lexical verbal vocabulary (cf. Lightfoot, 1979), while no such distinction holds in German.¹³ In generative grammar, the formal features of AUX have been first reduced to I(NFL) and have, since Pollock (1989), been decomposed into a series of functional heads for Tense (T), subject agreement (AgrS), object agreement (AgrO) etc. Beginning with Larson (1988) and Hale and Keyser (1993), evidence has been adduced that also the lexical verb may be associated with a series of light verbs (*v*) which license their own specifiers. Various proposals concerning the number and order of functional heads are available. The important consequence of all of them is that the verb undergoes verb raising to a series of functional heads, and that these functional heads may be associated with specifiers which are filled with phrases that undergo spec-head agreement.

More recently, Chomsky (2001a,b) suggested that agreement should not automatically be identified with movement to a specifier position. According to Chomsky, a functional head F (the “probe”) may agree with X (the “goal”) without X necessarily moving to SpecFP. Movement to SpecFP or base-insertion into SpecFP is then triggered by an additional feature: an “EPP-feature” or “OCC(urrence)-feature”, i.e. a device that forces the phonetic realization of a specifier position.¹⁴ Agreement between a functional head for subject agreement (AgrS or T) and the subject-DP can then be divorced from DP actually

¹³For instance, German AUX-verbs use the regular inflectional paradigm, while English AUX-verbs do not. The form for 3rd person singular is not the expected **cans, *musts, *wills* etc. but *can, must, will*. German AUX-verbs can also be used quasi as main verbs while their English counterparts cannot: *Ich kann das nicht* vs. **I cannot this / I am not able to do this*. For discussion of the emergence of VO-order in the history of English in connection with the development of a pre-VP functional head, cf. Kiparsky (1996). For relevant discussion of the status of modals and light verbs, cf. van Riemsdijk (2002).

¹⁴EPP is an acronym for EXTENDED PROJECTION PRINCIPLE, i.e. the principle which stipulates that every sentence has a subject. In Chomsky’s usage, an EPP-feature is then a feature that requires the occurrence of a phrase in a specifier position at PF.

moving to SpecAgrSP (or SpecTP). The core evidence for this move of the theory is the existence of expletive constructions. In the English sentence *There are_{plural} [several students]_{plural} in my office*, the specifier position is filled with the non-agreeing adverbial *there*. This adverbial is in a position to check the EPP-feature associated with *are*, but the number agreement between *are* and the DP *several students* remains a separate issue. Chomsky's proposal is that the probe *are* agrees with the goal *several students* without the latter (or formal features of the latter) undergoing movement. Actual displacement is then an issue of PF and is relegated to EPP-checking.

With respect to German, we have seen no evidence for DP-displacement in the service of formal licensing, e.g. person/number agreement, Case checking etc. It looks as if there is agreement without displacement. In Chomsky's terms this means that there are functional heads which are not enriched with an EPP-feature. It has been claimed that this is a general property of head-final languages or head-final constructions. To our knowledge, head-final languages never show expletives, and they are in most cases scrambling languages. Both of these properties are expected if there is no displacement for the sake of EPP-checking. German, being a mixed language in terms of head positions, does show expletives in its CP-structure but not in its IP/VP-structure:

- (46) a. **Es** warten zwei Freunde von dir im Wohnzimmer.
 it wait two friends of your in-the living-room
 'There are two friends of yours waiting in the living room.'
 b. **Es** wurde die ganze Nacht lang getanzt.
 it was the whole night long danced
 'There was dancing through the whole night.'
- (47) a. dass (***es**) zwei Freunde von dir im Wohnzimmer warten.
 b. dass (***es**) die ganze Nacht lang getanzt wurde.

This is expected because the C-position into which the finite verb moves is a phrase-initial functional position which gives rise to a specifier that may be filled with some XP which—next to various other choices—may also be an expletive. The IP/VP-layer, however, is not headed by a phrase-final functional head which could give rise to a specifier position. The finite verb is inflected for T and Agr, but there is no evidence for the verb undergoing head movement to the right, and neither is there evidence for DPs moving to functionally defined specifier positions for Case checking etc.¹⁵

¹⁵The existence of genuine, i.e. base-generated, head-finality has been challenged by Kayne (1994), who suggests that final heads do not exist at all, and that the order COMPLEMENT < HEAD is always derived such that the complement has been moved into a specifier position to the left of the head. His theory is not necessarily incompatible with what we say here, but requires various supplementary assumptions. Kayne's theory has been applied to Dutch in Zwart (1994 and 1997).

Various theoretical proposals have been made as how to capture the nature of argument licensing under the assumption of genuine head-finality. While earlier accounts within GB-theory argued for extra mechanisms such as “chain government” in order to license nominatives inside VP (cf. den Besten, 1989), later work on Dutch and German has tried to locate the differences in morphology (cf. Bayer and Kornfilt, 1990; Bayer and Kornfilt, 1994; Haider, 1993; Reuland, 1990; Reuland, 1988; Reuland and Kosmeijer, 1993). Haider (1993; 2000) argues that in head-final languages the verb’s features for tense and agreement are added in the lexicon and project jointly with the lexical verb. Thus, the finite verb may discharge arguments licensed by it regressively along the span of VP.¹⁶ Questions about morphological and lexical representation arise which we can obviously not address in the present context.

To summarize at this point, the potentially controversial assumptions we have made about the structure of German clauses are the following:

- (48)
- a. Phrase-final functional heads are features rather than syntactically defined positions.
 - b. Due to (48-a), phrase-final functional heads lack an EPP-feature, and thus do not license a specifier.
 - c. The German transitive verb is endowed with the feature <AgrO> which is checked (and subsequently removed) by the attachment of a direct object (typically but not necessarily an accusative NP/DP).
 - d. The German finite verb is endowed with a set of features which at least consist of <T> and <AgrS>, the latter of which being composed of <Num> and <Pers>. AgrS is checked (and subsequently removed) by the attachment of a subject (typically but not necessarily a nominative NP/DP).¹⁷
 - e. The attachment of further arguments (indirect objects, dative and genitive objects, prepositional objects)—which may be forced by the argument structure of the verb—is not licensed by functional heads and/or the agreement system in German.
 - f. Case is checked anywhere to the left of the functional features which are part of the verbal complex. The licensing relation which holds between the two constituents marked with <F> in [XP YP<F>

¹⁶Let us add that this view can perhaps be reconciled with the idea that feature checking can only occur in specifiers. The reason is that the left side of a phrase-final functional head can be seen as a specifier with multiple occurrences. For Dravidian as well as Indo-Aryan SOV-languages such a solution has been suggested by Jayaseelan (2001) and Simpson and Bhattacharya (2003). Various problems arise, however, some of which have been discussed in Bayer (1999). For present purposes it would be irrelevant to dig deeper into this matter.

¹⁷It should be noticed that we do not take grammatical functions such as “subject” to be primitives of the theory. This is especially important where non-nominative subjects—so-called “quirky subjects”—play a role. For detailed discussion of German and Bengali versus Icelandic, cf. Bayer (2004).

... $X^0_{<F>}$] is M-COMMAND (cf. (7) on page 56 for the definition of m-command).

It was pointed out in (48-e) that Case checking pertains only to the “structural Cases” nominative and accusative, not to the dative. Since the dative and its representation play a major role in the chapters to come, we will now turn to the structure of NP and DP and the question of how Case—and in particular “lexical Case”—is implemented in NP/DP.

4. The Case Structure of NP and DP

So far we have considered the licensers of Case, i.e. we have been looking at the Case assigner and have said next to nothing about the Case assignee. In this section we will take a look at the Case assignee, and try to integrate what we have developed so far into a coherent picture of what role Cases of different kinds play in grammar and especially in the grammar of German. Our account will partially lead to a reconfirmation of the classical GB-distinction between “structural” Case and “inherent” or “lexical” Case. As has been pointed out in section 2.2 already, there is much evidence that the dative in ditransitive predicates appears in a rule-governed fashion, is therefore predictable, and is therefore considered by various researchers to be a structural rather than an inherent/lexical Case. Nevertheless we believe that such an account overlooks central aspects of the German Case system according to which nominative and accusative have a privileged status. We will take Case morphology as our starting point and then consider a number of syntactic asymmetries between structural and lexical Cases which receive a straightforward explanation, if the morphological findings are evaluated in terms of syntax.

4.1 Structural and Inherent Case

At first sight, the Case assignee appears to be a rather boring candidate to look at. Not only in English but also in German, nominatives, accusatives and datives (although not genitives) seem to enjoy the privilege of being able to look exactly alike. Consider the proper name *Mary/Maria* in the following examples:

- (49) a. **Mary** started laughing. (SUBJECT/NOM)
 b. I met **Mary**. (DIRECT OBJECT/ACC)
 c. I gave **Mary** a book. (INDIRECT OBJECT/DAT)
- (50) a. **Maria** begann zu lachen. (SUBJECT/NOM)
 b. Ich traf **Maria**. (DIRECT OBJECT/ACC)
 c. Ich gab **Maria** ein Buch. (INDIRECT OBJECT/DAT)

The fact that the name invariantly remains the same reduces the motivation of taking a serious look at the Case morphology of the Case assignee, and it

invites the belief that the dative is a structural Case not only by its rule governed appearance but also by its form. The impression is that we are dealing with ABSTRACT rather than with MORPHOLOGICAL Case. This may in fact be true for modern English where there is no distinctive dative morphology left, and where—according to our assumptions—the Case of the indirect object is licensed in a specifier position for objects in analogy to the position of the direct object. The system of German which has been sketched above does not give rise to such an expectation, however. Since the Case-bearing NPs/DPs can be arranged in any order and without the topology of spec-head configurations, morphological reflexes on the Case assignees are more or less expected. And indeed, not only modern German but also its Indo-European ancestral languages show a clear distinction according to which the forms of nominatives and accusatives often collapse whereas the forms of datives and genitives tend to remain morphologically discernible from the former or even from each other (cf. Tables 3.1 and 3.2 on page 51).

Case is assigned to the entire NP/DP and not to N. The Case morphology of the N-system is seriously reduced such that the morphological exponent of Case is the pre-NP agreement system of which the D-system is a part.¹⁸ Interestingly, the masculine singular paradigm is the only one with a fully distinctive paradigm. Only in this paradigm is the nominative not form-identical with the accusative. In all the other cases, the nominative/accusative distinction has dissolved, while the oblique Cases genitive and dative retain distinctive morphology. This pattern is by no means a morphological accident, as we will see directly.

In the following we will summarize evidence from Bayer, Bader and Meng (2001) which shows that contrary to the impression that the examples in (50) may leave, datives (as well as genitives) fail in a large number of tests which accusatives pass. We will confine the discussion to datives and leave verb-governed genitives aside because these genitives are exceedingly rare in German and do not play a role in the experimental work to be presented later.

One widely known fact is that function changing operations such as passive and middle affect the structural Cases nominative and accusative while excluding the dative (and lexically selected genitive). Consider first the passivization data in (51) and (52):

- (51) a. Oswald hat **den** Präsidenten ermordet.
 Oswald has the president-ACC assassinated
 ‘Oswald has assassinated the president.’

¹⁸Agreement shows up in adjectives, quantifiers and certain possessive constructions. We will return to the latter because possessive constructions such as *Marias/wessen Buch* (‘Mary’s/whose book’) will play a role in some of the experiments to be presented later on.

- b. **Der** Präsident wurde ermordet.
the president-NOM was assassinated
- (52) a. Oswald hat **dem** Präsidenten gehuldigt.
Oswald has the president-DAT given-homage
'Oswald gave homage to the president.'
- b. **Dem** Präsidenten/***der** Präsident wurde gehuldigt.

(51-b) shows that the nominative subject is demoted while the accusative object is promoted to the grammatical subject function.¹⁹ The same effect appears in middle constructions and in ergative (unaccusative) constructions.

Bayer et al. (2001) show that constituents which have a nominal feature but cannot undergo Case inflection qualify as nominatives and accusatives but not as datives. This is true for *dass*-clauses and for non-inflecting indefinites such as *genug* ('enough'), *nichts* ('nothing'), *allerlei* ('much'), *etwas* ('something'), *wenig* ('little') (cf. Gallmann, 1996; Gallmann, 1997). Sentences with such an indefinite as the object of a dative assigning verb are deviant, as seen in (53-a).

- (53) a. *Die Feuchtigkeit schadete nichts.
the humidity harmed nothing
- b. Die Feuchtigkeit schadete nichts isoliert-em.
the humidity harmed nothing insulated-DAT

This deviance disappears as soon as a properly inflected form is added, as in (53-b). We are thus led to the generalization in (54):

- (54) Dative Case must be realized morphologically.

(54) seems to be contradicted by the fact that proper names such as *Maria* in (50-c) qualify as datives. One should notice, however, that proper names had been Case-inflected in earlier stages of German.²⁰ In most spoken varieties of German in which nominal Case inflection has been lost almost entirely, person names are used with the definite determiner: *der Hans* ('the Hans'), *die Maria* ('the Maria') etc. instead of *Hans* and *Maria*. At first sight this seems strange because proper names are intrinsically definite so that the use of the definite determiner is semantically redundant. However, as Paul (1916) observes, since the determiner retains explicit Case morphology there is a way to Case-mark the proper name overtly via a DP-shell. Seen in this light, the

¹⁹Except in the so-called *bekommen/kriegen* passive which has already been referred to in note 7 on page 61. Let us emphasize once again that we do not see the *bekommen/kriegen* passive on a par with the familiar function changing operations.

²⁰The Old High German Case forms of the male name *Hartmout* are *Hartmuot* (nom), *Hartmuot-es* (gen), *Hartmuot-e* (dat) and *Hartmuot-an* (acc). The inflection of proper names was retained deep into the 19th century and continues to occur in dialects.

fact that modern Standard German allows oblique proper names without overt morphological marking seems to be the exception rather than the rule. We will show that under certain theoretical assumptions about proper names, even this exceptional status is only apparent, and that the generalization in (54) can be retained.

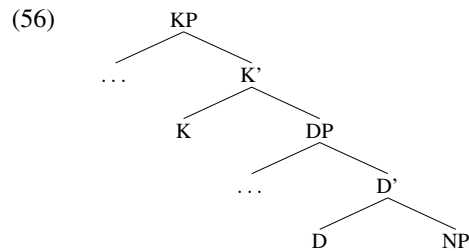
4.2 The KP-Hypothesis

Following Bayer et al. (2001), we want to propose an analysis of the dative DP which leads to a straightforward explanation of the contrasts between structural (nominative and accusative) and inherent (dative) Case that we reviewed in the previous section, as well as a number of surprising Case-related effects. Our proposal will provide a coherent general picture of Case licensing in German. The core of our proposal is the KP-HYPOTHESIS given in (55):²¹

(55) *The KP-hypothesis*

Dative Case is syntactically represented as a KASE PHRASE (KP).

It has been shown so far that German datives must be morphologically marked, and it has been argued that proper names contradict this generalization only apparently. Our claim now is that in the syntax the dative's morphological exponent corresponds to a functional head K which projects a KP as has been proposed with varying motivations and intentions by Suñer (1984), Lamontagne and Travis (1987), Grosu (1994), Bittner and Hale (1996), and certainly various others too. Consider a phrase structure according to which the DP is immediately dominated by a functional layer which is headed by a functional head K, K for Kase, such that KP is an EXTENDED PROJECTION of NP/DP in the sense of Grimshaw (1991).



²¹We will explain shortly why we use the terminology KASE instead of CASE, and what we consider to be the actual scope of this notion.

In spite of overt Case morphology that may appear in German nominatives and accusatives, we do not consider a KP layer for them.²² The reason for this is that nominatives and accusatives are licensed by features of the (finite) verb, whereas datives have to import their own functional structure. Recall that we assume no agreement for dative objects, genitive objects, or any further arguments such as PPs and adverbs.

4.2.1 On the Relatedness of KP and PP

Abstracting away from certain details to which we will turn shortly, this puts datives on a par with PPs. Both K and P are functional heads that license an NP/DP argument.²³

Consider first PPs. Dutch, English and German show the raising of adverbial elements such as *er/waar*, *there* or *da/wo* to the left of a preposition.

- (57) a. Dutch: *er+van*, *waar+van*
 b. English *there+of*, *where+of* (archaic)
 c. German *da+von*, *wo+von*

In GB-theory it was argued that the preposition governs its object and assigns Case to it. It has never become clear, however, how adverbs (like those in (57)) can turn into carriers of Case, let alone oblique Case such as dative. Notice that the German preposition *von*, if merged with a full DP, requires dative Case: *von dem Vorschlag* ('from/of the proposal'). Given that in the languages listed above Case can only appear on NPs/DPs, the question is how such adverbs can ever be able to be assigned Case. In fact, we assume that they never do. The adverbs in question are likely to be categorially underspecified elements which acquire the category N only after raising to P.²⁴

For concreteness one could formulate this as a case of spec-head agreement: By virtue of selecting an NP/DP complement, the feature structure of P must contain +N or +D. If *da* raises and adjoins to P (or moves to SpecPP), its underspecified feature value can be specified with P's sub-feature +N/+D.

²²We do not wish to exclude the possibility that so-called "free accusatives" such as the adverbial *den ganzen Tag* ('the whole day') rely on a KP-shell too.

²³Prominent evidence is the shift from dative Case to PP in the Romance languages or the "dative alternation" in English. Kayne (1984) and Emonds (1985) have argued that the dative is something like a hidden PP. More recently syntactic theory offers promising roads to capturing their insights in a less ad hoc way.

²⁴That *da* must have an N-feature at this stage is suggested by the fact that it can be coindexed with a CP only if the CP is headed by a C with an N-feature, but not with a V2-CP:

- (i) Er hat davon gesprochen, dass Klaus ins Kino gegangen sei. (dass-CP)
 he has thereof spoken that Klaus to-the movie gone had
 'He talked about Klaus having gone to the movies.'
- (ii) *Er hat davon gesprochen, Klaus sei ins Kino gegangen. (V2-CP)

What about Case? The feature matrix of P must equally contain information about Case: *durch*, *für*, *gegen* etc. require accusative Case, *bei*, *mit*, *nach*, *zu* etc. require dative Case, sometimes in combination with the \pm telic aspect of the verb. Since, being particles, *da* and *wo* are notoriously without morphological Case, the natural conclusion is that the Case information remains where it is, namely in P, i.e. rather than *assigning* Case, P *adds* Case to its otherwise deficient complement/specifier. According to the standard view on checking, the Case-feature of the moved item would remain in the derivation, while the Case feature of the target would be deleted. What we face here is the reverse. Since *da* has no Case feature, it is fundamentally unable to undergo Case checking. This means that the Case feature in P will remain in the derivation. As a consequence we can view P as a Case morpheme which—being a featurally complex item—bears other features as well. At the semantic interface, a German PP like *davon* will then look as in (58).

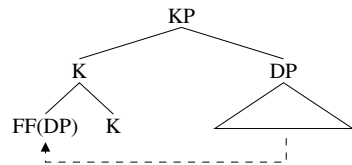
(58) [PP [N *da*] [P *von* ... <dat>...]]

The feature N derives from agreement with P; the feature <dat> belongs to the set of features of the preposition *von*. We will shortly see that this line of analysis makes the right predictions for a number of phenomena that remain puzzling problems otherwise.

After this digression to pronominal PPs we return now to K and its projection KP. Imagine K being something like P but with a much more impoverished feature matrix. Most importantly, K does not—unlike P—carry a specific Case value at the time it is merged with NP or DP. K must be specified for whichever Case is required, the choice in German being between dative and genitive. How can K be properly specified? Our suggestion has been that K is the syntactic exponent of overt oblique Case morphology. Assume now covert movement from DP to K. According to Chomsky (1995), covert movement would be FEATURE MOVEMENT rather than phrasal movement.²⁵ In (59), FF(XP) is short for “formal features of the phrase XP”, i.e. grammatical features among which there would be features for person, number and Case.

²⁵There are alternative theories which try to abandon covert movement altogether (cf. Kayne, 1998; Koopman, 1997; Koopman, 2000). According to these theories, DP would overtly move to SpecKP. We stick to covert feature movement for empirical reasons we cannot spell out here. A more advanced account in terms of Chomsky's (2001a,b) theory of agreement is given in Bayer and Bader (2004).

(59)



If DP bears dative Case by virtue of its head D—the main carrier of distinctive Case morphology in modern German—raising of FF(DP) will specify K as a dative phrase. Since there is no agreement process with the verb, this is where processes of Case agreement stop. This means that datives import their own functional category K, while nominatives and accusatives rely on agreement with features on the verb.

KP and PP resemble each other because both K and P are functional heads which host Case features. While K hosts only Case features, P normally carries semantic features which give rise to the familiar differences between dative and prepositional constructions. KP and PP also differ by their syntactic composition. Pronominal PPs show that the adverbial complement/specifier of P is Case-less. Given the generalization in (54), we were led to the conclusion that the locus of Case cannot be the complement/specifier but rather P itself. In the case of KP the reverse is true. K has no specification, while DP is overtly marked for dative Case. Feature movement from DP to K provides the necessary Case specification for K.

4.2.2 The Syntactic Nature of KP

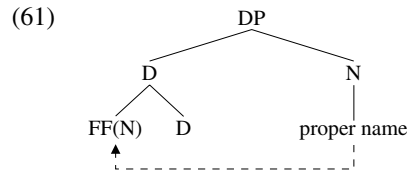
The involvement of a KP-shell predicts that there is no agreement of the dative with the verb although the dative may be required by a dative-selecting verb or may be predictable from the verb's argument structure. If datives are associated with verb-independent functional structure, the non-affectedness of datives by function changing operations—cf. the passive in (52)—is expected.

The KP-hypothesis also provides the right structure for indefinites like *nichts* ('nothing') which—as we have seen above—show no morphological Case paradigm. Due to their lack of morphology, these elements cannot identify KP. If prepositions bear a strong resemblance with K and there is feature movement of FF(DP) to P as in (59), it is expected that they may be licit as complements of P. This expectation is, in fact, borne out. As Gallmann (1997) has pointed out, sentences with a dative-assigning preposition like (60) are fully grammatical.

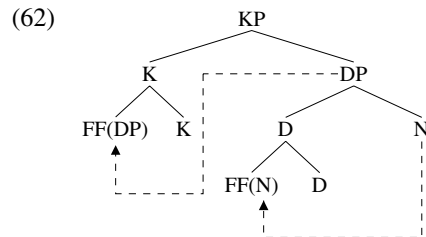
- (60) Otto ist mit nichts zufrieden.
 Otto is with nothing content
 'Otto is content with nothing.'

According to the KP/PP-theory sketched above, the indefinite is not assigned Case. It is rather the preposition *mit* ('with') which bears the Case feature <dat>, and which attaches it to the otherwise Case-less nominal.

Proper names, which in Standard German are normally uninflected for dative Case, were pointed out as a potential challenge for the generality of (54). According to our analysis, proper names must be either Case-inflected or associated with a determiner that bears the right Case morphology. The analysis in terms of the KP-hypothesis offers an explanation for why proper names can still function as datives. Longobardi (1994) has argued extensively for N-to-D raising.²⁶ Assume that German proper names can access the D-system by undergoing raising to an empty D-head as shown in (61).



Following Wunderlich and Fabri (1995), we assume that the lexicon allows access to inflectional paradigms. Since in German D is connected to a paradigm which provides Case morphology for the dative, we suggest that N may derive the necessary Case specification via feature movement from N to D. The next step is then to extend the tree in (61) up to the KP-level.



Lexical look-up must be sandwiched between N-to-D raising and D-to-K raising. This makes the whole derivation a rather complex operation which one would like to see only if it is necessitated by interface conditions. Given that anything with nominal features can check the features of structural Case, we assume that a pure N may be inserted as a nominative or accusative. Thus, no raising and lexical look-up will occur. According to our assumptions, no

²⁶Related Germanic languages such as Swedish show overt N-to-D raising as in *hus+et* ('house the') which can be analyzed as a raising construction: [_{DP} *hus*_i [_{D'} *et* [_{NP} *t*_i]].

similar strategy for Case licensing exists in the case of the German dative. In this case, N can only access the Case paradigm via the D-system. This forces N-to-D raising. The following lexical look-up is an option in German because the determiner in modern German (unlike the one in modern Dutch, for instance) provides a form for dative Case. The dative feature which is picked up in this fashion is then able to derive a DP whose formal features can be used to specify KP.

We will see in the chapters to follow that a morpho-syntactic account along these lines makes the right predictions for a number of processing phenomena which seem to be transparently related to these derivational steps of the competence grammar.

The assumption of a syntactic structure for datives in the sense of the KP-hypothesis has a number of further advantages which cannot be discussed here. The predictions of the KP-hypothesis pertain to effects for binding theory, secondary predication, extraction, recoverability in topic-drop and comparative constructions, and synthetic compounds. The gist of the explanation is in each case that the head K adds phrase structure to the DP/NP which is absent in DPs/NPs with structural Case. For details, the interested reader is referred to Bayer et al. (2001).

4.3 The Special Role of Dative Case

Dative Case is found to be generally morphologically richer in German than nominative or accusative Case. This undisputed fact which appears to be far from accidental has been argued to reflect a phrase structural syntactic property by which datives (and genitives for that matter) are distinguished from the structural Cases nominative and accusative. Our suggestion was that a dative NP/DP is dominated by a layer of functional syntactic structure which we call K(ASE) Phrase (KP). K is the syntactic exponent of Case morphology. It is specified by feature movement from D to K (or from N to D to K). Indeclinable nominal forms normally do not qualify as datives. The KP-hypothesis predicts a fair amount of constraints which distinguish inherent from structural Case. The obvious problem cases are proper names. Proper names may derive dative morphology too, but only if they undergo N-to-D raising. Feature movement from N to D specifies a DP whose head D can be mapped onto a dative Case form in the lexicon. This enables proper names to ultimately specify a KP, if required: $N \Rightarrow \{D N\} \Rightarrow \{K \{D N\}\}$.

Morphologically Case-less proper names—as well as Case-ambiguous inflected forms such as *-en* plurals—constitute highly interesting specimens for probing into ambiguity resolution and structural predictions in syntactic comprehension. They will figure prominently in the experiments to be reported in the following chapters.

5. Summary

This chapter has provided the necessary grammatical background for the chapters on syntactic comprehension to follow. The following syntactic characteristics have been noted for German.

- The language is partially head-final, with a head-final verbal projection and rather free order of constituents.
- A morphological Case system is retained which distinguishes four Cases, but at the same time shows Case syncretism in its paradigms.
- Arguments are not ordered according to tree-geometrically defined landing sites for Case checking (with the exception that Case-bearing arguments should be to the left of the verb); the order of arguments is determined rather by argument structure and its conditioning forces directly.
- Verb-related functional categories below CP such as AgrS, AgrO, T etc. are features of the verb rather than syntactically active positions which are associated with their own specifiers and related requirements of EPP-checking.
- The language has the Verb-Second property, i.e. the finite verb moves to C in root clauses and in certain embedded clauses
- While the structural Cases nominative and accusative are formally licensed by the verb's agreement features, the lexical Cases dative and genitive must be licensed by separate functional projections.
- Morphological as well as syntactic evidence suggests that arguments with lexical Case are not only NPs and DP but in addition KPs (Kase-Phrases).
- The “defects” of the Case paradigms are almost perfectly tuned to the rest of the syntactic system. The fact that morphology is largely irrelevant for nominatives and accusatives but highly relevant for datives (and genitives) appears to be far from accidental.
- The extra structure that is associated with K leads to a strong similarity between KP and PP.
- Due to Case syncretism which partially also affects the morphology of the dative, the projection of KP may require access to lexically stored paradigms.

Chapter 4

FIRST-PASS PREFERENCES IN SYNTACTIC-FUNCTION AMBIGUITIES

1. Introduction

In the introduction to this book we gave a general outline of our theory in form of the diagram shown in Figure 4.1 (repeated from Chapter 1).

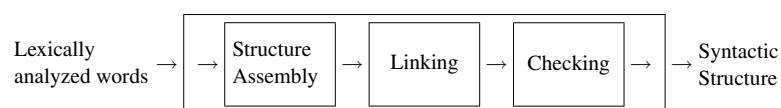


Figure 4.1. A model of the HSPM

Beginning with this chapter, we will give content to the three boxes labeled “structure assembly”, “linking”, and “checking” in Figure 4.1. Since the linking and checking processes operate on the products of the structure assembly processes, the latter are the natural starting point for our endeavor.

Our primary goal is to provide a comprehensive account of how the HSPM assigns syntactic functions during language comprehension. As with models of the HSPM in general, two kinds of data will be of prime importance in pursuing this goal. First, data concerning the first-pass preferences of the HSPM, and, second, data concerning garden-path strength in case a preferred analysis is contradicted at some point during the ongoing analysis. In this chapter we will first review what is already known about first-pass preferences in the processing of German syntactic function ambiguities, and then specify the structure assembly processes of the HSPM as far as necessary in order to derive the preferences that will emerge from our review. In addition, we will summarize the basic differences in garden-path strength that have been reported in the literature on parsing German.

Early experimental work on German syntactic function ambiguities was inspired by the question as to how the HSPM copes with ambiguous filler-gap dependencies. For subject-object ambiguities in Dutch, this question had already been tackled by Frazier (1987). Dutch is like German in that it is both a SOV-language and a general verb-second language. Dutch therefore exhibits some of the same subject-object ambiguities that are found in German, although their range is more restricted because Dutch does not allow scrambling of the object in front of the subject, probably because it has lost almost all of its Case morphology (cf. den Besten, 1989; Neeleman, 1994). The particular type of subject-object ambiguity in Dutch investigated by Frazier (1987) is shown in (1).

- (1) Jan houdt niet van de Amerikaanse die de Nederlander will
 Jan likes not of the American who the Dutchperson wants
 uitnodigen.
 to invite
 ‘Jan does not like the American ...’
 ‘... who wants to invite the Dutchperson’
 or ‘...who the Dutchperson wants to invite’

Sentence (1) contains a globally ambiguous relative clause. The relative pronoun *die*, which is assumed to be located in SpecCP, can be linked either to a trace in SpecIP (cf. (2-a)) or to a trace within VP (cf. (2-b)). In the former case, the relative pronoun functions as a subject, in the latter case as an object.

- (2) a. ... de Amerikaanse
 [CP die_i [IP t_i [VP de Nederlander will uitnodigen]]]
 b. ... de Amerikaanse
 [CP die_i [IP de Nederlander [IP t_i will uitnodigen]]]

When participants read sentences like (1) and then had to answer a question of the form “Who will invite whom”, the head DP of the relative pronoun was chosen as subject with 74%. In other words, participants interpreted the relative clause preferentially with the subject preceding the object. To account for this SO-preference, Frazier (1987) postulated the ACTIVE FILLER HYPOTHESIS which is given in (3) in the formulation of Clifton and Frazier (1989).

- (3) *Active Filler Hypothesis (AFH)*
 When a filler of category XP has been identified in a non-argument position, such as COMP, rank the option of assigning its corresponding gap to the sentence over the option of identifying a lexical phrase of category XP.
 (Clifton and Frazier, 1989:292)

The relative pronoun *die* in (1) qualifies as an active filler because it is located in the specifier of CP (= COMP in the formulation of the AFH) which entails that it has to be coindexed with a trace somewhere in the phrase-marker under construction. After the HSPM has processed the active filler *die*, the next position to fill is the specifier of IP. At this point, the HSPM has two options: It could either insert a trace of the relative pronoun into the specifier of IP, or it could look for an upcoming DP within the input string with which to fill this position. Taking the first option would result in the construction of structure (2-a), taking the second option would result in structure (2-b) being built. According to the Active Filler Hypothesis, the HSPM will prefer the first option over the second, which results in the observed subject-object preference for Dutch relative clauses.

Frazier's (1987) seminal study on Dutch initiated a thorough and still ongoing investigation of all sorts of syntactic function ambiguities in German (cf. Bader, 1991; Bader, 1996; Bader and Meng, 1999; Bader et al., 1996; Bornkessel et al., 2002; Bornkessel et al., 2003; Farke, 1994; Fiebach et al., 2001; Friederici and Mecklinger, 1996; Hemforth, 1993; Hemforth et al., 1993; Konieczny, 1996; Mecklinger et al., 1995; Meng, 1998; Meng and Bader, 2000b; Meng and Bader, 2000a; Scheepers, 1996; Schlesewsky, 1996; Schlesewsky et al., 2000; Schriefers et al., 1995).¹ Let us summarize at the outset what these studies have revealed with regard to first-pass parsing. This summary is given in (4).

(4) *The Case Assignment Generalization*

1. Assign nominative!
2. If 1. is not possible, assign accusative!
3. If neither 1. nor 2. is possible, assign dative!

The generalization in (4) is to be read as follows: If the HSPM has to assign Case to some DP and there is a choice between nominative, accusative, and dative Case, nominative Case will be assigned. If nominative Case has already been assigned before, or if it cannot be assigned for morphologically reasons, and a choice between accusative and dative Case remains, accusative will be assigned. Dative Case, finally, will only be assigned as a last resort, if no other Case is left over and the input is compatible with dative Case.

Note that (4) is nothing more than a succinct generalization of a broad range of experimental findings. These findings will be reviewed in sections 2 and 3. In section 4 we will make a proposal as to how the generalization in (4) can be derived from independently motivated parsing principles of the HSPM together

¹Follow-up studies on Dutch syntactic function ambiguities include Kaan (1996), Lamers (2001, 2005), and Mak, Vonk and Schriefers (2002).

with the grammar of Case in German. Since the literature on syntactic-function ambiguities is already large, we will confine our review to this literature. Some additional important work that has been done on various topics in the on-line computation of German sentence structure, for example the computation of traces (in particular, Featherston, 2001, and Muckel, 2002), can therefore not be taken into account.

2. Subject-Object Ambiguities: “Prefer Nominative!”

We will present the already vast experimental literature on subject-object ambiguities in two parts:

- Subject-object ambiguities involving movement of an ambiguous phrase to the specifier of CP
- Subject-object ambiguities within the middle-field (that is, in the part of the sentence below C')

Besides demonstrating the broad coverage of the subject-object preference, the following survey will summarize the major facts about differences in garden-path strength.

2.1 Movement to SpecCP

The most widely studied type of subject-object ambiguity involves sentences where a DP has been moved to the specifier of CP (SpecCP) and where there is a local ambiguity as to whether this DP originated in the subject or object position. Subject-object ambiguities of this type provide the classic instance of filler-gap ambiguities in German. They can be further classified according to where the movement started (matrix or embedded clause) and according to the landing site of the movement (matrix or embedded clause). Given the ban on downward-movement (“proper binding”), this gives us three types of filler-gap ambiguities involving movement to SpecCP. These are summarized in (5) together with their respective subtypes.

- (5) a. *Movement to SpecCP confined to embedded clause*
 (i) indirect questions (cf. (7), (8))
 (ii) relative clauses (cf. (6))
- b. *Movement to SpecCP confined to matrix clause*
 (i) direct questions (cf. (9), (10))
 (ii) declarative main clauses (cf. (13))
- c. *Movement to SpecCP from embedded into matrix clause*
 (i) movement from embedded verb-second clause (cf. (14), (15))
 (ii) movement from embedded verb-final clause (cf. (16))

As numerous experimental studies have shown, when the HSPM has encountered a DP in SpecCP which might be analyzed as a subject or as an object, the subject-analysis will be the preferred one. Given that a DP can only end up in SpecCP by movement from a lower position, subject-object ambiguities of the sort shown in (5) contain an active filler. Finding a preference for the SO-structure in such sentences therefore confirms the initial observations of Frazier (1987) for corresponding structures in Dutch. Given the general preference for subject before object, sentences involving wh-movement to SpecCP thus form a homogeneous class with respect to first-pass parsing. With respect to second-pass parsing, in contrast, we will see that these ambiguities are not homogeneous at all. Instead, two important differences in garden-path strength will show up.

2.1.1 Movement to SpecCP Confined to Embedded Clause

In embedded clauses, movement to SpecCP occurs in relative clauses and indirect wh-questions. An example for a subject-object ambiguity involving relative clauses is given in (6). The sentences in (6), which are the German counterparts to the Dutch sentences investigated by Frazier (1987), are disambiguated by the clause-final auxiliary which has to agree with the subject in number (and—irrelevantly here—person). Several experiments have provided evidence for an SO-preference in relative clause constructions (cf. Bader, 1991; Mecklinger et al., 1995; Schriefers et al., 1995; Bader and Meng, 1999).

(6) *Relative Clauses*

- a. Das ist die Tante, die die Jungen gestern besucht hat.
this is the aunt who the boys yesterday visited has-SING
'This is the aunt who visited the boys yesterday'
- b. #Das ist die Tante, die die Jungen gestern besucht haben.
this is the aunt who the boys yesterday visited have-PLUR
'This is the aunt who the boys visited yesterday'

Indirect wh-questions, the second type of movement to SpecCP within an embedded clause, are exemplified in (7) and (8).

(7) *Embedded Questions with Verbal Disambiguation*

- a. Ich weiß, welche Tante die Jungen gestern besucht hat.
I know which aunt the boys yesterday visited has-SING
'I know which aunt has visited the boys yesterday'
- b. #Ich weiß, welche Tante die Jungen gestern besucht haben.
I know which aunt the boys yesterday visited have-PLUR
'I know which aunt the boys have visited yesterday'

(8) *Embedded Questions with Nominal Disambiguation*

- a. Ich weiß, welche Tante den Jungen gestern besucht hat.
 I know which aunt the-ACC boy yesterday visited has
 'I know which aunt has visited the boy yesterday'
- b. #Ich weiß, welche Tante der Junge gestern besucht hat.
 I know which aunt the-NOM boy yesterday visited has
 'I know which aunt the boy has visited yesterday'

(7) and (8) are phrase-structurally identical, but they differ with respect to the means by which disambiguation is achieved. In (7), both DPs are compatible with either nominative or accusative Case. The DPs differ, however, in that the first DP is a singular DP whereas the second DP is a plural one. Disambiguation is therefore effected by the number marking on the finite verb which has to agree with the subject: When the finite verb is in the singular, the wh-phrase has to be the subject (7-a), when it is in the plural, the second DP is the subject and the wh-phrase accordingly the object (7-b). In the following, disambiguation via number-agreement between subject and finite verb will be called *VERBAL DISAMBIGUATION*. Verbal disambiguation contrasts with *NOMINAL DISAMBIGUATION* which is found in the sentences in (8). The sentences in (8) contain only singular DPs. The first one, the wh-phrase, is Case-ambiguous. The second DP, in contrast, is unambiguously marked for Case: *den Jungen* in (8-a) is a masculine accusative DP and therefore the object, whereas *der Junge* in (8-b) is a masculine nominative DP and therefore the subject of the clause.

While the type of disambiguation does not affect first-pass preferences—the SO-structure is preferred in both (7) and (8), the strength of the garden-path effect that can be observed in OS-sentences is heavily dependent on how disambiguation is achieved: Verb disambiguation results in a severe and robust garden-path whereas nominal disambiguation leads to a relatively weak one. This has been demonstrated in quite a number of experiments (cf. Meng, 1998; Meng and Bader, 2000a).

Since disambiguation by the second DP occurs earlier than disambiguation by the verb, a first guess might be that this difference in garden-path strength is simply a function of the distance between point of ambiguity and point of disambiguation (for syntactic ambiguities where distance has this kind of effect, cf. Ferreira and Henderson, 1991). However, results on direct wh-questions, to which we turn next, show that this is not so. To our knowledge, relative clauses have not yet been tested with respect to the type of disambiguation, but one should expect that the same dependency on type of disambiguation will show up.

2.1.2 Movement to SpecCP Confined to Main Clause

The main-clause counterparts to the embedded wh-questions in (7) and (8) are given in (9) and (10), respectively.

(9) *Main Clause Questions with Verbal Disambiguation*

- a. Welche Tante hat die Jungen gestern besucht?
which aunt has-SING the boys yesterday visited
‘Which aunt has visited the boys yesterday?’
- b. #Welche Tante haben die Jungen gestern besucht?
which aunt have-PLUR the boys yesterday visited
‘Which aunt have the boys visited yesterday?’

(10) *Main Clause Questions with Nominal Disambiguation*

- a. Welche Tante hat den Junge gestern besucht?
which aunt has the-ACC boy yesterday visited
‘Which aunt has visited the boy yesterday?’
- b. #Welche Tante hat der Junge gestern besucht?
which aunt has the-NOM boy yesterday visited
‘Which aunt has the boy visited yesterday?’

The first pair, (9), is again disambiguated by means of number agreement between subject and finite verb, while the second pair, (10), exhibits disambiguation by the unambiguous Case morphology on the second DP. The distance between the point where the ambiguity arises and the point where it is resolved, is now exactly the reverse of what we saw for embedded wh-questions: Verb disambiguation occurs at an earlier point in time than DP disambiguation. Nevertheless, a range of experiments have revealed the same pattern as the one found for embedded clauses (cf. Meng, 1998; Meng and Bader, 2000a; Schlesewsky et al., 2000). An SO-preference independent of the type of disambiguation, and a much stronger garden-path effect for OS-sentences disambiguated by agreement with the verb (9-b) than for OS-sentences disambiguated by the second DP (10-b). This holds independently of whether the clauses contain a composite tense form, with the finite auxiliary in verb-second position ((9) and (10)), or a simple tense form, with the main verb in clause second position (cf. (11) and (12)).

(11) *Main Clause Questions with Verbal Disambiguation*

- a. Welche Tante besuchte die Jungen gestern?
which aunt visited the boys yesterday
‘Which aunt visited the boys yesterday?’
- b. #Welche Tante besuchten die Jungen gestern?
which aunt visited the boys yesterday
‘Which aunt did the boys visit yesterday?’

(12) *Main Clause Questions with Nominal Disambiguation*

- a. Welche Tante besuchte den Junge gestern?
which aunt visited the boy yesterday
'Which aunt visited the boy yesterday?'
- b. #Welche Tante besuchte der Junge gestern?
which aunt visited the boy yesterday
'Which aunt did the boy visit yesterday?'

Since German is a general verb-second language, movement of a phrase to SpecCP is not confined to wh-phrases. An example of a subject-object ambiguity where a Case-ambiguous DP has been moved to SpecCP is provided in (13).

(13) *Declarative Main Clauses*

- a. Die Tante besuchte den Jungen gestern.
the aunt visited the boy yesterday
'The aunt visited the boy yesterday.'
- b. #Die Tante besuchte der Junge gestern.
the aunt visited the boy yesterday
'The boy visited the aunt yesterday.'

Several experiments have investigated declarative main clauses as in (13). These experiments have shown that—as with parallel wh-questions—the subject-before-object structure is preferred on first-pass parsing (cf. Hemforth, 1993; Scheepers, 1996; Scheepers et al., 2000). These experiments have also revealed that sentences like (13) with a definite DP in SpecCP cause stronger garden-path effects than sentences like (9) - (12) where a wh-phrase has been moved to SpecCP.

2.1.3 Movement to SpecCP from Embedded Clause into Matrix Clause

In normative Standard German, movement out of an embedded clause is considered as grammatical only if the embedded clause is a verb-second clause, i.e., a complementizerless clause having the same syntactic structure as a main clause. Examples for such sentences are given in (14) and (15). The sentences in (14) are identical to the sentences in (9) with the exception of the main clause part intervening between the clause initial wh-phrase and the finite verb of the embedded clause. The same holds for the sentences in (15) in relation to the sentences in (10).

(14) *Main Clause Questions with Verbal Disambiguation*

- a. Welche Tante glaubst du, hat die Jungen gestern besucht?
which aunt believe you has the boys yesterday visited
'Which aunt do you believe visited the boys yesterday?'

- b. #Welche Tante glaubst du, haben die Jungen gestern besucht?
 which aunt believe you have the boys yesterday visited
 ‘Which aunt do you believe the boys visited yesterday?’

(15) *Main Clause Questions with Nominal Disambiguation*

- a. Welche Tante glaubst du, hat den Junge gestern besucht?
 which aunt believe you has the-ACC boy yesterday visited
 ‘Which aunt do you believe visited the boy yesterday?’
- b. #Welche Tante glaubst du, hat der Junge gestern besucht?
 which aunt believe you has the-NOM boy yesterday visited
 ‘Which aunt do you believe the boy visited yesterday?’

Given what we already said above, it will come as no surprise that sentences of the kind shown in (14) and (15) exhibit a SO-preference, with disambiguation by number causing a more severe garden-path effect than disambiguation by Case (cf. Meng, 1998; Meng and Bader, 2000a; Schlesewsky et al., 2000).

Sentences where a wh-phrase has been extracted from a complementizer-introduced CP are shown in (16).

(16) *Main Clause Questions*

- a. Welche Tante glaubst du, daß den Junge gestern besucht hat?
 which aunt think you that the boy yesterday visited has
 ‘Which aunt do you think has visited the boy yesterday?’
- b. #Welche Tante glaubst du, daß der Junge gestern besucht hat?
 which aunt think you that the boy yesterday visited has
 ‘Which aunt do you think (that) the boy has visited yesterday?’

In southern German as well as in many other varieties, wh-movement out of *daß*-clauses is grammatical. Furthermore, there is no subject-object asymmetry as it is found in English where normally only non-subjects can be extracted out of *that*-clauses (the so-called *that*-trace-effect). With native speakers of Bavarian as participants, Brueck (1996) and Macketanz (1996) (reported in Schlesewsky et al., 2000) investigated sentences like those in (16). As expected, they found the by-now familiar SO-preference also in this kind of construction.

2.1.4 Further Results

Before leaving the topic of sentences involving movement to SpecCP, it should be mentioned that an SO-preference has also been found in sentences with an initial inanimate DP. Schlesewsky et al. (2000) investigated sentences like those in (17) in a self-paced-reading study.

- (17) a. Welches System unterstützt die Programme auf dem Computer?
 Which system supports the programs on the computer
 ‘Which system supports the programs on the computer?’

- b. #Welches System unterstützen die Programme auf dem Computer?
 Which system support the programs on the computer
 ‘Which system do the programs support on the computer?’

Syntactically, these sentences are identical to the sentences in (9). Here too, Schlesewsky et al. (2000) found the expected SO-preference. This is an important finding because it shows that the SO-preference that has been found in so many experiments on German cannot be reduced to a semantically based parsing-principle like “Analyze an animate DP as subject and an inanimate DP as object”.

2.2 Subject-Object Ambiguities within the Middle Field

We now turn to subject-object ambiguities within the middle-field, that is, the region of the sentence between C^0 and the clause-final verb(s). A major distinction which has to be drawn with regard to these ambiguities concerns the syntactic means by which an object can show up in front of the subject. As explained in the preceding chapter, the object can be located in front of the subject either because it has been moved there from a position lower than the subject, or because it has been base-generated to the left of the subject. The resulting two classes of subject-object ambiguities, together with their respective subtypes, are summarized in (18) and (19).

- (18) *OS-structure derived by movement*
 a. Scrambling (cf. (20))
 b. Pronoun movement (cf. (21))
- (19) *OS-structure base-generated*
 a. Unaccusative and passive verbs with dative object (cf. (27))
 b. Psych verbs with accusative experiencer object (cf. (31))

As with the ambiguities discussed in the preceding section, the ambiguities in (18) invariably show a preference for the SO-structure, but again the garden-path effects that are observed when disambiguation is towards the non-preferred OS-structure vary substantially in strength.

2.2.1 Sentences with OS-Structure Derived by Movement

As pointed out in chapter 3, one of the characteristic features of German syntax is the availability of a movement operation that places the object in front of the subject within the so-called middle field. This kind of middle-field internal movement, which is called SCRAMBLING, gives rise to local ambiguities of the type shown in (20) and (21).

- (20) a. Peter schrieb, daß die Tante gestern die Jungen besucht hat.
 Peter wrote that the aunt yesterday the boys visited has
 ‘Peter wrote that the aunt has visited the boys yesterday.’
 b. #Peter schrieb, daß die Tante gestern die Jungen besucht haben.
 Peter wrote that the aunt yesterday the boys visited have
 ‘Peter wrote that the boys have visited the aunt yesterday.’
- (21) a. Die Tante schrieb, daß sie gestern die Jungen besucht hat.
 the aunt wrote that she yesterday the boys visited has
 ‘The aunt wrote me that she has visited the boys yesterday.’
 b. #Die Tante schrieb, daß sie gestern die Jungen besucht haben.
 the aunt wrote that she/her yesterday the boys visited have
 ‘The aunt wrote me that the boys have visited her yesterday.’

The sentences (20-a) and (21-a) reflect the basic subject-object word order projected by a normal transitive verb like *besuchen* (‘to visit’). In (20-b) and (21-b), the basic word order has been reversed by moving the object—a definite DP in (20-b) and a pronoun in (21-b)—in front of the subject. As stated in chapter 3, we assume that the SO-word order is base-generated irrespective of whether the subject is a definite DP (20-b) or a pronoun (21-b); similarly, we assume that the object is moved in both (20-b) and (21-b). We nevertheless distinguish here between DP-scrambling and pronoun movement because of the clear differences that are observed with respect to the effect movement has on the information-structure of a sentence. As explained in chapter 3, moving a pronominal object in front of the subject does not preclude wide focus, that is, an information structure in which the whole sentence is in focus. Moving a definite DP object, in contrast, obligatorily leads to an information structure with narrow focus on the subject.²

Like all other subject-object ambiguities considered so far, a preference for the SO-structure has been found for sentences like those in (20) and (21) (for pronoun sentences, cf. Bader, 1996; Bader and Meng, 1999; for scrambling sentences, cf. Bader and Meng, 1999; Friederici and Mecklinger, 1996; Scheepers, Hemforth and Konieczny, 2000). Note that this preference does not follow from the Active Filler Hypothesis because these sentences do not contain an active filler. Recall that an active filler is a phrase that is in a position within the phrase-structure tree which can only be reached by movement. For such a phrase, the HSPM knows from the outset that it has to be coindexed with a trace somewhere lower in the tree. However, given our syntactic assumptions, the definite DP *die Tante* in (20) and the pronoun *sie* in (21) are moved only

²It is also possible that DP-scrambling and pronoun movement have to be distinguished on syntactic grounds. The reason is that pronoun movement may follow the pattern of clitic movement, an operation that may be available independently of scrambling.

in sentences with OS word-order; in sentences with subject-object word-order, in contrast, they are generated at the position in which they surface. In other words, these DPs bind a trace only when functioning as an object but not when functioning as a subject.

While the Active Filler Hypothesis cannot be applied to sentences like (20) and (21), a generalization of it is applicable. This generalization is the Minimal Chain Principle of De Vincenzi (1991) which was first introduced in Chapter 1, and which is repeated in (22).

(22) *Minimal Chain Principle*

Avoid postulating unnecessary chain members at S-structure, but do not delay required chain members.

(De Vincenzi, 1991: 13)

The simplest type of chain is a chain with only a single element—that is, a trivial chain consisting of a phrase in its base position. The Minimal Chain Principle therefore predicts that the HSPM will assume that a phrase has not been moved at all, except if it is in a position which can only be reached by movement, such as SpecCP. Applied to the sentences in (20) and (21), this means that the SO-word order will be preferred because this word-order has both subject and object in their respective base-generated position whereas for the competing OS-word order a non-trivial chain would have to be postulated for the first DP (the object).

While locally ambiguous sentences with either a pronoun or a definite first DP do not differ with respect to first-pass parsing—both exhibit the subject-object preference typical for German—the strength of the garden-path effect that is observed on disambiguation towards the unpreferred OS-structure differs significantly. In an experiment designed to determine garden-path strength in different types of subject-object ambiguities, Bader and Meng (1999) presented their subjects with scrambling and pronoun-movement sentences, as well as with sentences with corresponding relative clauses and embedded wh-questions (cf. (23)).

- (23) a. #Peter schrieb, daß die Tante gestern die Jungen besucht haben.
Peter wrote that the aunt yesterday the boys visited have
'Peter wrote that the boys have visited the aunt yesterday.'
- b. #Die Tante schrieb, daß sie gestern die Jungen besucht haben.
the aunt wrote that she/her yesterday the boys visited have
'The aunt wrote that the boys have visited her yesterday.'
- c. #Das ist die Tante, die gestern die Jungen besucht haben.
That is the aunt who yesterday the boys visited have
'That's the aunt who the boys have visited her yesterday.'

- d. #Ich weiß, welche Tante gestern die Jungen besucht haben.
 I know which aunt yesterday the boys visited have
 'I know which aunt the boys have visited her yesterday.'

The results of Bader and Meng (1999) showed that scrambling sentences caused the most severe garden-path effect whereas sentences with pronoun-movement, relative-clauses and indirect wh-question caused garden-path effects of still substantial strength which, however, did not differ significantly from each other. That scrambling sentences cause a stronger garden-path effect than relative clauses has also been found by Friederici and Mecklinger (1996) in a study recording Event Related Brain Potentials (ERPs).

The sentences reviewed in this section are all disambiguated at the clause-final verb by means of subject-verb agreement, and they all lead to rather severe garden-path effects, with certain variations depending on the particular type of moved element. While this contrasts with the cases of disambiguation by a second DP (cf. (8)), for a strong garden-path effect to emerge it is not crucial whether disambiguation is achieved at the verb via number marking (subject-verb agreement) or via Case requirements. This is shown by our next pair of examples.

- (24) a. . . . daß Maria die Lehrerin gesehen hat.
 that M. the teacher seen has
 'that Maria has seen the teacher.'
- b. #. . . . daß Maria_i die Lehrerin t_i geholfen hat.
 that M. the teacher helped has
 'that the teacher has helped Maria.'

On first-pass parsing, these sentences will be assigned the usual SO-structure. This structure can be completed with a verb assigning accusative Case to its object but not with a verb assigning dative Case to its object, because the second DP *die Lehrerin* is morphologically compatible with either nominative or accusative Case but not with dative Case. For (24-b), reanalysis therefore becomes necessary in order to turn the proper name, which is compatible with dative Case, into an object. As pointed out in Bader (1994), when people are presented with sentences like (24-b), they often judge the sentence as ungrammatical and realize that it has a grammatical reading indeed only if the correct structure is explicitly pointed out to them³.

³For experimental results on this point, cf. Bader (in preparation)

2.2.2 Sentences with OS-Structure Base-Generated

As stated in the preceding chapter, three types of verbs have been proposed to project their arguments in the order object-before-subject (cf. (25)). In addition to these verbs, an underlying OS-structure is also licensed when ditransitive verbs are passivized (cf. (26)).

- (25) a. DAT-NOM verbs selecting *sein* ('to be') as perfect auxiliary:
einfallen ('to occur to'), *auffallen* ('to strike'; 'to catch s.o.'s eye'),
 ...
 b. DAT-NOM verbs selecting *haben* ('to have') as perfect auxiliary:
gefallen ('to please'), *imponieren* ('to impress'), ...
 c. ACC-NOM verbs:
interessieren ('to interest'), *langweilen* ('to bore'), ...
- (26) DAT-NOM passivized ditransitive verbs:
geschickt werden ('to be sent'), *gebracht werden* ('to be brought'), ...

Of the four verb classes listed in (25) and (26), two are generally held to project an OS-structure when used with an inanimate subject: Unaccusative verbs with a dative object (cf. (25-a)) and passivized ditransitive verbs (cf. (26)). For the remaining two verb classes, the question of base-generating the OS-structure is somewhat under dispute. All surrounding syntactic uncertainties notwithstanding, extensive experimental research on sentences containing verbs of the sorts listed in (25) and (26) have consistently confirmed the generality of a preference for the SO-structure in German subject-object ambiguities.

The question how locally ambiguous sentences with base-generated OS-structure are processed by the HSPM was first raised in Bader (1996) where pairs of active and passive sentences like those in (27) and (28) were presented in a selfpaced-reading study.

- (27) a. Ich weiß, daß meine Mutter ein Päckchen geschickt hat.
 I know that my-NOM mother a parcel sent has
 'I know that my mother has sent a parcel.'
 b. Ich weiß, daß Maria ein Päckchen geschickt hat.
 I know that M. a parcel sent has
 'I know that Maria has sent a parcel.'
- (28) a. Ich weiß, daß meiner-DAT Mutter ein Päckchen geschickt wurde.
 I know that my mother a parcel sent was.
 'I know that a parcel was sent to my mother'.
 b. #Ich weiß, daß Maria ein Päckchen geschickt wurde.
 I know that M. a parcel sent was.
 'I know that a parcel was sent to Maria'.

Intuitively, such sentences do not give rise to garden-path effects, and the experiment reported in Bader (1996) did not find a statistically significant difference between matched pairs of ambiguous and unambiguous sentences (although numerically such a difference showed up). However, several follow-up studies—using both the method of speeded grammaticality judgments and the self-paced reading method—have established that sentences like those in (27) and (28) exhibit a clear-cut subject-object preference (cf. Bader and Meng, under revision; Meng and Bader, 2000b). While locally ambiguous SO-sentences never differed from their unambiguous counterparts in terms of performance, locally ambiguous OS-sentences consistently lead to worse performance than unambiguous OS-sentences.

What holds for OS-sentences with a passivized ditransitive verb also holds for OS-sentences with verbs like those listed in (25-a) and (25-b). Locally ambiguous OS-sentences terminating in such verbs give rise to worse performance when compared to unambiguous control sentences (cf. (29-a) vs. (29-b)). Parallel locally ambiguous SO-sentences, in contrast, do not differ from unambiguous control sentences (cf. (30-a) vs. (30-b)).

- (29) a. #Ich glaube, daß Peter die Antwort entfallen ist / gefallen hat.
 I believe that P. the answer escaped is / pleased has
 ‘I believe that the answer escaped/pleased Peter.’
 b. Ich glaube, daß dem Mann die Antwort entfallen ist / gefallen hat.
 I believe that the man the answer escaped is / pleased has
 ‘I believe that the answer escaped/pleased the man’
- (30) a. Ich glaube, daß Peter die Antwort gewußt hat.
 I believe that P. the answer known has
 ‘I believe that Peter knew the answer.’
 b. Ich glaube, daß der Mann die Antwort gewußt hat.
 I believe that the man the answer known has
 ‘I believe that the man knew the answer’

Psych-verbs whose experiencer argument is realized by an accusative DP have been intensively investigated by Scheepers (1996) (cf. Scheepers et al., 2000). An example from the studies by Scheepers (1996) is given in (31).

- (31) a. #Vielleicht fürchtete die strenge Lehrerin der stille Schüler ein
 perhaps feared the strict teacher the quiet pupil a
 wenig.
 bit
 ‘Perhaps the quiet pupil feared the strict teacher a little bit.’

- b. #Vielleicht ängstigte die stille Schülerin der strenge Lehrer ein
 perhaps frightened the quiet pupil the strict teacher a
 wenig.
 bit
 'Perhaps the strict teacher frightened the quiet pupil a little bit.'

Sentence (31-a) contains a psych-verb for which the experiencer is realized as a (nominative) subject; the experiencer of the psych-verb in (31-b), in contrast, is realized as an (accusative) object. In comparison to corresponding SO-sentences (not shown here), Scheepers found evidence for a garden-path effect for both (31-a) and (31-b), with (31-b) being more difficult to comprehend than (31-a). In a further experiment, sentences like (31-b) were compared to sentences like (32). These sentences differ in that the subject of the psych-verb (the cause or target of emotion) is an animate DP in (31-b) but an inanimate DP in (32).

- (32) #Vielleicht ängstigte die stille Schülerin der Gesichtsausdruck des
 Perhaps frightened the quiet pupil the face-expression the
 Lehrers ein wenig.
 teacher a bit
 'Perhaps, the facial expression of the teacher frightened the quiet pupil
 a bit.'

Scheepers found evidence for a garden-path effect in both (31-b) and (32), but the effect was larger when the subject was animate than when it was inanimate.

In summary, the results of Scheepers (1996) lend further support to the generality of the subject-object preference found in German syntactic function ambiguities. More importantly, these results show that garden-path strength in syntactic function ambiguities is not solely a function of phrase-structural configurations. Instead, garden-path strength can be modulated by verb-type and by the kind of arguments used with a given verb.

Under the syntactic assumptions made above, neither the Active Filler Hypothesis nor its generalization, the Minimal Chain Principle, applies to the OS-sentences considered in this subsection, for the simple reason that these OS-sentences do not differ from their SO-counterparts in phrase-structural terms, and thus contain neither an active filler nor an inactive one. Recall that our syntactic assumption was that Case is available "everywhere" within VP such that OS-sentences can be generated without movement. The choice between base-generated SO- and OS-structure is made by the argument structure of the verb. OS-sentences may be the result of movement only under the condition of scrambling and/or pronoun movement. The finding of an SO-preference in the absence of phrase-structural differences thus points to the conclusion that the HSPM might have parsing principles at its disposal that make direct reference

to Case features. How this conclusion ties in with the other parsing principles alluded to in the preceding discussion (the Active Filler Hypothesis and the Minimal Chain Principle) will be considered in section 4.

With regard to garden-path strength, one of the most robust findings has been that a clear difference exists between locally ambiguous sentences with base-generated OS-structure and closely matched locally ambiguous sentences with an OS-structure derived by movement. All of the sentences discussed in this subsection under the heading of base-generated OS-sentences give rise to only the mildest sort of garden-path effects—garden-path effects which are usually not perceived consciously. In contrast to base-generated OS-sentences, comparable sentences with a derived OS-structure, that is, embedded OS-sentences consisting of two Case-ambiguous DPs followed by the clause-final disambiguating verb, cause severe garden-path effects which are often perceived consciously. This difference in garden-path strength has been confirmed by all experimental settings that contained sentences of both types.

2.3 Summary: Experimental Studies of Subject-Object Ambiguities

With regard to first-pass parsing, the existing experimental results on German subject-object ambiguities present a simple picture: When the HSPM has a choice between analyzing an ambiguous DP as either subject or object, it is analyzed as subject. This holds irrespective of (i) main or embedded clauses, (ii) sentences containing an active or an “inactive” filler, or (iii) sentences with an OS-structure derived by movement or sentences with a base-generated OS-structure, to name just the most important distinctions to be drawn when it comes to subject-object ambiguities in German.

With regard to garden-path strength, a more complicated, but therefore also more challenging picture, emerged. The two major distinctions that have to be drawn are the following:

- *Verbal versus Nominal Disambiguation*
The mode of disambiguation has a strong effect on the processing of sentences containing an active filler: Wh-questions disambiguated by Case morphology on the second DP only give rise to very mild garden-path effects; Wh-questions disambiguated by the finite verb, in contrast, elicit quite substantial garden-path effects.
- *Derived versus Base-generated OS-sentences*
For verb-final clauses disambiguated at the clause-final verb, it has been found that derived (“scrambled”) OS-sentences give rise to much more severe garden-path effects than base-generated OS sentences. This is true irrespective of whether disambiguation is achieved by means of Case requirements or by means of subject-verb agreement.

In addition to these two major oppositions, a range of more fine-grained distinctions have been observed:

- The strength of the garden-path effect caused by filler-gap sentences may vary with the particular type of movement and with the kind of DP moved.
 - (i) For main clauses, movement of a definite DP within the middle field (“scrambling”) gives rise to more severe garden-path effects than movement of a definite DP to SpecCP (“topicalization”) which in turn causes a more severe garden-path effect than moving of a wh-phrase to SpecCP.
 - (ii) For embedded clauses, movement of a definite DP causes a more severe garden-path effect than movement of a pronoun, a wh-phrase or a relative pronoun, with the latter three being roughly on a par. Comparable results have been found for main-clauses.
- As revealed by the results of Scheepers (1996), garden-path strength in subject-object ambiguities is modulated by fine-grained lexical-semantic differences associated with different types of verbs and their arguments.

3. Object-Object Ambiguities: ‘Prefer Accusative!’

While subject-object ambiguities have been in the center of psycholinguistic research on German from the beginning, ambiguities in which only the syntactic function of the object is at stake entered the stage rather lately. Given that an object can bear any of three Cases (accusative, dative, genitive), there are in principle four types of object-object ambiguities: (i) accusative-dative (ii) accusative-genitive (iii) dative-genitive (iv) accusative-dative-genitive. Given that in German genitive as a Case governed by a verb is rather rare (and diachronically declining), research on object-object ambiguities so far has only considered the ambiguity between accusative and dative object.

Bader, Bayer, Hopf and Meng (1996) (cf. Hopf et al., 1998) presented ambiguous sentences like (33-a) and (33-b) in two experiments: in a paper-and-pencil test where participants had to judge sentences for sounding natural or not, and in an experiment recording event-related-potentials (ERPs).

- (33) a. Menschen, die in Not sind, sollte man unterstützen.
 people who in distress are should one support
 ‘One should support people who are in distress.’
 b. #Menschen, die in Not sind, sollte man helfen.
 people who in distress are should one help
 ‘One should help people who are in distress.’

Considered in isolation, the first DP in these sentences is three-way ambiguous: it might be a subject, an accusative object, or a dative object. The fact that *Menschen* is Case-ambiguous in this way does not affect the claim that dative Case must be realized morphologically (cf. (54) in chapter 3 on page 78).

Although *-en* is ambiguous it is a morpheme that encodes dative Case, among other things

When reading sentences like (33), lack of agreement with the finite modal verb makes it clear immediately that the first DP cannot be the subject. After processing of the modal, these sentences therefore present an instance of an object-object ambiguity: Depending on the clause-final main verb, the first DP is either assigned accusative Case (33-a) or dative Case (33-b).

Sentences in which the object's Case is signaled by morphological means are shown in (34). The plural noun *Mitbürger* in (34-a) is ambiguous between nominative and accusative, and sentence (34-a) therefore becomes unambiguous immediately with processing of the auxiliary which does not agree with *Mitbürger* in number. (34-b) is completely unambiguous because, due to the inflectional morpheme *-n*, the noun *Mitbürgern* can only head a dative DP.

- (34) a. Mitbürger, die in Not sind, sollte man unterstützen.
citizens who in distress are should one support
'One should support citizens who are in distress'
- b. Mitbürgern, die in Not sind, sollte man helfen.
citizens who in distress are should one help
'One should help citizens who are in distress'

Hopf et al. (1998) investigated sentences corresponding to (33-a), (33-b) and (34-b). The results showed a garden-path effect for ambiguous sentences like (33-b) which terminate in a dative-assigning verb. This result was corroborated in a follow-up study which included all four sentence types shown in (33) and (34) (cf. Hopf et al., 2003). These results led Hopf et al. (1998) to conclude that the HSPM prefers the assignment of accusative Case to the assignment of dative Case in situations of a local object-object ambiguity.

But how general is this accusative preference? First of all, the accusative preference observed for sentences like (33-a)/(34-a) is probably a second-pass effect, not a first-pass effect. According to all the experimental evidence reviewed above, the HSPM should assign nominative Case to the initial DP in these sentences. When the lack of subject-verb agreement with the modal verb shows that the initial DP cannot be the subject, the HSPM will conclude that the initial DP is an object. Thus, only during reanalysis does the question arise which Case to assign to the object.

A second observation which might call into question the generality of the preference for accusative Case assignment concerns sentences in which the ambiguous object is located within the middle field. In Bader et al. (1996), it was pointed out that when sentences like (33) are transformed in a way that locates the object immediately to the left of the main verb (cf. (35)), the garden-path effect that is intuitively perceived in a sentence like (33-b) vanishes.

- (35) a. Man sollte Menschen unterstützen, die in Not sind.
 One should people support who in distress are
 ‘One should support people who are in distress.’
 b. Man sollte Menschen helfen, die in Not sind.
 One should people help who in distress are
 ‘One should help people who are in distress.’

Despite the absence of a consciously perceivable garden-path effect in sentences like (35-b), Bader et al. (1996) assumed that accusative Case is generally preferred when there is a choice between accusative and dative assignment, but that the strength of the resulting garden-path effect depends on the distance between point of ambiguity and point of disambiguation (cf. Frazier and Rayner, 1982; Ferreira and Henderson, 1991). Due to the clause initial position in SpecCP and the following relative clause, this distance is rather long in (33-a) whereas it is short in (35-b). If garden-path strength increases with increasing distance between the point of ambiguity and the point of disambiguation, the difference in garden-path strength between (33-b) and (35-b) would follow. A more detailed discussion of this proposal will follow in chapter 8.

Experimental evidence for the claim that sentences like (33-b) (topicalized object/late disambiguation) produce a stronger garden-path effect than sentences like (35-b) (object in base position/early disambiguation) has been provided by Scheepers, Hemforth, and Konieczny (1997), who in fact found no significant garden-path effect when the ambiguous object was contained within the middle-field (cf. (35-b)). However, in a follow-up experiment using the methodology of speeded-grammaticality judgments, Bader (under revision) found a garden-path effect even for sentences with an ambiguous DP in the middle field. Notice that the possessor determiner *Marias* obviates unambiguous morphological Case within its containing DP (which would otherwise be unambiguously Case marked, cf. the dative form *der Tante*).

- (36) a. Der Direktor hat seiner Tante (mehr als nur einmal) geholfen.
 the director has his aunt more than only once helped
 ‘The director supported his aunt more than once.’
 b. #Der Direktor hat Marias Tante (mehr als nur einmal) geholfen.
 the director has M. aunt more than only once helped
 ‘The director supported Maria’s aunt more than once.’
- (37) a. Der Direktor hat seine Tante (mehr als nur einmal) unterstützt.
 the director has his aunt more than only once supported
 ‘The director supported his aunt more than once.’
 b. Der Direktor hat Marias Tante (mehr als nur einmal) unterstützt.
 the director has M. aunt more than only once supported
 ‘The director supported Maria’s aunt more than once.’

In comparison to unambiguous sentences like (36-a), locally ambiguous sentences like (36-b) needed more time to be judged as grammatical (with respect to percentages of correct answers, there was no significant difference). This effect was even stronger when the sentences included the material in parentheses, indicating that garden-path strength increases with increasing distance between point of ambiguity and point of disambiguation. For parallel sentences with either an unambiguous or an ambiguous accusative object (cf. (37-a) and (37-b), respectively), in contrast, no significant differences were found at all.

In summary, the experimental evidence about object-object ambiguities that has been collected so far supports the conclusion that in situations where the HSPM has a choice between assigning accusative or dative Case to a Case-ambiguous DP, the assignment of accusative Case is preferred. This preference holds for both first- and second-pass parsing. This provides supporting evidence for theories of the HSPM which have claimed that parsing principles at work during first-pass parsing are shared by the processes responsible for second-pass parsing, as claimed by, e.g., the “Minimal Revisions Principle” of Frazier (1990).

With regard to garden-path strength, experimental work has shown that a more severe garden-path effect occurs when the ambiguous object has been topicalized than when it is in its base-generated position. Garden-path strength has also been shown to increase with increasing distance between an ambiguous object in the middle field and the clause-final verb. Given that in the experiments showing an effect of topicalization, topicalized objects were separated from the disambiguated verb by more material than non-topicalized objects, the possibility exists that the former effect might reduce to the second one, that is, that only the distance between ambiguous object and disambiguating verb matters. To our knowledge, there is no experimental evidence yet that might resolve this question.

4. Deriving the Case Assignment Generalization

The experimental evidence that we have reviewed in this chapter gives rise to the Case Assignment Generalization which is repeated in (38).

(38) *The Case Assignment Generalization*

1. Assign nominative!
2. If 1. is not possible, assign accusative!
3. If neither 1. nor 2. is possible, assign dative!

In this section, we will consider which properties of the HSPM give rise to the generalization in (38). The main question will be whether the HSPM needs to be equipped with parsing principles that refer to Case directly, or whether the assignment of particular Case features follows as a side-effect from more gen-

eral, independently needed parsing principles referring only to phrase-structural configurations.

As a point of departure, let us consider (39) which states the CASE PREFERENCE PRINCIPLES that were proposed by Bader et al. (1996), who were not yet working under the assumption that dative objects are embedded in a KP shell.

- (39) *The Case Preference Principles* (Bader et al., 1996:15)
- (i) If possible, prefer structural Case over lexical Case.
 - (ii) If possible, prefer nominative Case over accusative Case.

According to the first clause of the Case Preference Principles, when the parser has a choice between assigning structural Case (nominative or accusative) or lexical Case (here dative Case) to a Case ambiguous DP (as, for example, a proper name), the former will be preferred. This clause of the Case Preference Principles therefore predicts that an ambiguous object will preferentially be assigned accusative Case on first-pass parsing. The second clause of the Case Preference Principles applies to subject-object ambiguities that only involve the two structural Cases nominative and accusative, for which, as extensively documented in the preceding sections, a general subject-before-object preference exists.

The Case Preference Principles were postulated on the basis of two premises concerning the phrase-structural encoding of syntactic functions:

- (40) a. In a sentence with a single object, accusative and dative objects do not differ either with regard to their phrase-structural position nor their phrase-structural complexity.
(This is why Bader et al. (1996) called object-object ambiguities “pure Case ambiguities”.)
- b. There are instances of subject-object ambiguities for which the SO- and the OS-structures do not differ in phrase-structural terms.

Given these premises and the first-pass preferences reviewed above, parsing principles making direct reference to Case features in one way or the other are unavoidable. For example, if it were true that sentence (33-a) with its accusative object differs from sentence (33-b) with its dative object only in the type of Case feature associated with the object DP, the observed accusative preference could only come about if the HSPM contained decision principles mentioning Case directly. The same kind of reasoning would apply to subject-object ambiguities if there really were instances of SO- and OS-sentences sharing one and the same phrase-structure tree.

The question whether preferences for particular Case assignments can be explained as side effects of more general decision principles within the HSPM,

or whether Case preference principles in one form or the other are necessary in addition to parsing principles related to phrase-structure building and chain formation, therefore boils down to the question whether or not each syntactic function can be uniquely defined in phrase-structural terms, that is, whether the two premises (40-a) and (40-b) are correct or not. As stated in chapter 3, we now assume a midway position on this point. On the one hand, we have argued that dative objects are phrase-structurally more complex than both subjects and accusative objects in being embedded in a KP (thereby giving up premise (40-a)). On the other hand, we do not assume that each grammatical function is associated with a uniquely defined position in the phrase marker. In particular, according to our syntactic assumptions, certain types of SO- and OS-sentences do not differ from each other in tree-configurational terms. Together, these syntactic assumptions imply that clause (i) of the Case Preference Principles proposed by Bader et al. (1996) is no longer needed whereas clause (ii) will continue to play a role.

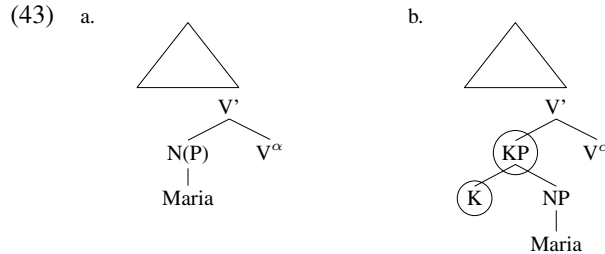
Let us first consider how clause (i) of the Case Preference Principles becomes superfluous under the syntactic assumptions stated in chapter 3. If dative objects are contained within an additional structural layer KP, as proposed by Bayer et al. (2001) and reviewed in chapter 3, the disadvantage of dative Case in situations of local ambiguity immediately follows from the economy principles of the HSPM that were discussed in chapter 2. Here and in the following, we will make use of the principle SIMPLICITY proposed by Gorrell (1995), repeated in (41).

- (41) *Simplicity*
 No vacuous structure building.
 (Gorrell, 1995)

To see how Simplicity derives the accusative preference, consider a sentence fragment like the one in (42).

- (42) Wir haben Maria ...
 We have M.

The clause-initial pronoun *wir* is unambiguously nominative-marked and therefore must be the subject of the sentence. The DP *Maria* thus must be an object, the question being what kind of object. Focusing on the part of the phrase-structure tree relevant to the object *Maria*, we get the two alternative attachments shown in (43) (where the superscripted α on the lower V-node indicates that at this point, the sentence might either end with a verb, or might continue with some further argumental or adverbial phrases).



As a comparison between (43-a) and (43-b) shows, attaching the noun *Maria* as a KP—and thereby as a phrase suitable for dative Case assignment—would involve vacuous structure building as the input does not contain a lexical license for the K-head. It therefore follows that *Maria* will be attached as a NP. The assignment of accusative Case is then an automatic consequence due to the fact that—with or without overt Case morphology—any bare nominal may qualify as a bearer of structural Case such as accusative (see chapter 3 and below for further discussion).

The question that remains is how to derive the subject-before-object preference found in sentences only involving structural Case. Given our syntactic assumptions that SO- and OS-structures are not always phrase-structurally differentiated, we must stick to the second clause of the Case Preference Principles and assume that the HSPM makes use of a parsing principle which states that nominative Case is preferred to accusative Case in situations of local ambiguity.

Does this mean that for parsing German the Minimal Chain Principle which we invoked above (repeated in (44)) can be dispensed with?

(44) *Minimal Chain Principle*

Avoid postulating unnecessary chain members at S-structure, but do not delay required chain members.

(De Vincenzi, 1991: 13)

As we will argue in the following, this is not the case. The Minimal Chain Principle is still needed for a general account of how filler-gap ambiguities in general, and subject-object ambiguities in particular, are resolved in German.

We will first show that the Minimal Chain Principle is at work in filler-gap ambiguities even if no Case ambiguity whatsoever is present. Consider for example the globally ambiguous sentence in (45).

- (45) Welcher Frau hat Peter versprochen, bei der Ernte zu helfen?
 Which woman has Peter promised at the harvest to help
 ‘Which woman did Peter promise to help during the harvest?’

- (46) a. [_{CP} [Welcher Frau]_i hat Peter t_i versprochen [_{CP} PRO bei der Ernte zu helfen]]
 b. [_{CP} [Welcher Frau]_i hat Peter versprochen [_{CP} PRO t_i bei der Ernte zu helfen]]

Sentence (45) consists of a main clause followed by an embedded infinitival clause. The initial wh-phrase *welcher Frau* can either be the dative object of the main clause verb (*versprechen* ‘to promise’) or of the verb contained within the embedded clause (*helfen* ‘to help’). Intuitions suggest that (45) is preferentially analyzed with the wh-phrase belonging to the main clause. The same is true when we consider sentences consisting of a main clause and an embedded finite clause, as illustrated in (47). There is again a preference for understanding the sentence in such a way that the initial wh-phrase is an object of the main-clause verb.

- (47) [Zu wem]_i hat Peter (t_i) gesagt, daß Maria (t_i) gegangen sei?
 To whom has Peter said that Maria gone is
 ‘To whom did Peter say that Maria had gone?’

The intuitions showing the Minimal Chain Principle at work get even stronger when we consider German instances of the filled-gap effect (cf. Crain and Fodor, 1985; Stowe, 1986). This is illustrated by sentence (48-a). When reading the second *zu*-PP (*zu Fritz*) in this sentence, one has a strong impression that there is no place for this PP because the sentence already contains a *zu*-PP, namely the clause initial wh-phrase (*zu wem*). This shows that the initial *zu*-PP has been analyzed as belonging to the main clause, thereby blocking the attachment of a PP of the same kind without undoing the first analysis.

- (48) a. #Zu wem hat Peter zu Fritz gesagt, daß Maria gegangen sei?
 To whom has P. to Fritz said that M. gone is
 ‘To whom did Peter say to Fritz that Maria had gone?’
 b. Zu wem hat Peter gesagt, daß Maria zu Fritz gegangen sei?
 To whom has P. said that M. to F. gone is
 ‘To whom did Peter say that Maria had gone to Fritz?’

Having shown that the Minimal Chain Principle is needed in order to account for first-pass parsing preferences that arise in the absence of any Case ambiguity, let us now return to the question of how to derive the subject-object preference found in German syntactic function ambiguities. For concreteness, consider the globally ambiguous sentence fragment in (49). According to the second clause of the Case Preference Principles, the clause-initial wh-phrase *welche Frau* will be assigned nominative Case. However, this alone is not sufficient to uniquely fix the position of its trace.

- (49) (Ich weiß), welche Frau die Oma ...
 I know which woman the grandmother
 a. [_{CP} [welche Frau]_i C⁰ t_i die Oma ...]
 b. [_{CP} [welche Frau]_i C⁰ die Oma t_i ...]

First of all, it has to be guaranteed that the trace is inserted locally in the current clause, in accordance with what we said when discussing the examples in (45), (47), and (48). If the Minimal Chain Principle is at work in addition to the second clause of the Case Preference Principles, we already have a principle at hand fixing the trace at the desired position.

Within the current parse of (49), there are still two further phrase-structural options: Either the trace is inserted immediately, as prescribed by the Minimal Chain Principle, and will therefore precede the upcoming second DP (cf. (49-a)). Or trace insertion is delayed until the second DP has been processed, with the result that the second DP will precede the trace (cf. (49-b)); such a delay would result from a gap-as-a-last-resort principle; (cf. Fodor, 1978). The first option will lead to a structure appropriate for the great majority of verbs with a subject and an accusative object, namely a verb with basic SO-order. The second option would lead to a structure appropriate for the small class of verbs that are compatible with OS base-order. This alone might be sufficient to argue that a trace whose position is ambiguous is inserted at the earliest position possible, in accordance with the Minimal Chain Principle. However, there is also a more subtle argument in favor of this conclusion.

This argument is based on the behavior of psych-verbs with an experiencer bearing accusative Case. As outlined in chapter 3, such verbs can have both an agentive and a non-agentive reading. Under the assumption that—as with all agentive verbs—the subject precedes the object in the agentive reading of such verbs, whereas it follows the object in the non-agentive reading, the two structures in (50) will differ in meaning.

- (50) Ich weiß, welche Frau die Oma geärgert hat.
 I know which woman the grandma bothered has
 a. Agentive (*molest*) sense
 which woman the grandmother bothered has
 b. Experiencer (*disturblannoy*) sense
 which woman the grandmother bothered has

When reading a sentence like the one in (50), there is a strong intuition that the subject of *ärgern* is an agent. Since this is not a difference in Case assignment—in both (50-a) and (50-b) the first DP is specified for nominative and the second DP for accusative Case, this intuition lends further support to the claim that both the second clause of the Case Preference Principles and the Minimal Chain Prin-

principle are at work in subject-object ambiguities. The Case Preference Principle will give the assignment of Case seen in both (50-a) and (50-b), and the Minimal Chain Principle will have the effect that structure (50-a) is actually computed, the net effect being that sentence (50) is understood in the way indicated.

In summary, then, we hypothesize that three parsing principles jointly account for first-pass preferences in syntactic function ambiguities: Simplicity (51), the Minimal Chain Principle (52), and the Case Preference Principle (53) (which is simply the second clause of the original Case Preference Principles proposed by Bader et al. (1996)).

- (51) *Simplicity*
No vacuous structure building. (Gorrell, 1995)
- (52) *Minimal Chain Principle*
Avoid postulating unnecessary chain members at S-structure, but do not delay required chain members. (De Vincenzi, 1991: 13)
- (53) *The Case Preference Principle*
If possible, prefer nominative Case over accusative Case.

Due to Simplicity, an NP/DP will always be attached directly to the phrase-marker unless Case-morphology forces an additional KP layer. The Minimal Chain Principle and the Case Preference Principle will have the joint effect that for an ambiguous sentence with a filler in the specifier of CP, the structure shown in (54-a) will be computed, whereas for an ambiguous sentence with all NPs located within the middle field, (54-b) will result.

- (54) a.
-
- ```

graph TD
 CP --> DP1i["DP1i
[NOM]"]
 CP --> C_prime["C'"]
 C_prime --> C
 C_prime --> VP
 VP --> DP1["DP1
ti"]
 VP --> V_prime["V'"]
 V_prime --> DP2["DP2
[ACC]"]
 V_prime --> V

```
- b.
- 
- ```

graph TD
    CP --> C
    CP --> VP
    VP --> DP1["DP1  
[NOM]"]
    VP --> V_prime["V'"]
    V_prime --> DP2["DP2  
[ACC]"]
    V_prime --> V
  
```

5. Summary

In this chapter, we have first reviewed the existing experimental literature on syntactic-function ambiguities in German. With respect to first-pass parsing, our review has revealed a simple picture: Subject-object ambiguities exhibit a preference for the SO-reading; object-object ambiguities exhibit a preference for accusative Case over dative Case. These two findings are captured by the Case Assignment Generalization.

(55) *The Case Assignment Generalization*

1. Assign nominative!
2. If 1. is not possible, assign accusative!
3. If neither 1. nor 2. is possible, assign dative!

As we have argued, these preferences are best understood as deriving from the interplay of three parsing principles: Simplicity, the Minimal Chain Principle, and the Case Preference Principle. Only the last principle is peculiar to the processing of syntactic function ambiguities, whereas the former two are independently necessary.

Our review of the experimental literature has also revealed several important contrasts in garden-path strength. Since the focus of this chapter was on the assembly processes of the HSPM, this chapter has confined itself to a presentation of these contrasts. How they follow from an explicit model of the HSPM will be the topic of the following chapters. The major findings—which can be seen as a kind of benchmark test for any viable model of the HSPM’s processing of syntactic function ambiguities—are summarized as below:

- When disambiguated by the clause-final verb, base-generated subject-object ambiguities are much easier to reanalyze than subject-object ambiguities that stem from movement of the object.
- Filler-gap subject-object ambiguities disambiguated by the second DP (nominal disambiguation) are easier to process than filler-gap subject-object ambiguities disambiguated by the verb (verbal disambiguation)
- Object-object-ambiguities with early disambiguation cause weaker garden-path effects than object-object ambiguities with late disambiguation.
- For filler-gap ambiguities, garden-path strength depends on the type of movement (wh-movement vs. topicalization vs. scrambling) as well as on the type of DP moved (pronoun movement versus movement of full DP).
- Garden-path strength can be modulated by the lexical semantics of the verb and its arguments, as shown, for example, by the findings of Scheepers (1996) discussed above.

Chapter 5

THE MENTAL REPRESENTATION OF CASE

1. Introduction

The preceding chapter has documented a wide range of first-pass preferences found in syntactic-function ambiguities which could be summarized by the Case Assignment Generalization “NOM > ACC > DAT”. To date, only one systematic exception to this generalization has been identified. This exception, which we have—following psycholinguistic and philological tradition—termed CASE ATTRACTION in prior work (cf. Bader, 1997; Bader and Meng, 1999), will be the topic of the current chapter. To introduce the phenomenon of Case attraction, consider the following contrasts which were noted in Bader (1994).

(1) *Nominative relative pronoun*

a. *#Dative Case assigned by verb*

... daß man Schwierigkeiten, **die** unangenehm sind,
that one difficulties-DAT which unpleasant are
aus dem Weg gehen soll.
out the way go should

‘... that one should avoid difficulties which are unpleasant.’

b. *Accusative Case assigned by verb*

... daß man Schwierigkeiten, **die** unangenehm sind,
that one difficulties-ACC which unpleasant are
aus dem Weg räumen soll.
out the way put should

‘... that one should remove difficulties which are unpleasant.’

(2) *Dative relative pronoun*a. *Dative Case assigned by verb*

... daß man Schwierigkeiten, **denen** man gegenübersteht,
 that one difficulties-DAT which one faces
 aus dem Weg gehen soll.
 out the way go should
 ‘... that one should avoid difficulties which one faces.’

b. *#Accusative Case assigned by verb*

... daß man Schwierigkeiten, **denen** man gegenübersteht,
 that one difficulties-ACC which one faces
 aus dem Weg räumen soll.
 out the way put should
 ‘... that one should remove difficulties which one faces.’

(1) and (2) contain a temporary ambiguity between accusative and dative object. In (1-a) and (2-a), the DP starting with *Schwierigkeiten* is assigned dative Case by the clause final verb; in (1-b) and (2-b), this DP receives accusative Case. (1) and (2) differ from each other in that the relative clause modifying *Schwierigkeiten* is headed by the relative pronoun *die* (morphologically ambiguous between nominative and accusative Case) in (1) but by the relative pronoun *denen* (unambiguously dative Case) in (2). To see the emerging pattern more easily, (1) and (2) are repeated below reduced to their essential parts.

- | | | | | | |
|-----|----|--|----------|---|-------|
| (3) | a. | ...[Schwierigkeiten + die -NOM] | ...V-DAT | - | GP |
| | b. | ...[Schwierigkeiten + die -NOM] | ...V-ACC | - | no GP |
| (4) | a. | ...[Schwierigkeiten + denen -DAT] | ...V-DAT | - | no GP |
| | b. | ...[Schwierigkeiten + denen -DAT] | ...V-ACC | - | GP |

As indicated in (3) (= (1)) and (4) (= (2)), when the object is followed by *die*, one intuitively perceives a garden-path effect on disambiguation by a dative verb; however, when *denen* follows the object, the pattern reverses and disambiguation by an accusative verb now gets problematic.

Given what was said about object-object ambiguities in the preceding chapter, it is of course not surprising that a garden-path effect can be observed in (1-a). What is surprising, however, is the fact that in (2) it is the accusative verb instead of the dative verb which causes processing difficulties. Given that in sentences without a relative clause (cf. section 3 of the last chapter for examples), or in sentences with a relative clause headed by a relative pronoun bearing structural Case (cf. (1)), an accusative preference is found, the only reason for finding a dative preference in (2) can be the fact that the ambiguous noun *Schwierigkeiten* is immediately followed by a dative relative pronoun. It seems as if the dative feature on the relative pronoun has overwritten the accusative feature which

normally would have been assigned to the object DP. In other words, the head noun seems to have attracted dative Case from the nearby relative pronoun.

Case attraction phenomena have provided important insights about how Case is represented and processed within the HSPM, in particular with respect to the grammatical distinction between structural and lexical Case. Before delving deeper into the topic of Case attraction, we will first discuss so-called NUMBER-ATTRACTION ERRORS in section 2. Number attraction errors are caused by the malfunctioning of feature processes involving subject-verb agreement. They have been intensively studied in research which antedates the research on Case attraction and which will provide a constant background for our discussion of Case attraction. Section 3 will provide some grammatical background pertinent to the phenomenon under consideration. In section 4, we will present the experiment that started our work on Case attraction, as well as further results concerning Case attraction. Section 5 will present a new account of Case attraction in terms of the KP-hypothesis that was introduced in chapter 3, together with a further experiment that has investigated a question not yet answered by the existing experimental literature. The final section will summarize this chapter.

2. Number Attraction

Case attraction—as a process by which one syntactic feature is erroneously replaced by another one—does not seem to be an isolated phenomenon. Besides Case features, number features have been reported to give rise to attraction effects, resulting in what has become known as NUMBER-ATTRACTION ERRORS. A typical example of such an error is provided in (5) (taken from Bock and Cutting, 1992).

(5) *The editor of the history books are ...

In (5), verb and subject do not agree in their number specifications. Instead, the verb seems to erroneously agree with the embedded DP *the history books*. In a sense, the head noun *editor* has attracted the number feature of the embedded noun, such that a plural marking on the finite verb results.

Starting with Bock and Miller (1991), number attraction errors have been the subject of numerous studies on language production (e.g., Bock and Cutting, 1992; Bock et al., 2001; Eberhard, 1997; Nicol, 1995). More recently, such errors have also been shown to occur during language comprehension (for English, cf. Nicol et al., 1997; Pearlmutter et al., 1999; for German, cf. Schriefers and van Kampen, 1993; Häußler et al., 2003; Konieczny et al., 2004).

An important finding with respect to number attraction errors in English has been that there exists an asymmetry between singular and plural. Whereas errors as in (5) are produced with some frequency, the reverse kind of error, which

is shown in (6), occurs with the same low frequency as do agreement errors in sentences where both nouns bear the same number feature, and therefore no interference is possible.¹

(6) *The editors of the history book is ...

According to Nicol (1995) (cf. Eberhard, 1997), attraction errors as in (5) result from the plural feature on *history books* percolating to the noun *editor*, thereby turning the subject DP into a plural DP. When this has happened, plural marking on the verb is an automatic consequence. The further finding of an asymmetry between singular and plural number—as witnessed by the regular occurrence of errors like (5) in contrast to errors like (6)—has been traced back to the fact that plural is the marked category within the English number system (and perhaps universally), whereas singular is the unmarked, default number specification. According to Eberhard (1997), plural as the marked category is represented by a specific plural feature—a plural flag—within the syntactic representation. It is this plural flag which gets erroneously attracted in errors like (5). Singular, in contrast, is the default number specification and lacks a featural representation. Therefore it cannot be attracted and errors as in (6) rarely occur.

3. Case Attraction: The Morpho-Syntactic Background

Case attraction is a linguistic phenomenon that has been described in detail for the first time in Grimm (1866). Grimm presented an impressive amount of data from Ancient Greek, Latin, Gothic, Old Saxon, Old, Middle and New High German in which two directions of attraction could be distinguished:

- a progressive process by which the Case of the head noun (or “head-DP”) is transferred to the relative pronoun
- a regressive process by which the Case of the relative pronoun is transferred to the head noun (or “head-DP”)

The following tradition reserved the term “Case attraction” to the progressive or—in terms of c-command relations—downward process, while the regressive or upwards process was termed “inverse attraction”. Although the focus of the current psycholinguistic work is exclusively on “inverse attraction”, we take the liberty to refer to it with the neutral term “Case attraction” as long as no confusions can arise.

Grimm and the researchers following his initial analysis described cases of attraction with a visible morphological effect in the sense of a transfer of

¹For German, such a strong asymmetry does not seem to exist (cf. Häussler et al, 2003). Currently, the exact reasons for this difference between German and English are unknown.

morphologically explicit Case forms. The Middle High German (MHG) and Old High German (OHG) examples of progressive (downward) attraction are taken from Pittner (1995):

(7) Attraction (progressive)

- a. si gedâht ouch [**maneger leide**] [der ir dâ
she thought also various sufferings-GEN which-GEN her at
heime geschach]
home happened
'She also thought of various misfortunes that happened to her at home'
- b. sendida mih [...] zi [**dheodom**] [**dhem** euuih biraubodon]
sent me to those-DAT that-DAT you robbed
'sent me to the people who robbed you'

Example (7-a) shows the replacement of a nominative relative pronoun by a genitive form which must be conditioned by the genitive "head-DP". (7-b) shows the replacement of a nominative relative pronoun by a dative form which must be conditioned by the dative of the demonstrative head nominal *dheodom*. The examples in (8) from Latin and Middle High German from Grimm (1866) show the reverse process, regressive (upward) attraction.

(8) Inverse Attraction (regressive)

- a. sed [**istum**] [**quem** quaeris] ego sum
but this-ACC who-ACC look-2SG I am
'but the one you are looking for is me'
- b. [**einen mantel**] [**den** er an truoc] der was gezieret
a coat-ACC which-ACC he at wore this-NOM was decorated
genuoc
enough
'a coat which he wore was richly embroidered'
- c. [**dem gote**] [**dem** ich dâ dienen sol] den
the god-DAT who-DAT I there serve should him-ACC
enhelfent si mir niht [...]
NEG-help they me not
'the god whom I should serve, they don't help me to [...] him'

The pattern to be found in the literature is overwhelmingly of the type seen in (8) where the "head-DP" which attracts the Case of the following relative pronoun is in a left-dislocated position, and is subsequently picked up by a pronoun with the Case that is licensed in the root clause. In the Latin example (8-a), this pronoun (which would be *iste*) is zero due to pro-drop. In the Middle High German example (8-b) it is overtly nominative. Most of the examples in Grimm (1866) are such that accusative Case is attracted to a DP which ought to

bear nominative Case. Nevertheless, as shown by (8-c), it is also possible that a dative is attracted to a DP that should actually bear accusative Case.

One of the most important aspects of (both forms of) Case attraction is the role which markedness seems to play. As has already been observed by Grimm and followers and has been analyzed in detail in Pittner (1995), it is almost always the case that the dative and the genitive overwrite the nominative or accusative, and that the accusative overwrites the nominative, whereas the reverse is hardly ever attested. Pittner (1995), who also deals with other aspects of Case and Case recoverability in German relative clauses, suggests the hierarchy in (9) where “ $x > y$ ” reads as “ x is less marked than y ”.

- (9) *Case Hierarchy*
Nominative > Accusative > Other

What determines markedness? Pittner suggests Case morphology. As has already been pointed out in chapter 3, the Case paradigm of German distinguishes datives and genitives pervasively, whereas it retains a distinction between nominative and accusative only in the masculine singular (*der* versus *den*). If nominative is the default Case, the hierarchy in (9) follows. Excluding the default Case, the distinction between accusative and the rest is then determined quantitatively. The fact that the accusative can be overwritten by Cases higher up in the hierarchy (as seen in (8-c)) could, however, also be indicative of a syntactic process that goes beyond paradigm morphology. In chapter 3 we have suggested that the structural Cases are licensed in a way that makes Case morphology essentially redundant. The inherent Cases rely on functional structure that is not provided by the verb. We have claimed that the rich(er) Case morphology that is observed in datives and genitives is the morpho-phonological reflex of a functional projection that dominates NP and DP, and which is missing in the structural Cases. We dubbed this projection KP, as shorthand for “KASE phrase”.

What difference is suggested by the KP-hypothesis? We suspect that it leaves the hierarchy in (9) intact, but implies a qualitative gap between “nominative > accusative” and “other” that does not hold between nominative and accusative, while the weak morphological distinction between the latter two is, of course, still retained. The distinction between “nominative > accusative” and “other” rests on more than morphology, namely on the more elaborate phrase structure that heads datives and genitives, whereas the distinction between nominative and accusative rests indeed on morphology as proposed by Pittner. A first indication of the suspected asymmetry is that in Grimm’s collection of downward attraction nominative overwrites accusative in only 2 out of 63 examples. The rest shows almost exclusively genitive overwriting nominative. More evidence to this extent will be provided by the attraction processes to which we turn now.

4. The Attraction of Dative Case

While effects of Case attraction have been observed in experiments investigating object-object ambiguities (cf. Schlesewsky, 1996) as well as in experiments investigating subject-object ambiguities (cf. Bader and Meng, 1999), the main bulk of experimental evidence on this topic stems from experiments that have made use of subject-object ambiguities for which both SO- and OS-structure are base-generated. A sentence pair illustrating this kind of ambiguity, which was first discussed in section 2.2.2 of the preceding chapter, is repeated in (10).

- (10) a. Ich weiß, daß Maria ein Päckchen geschickt hat.
 I know that M. a parcel sent has
 'I know that Maria has sent a parcel.'
- b. #Ich weiß, daß Maria ein Päckchen geschickt wurde.
 I know that M. a parcel sent was.
 'I know that a parcel was sent to Maria.'

Sentence (10-a) is a simple SO-sentence, sentence (10-b) a base-generated OS-sentence which requires that the proper name *Maria* is assigned dative Case. As pointed out in the preceding chapter, sentences like those in (10) exhibit the usual preference for the SO word-order. SO-sentences, in particular, do not show any sign of a garden-path effect. OS-sentences (10-b), in contrast, systematically result in a garden-path effect. The strength of this effect is usually rather weak.

On analogy to the sentences with object-object ambiguity in (1) and (2), let us consider what happens when we modify the ambiguous proper name by a relative clause. In (11), the proper name is followed by a relative clause with a relative pronoun bearing nominative Case (that is, one of the structural cases).

- (11) a. Ich weiß, daß Maria, **die** mich gerade besucht hat, ein
 I know that M. who-NOM me just visited has a
 Päckchen geschickt hat.
 parcel sent has
 'I know that Maria, who just visited me, has sent a parcel.'
- b. #Ich weiß, daß Maria, **die** mich gerade besucht hat, ein
 I know that M. who-NOM me just visited has a
 Päckchen geschickt wurde.
 parcel sent was.
 'I know that a parcel was sent to Maria, who just visited me.'

For an SO-sentence like (11-a), the relative clause should have no effect, because the Case of the proper name and the Case of the relative pronoun match. For OS-sentences, a garden-path effect is expected even if no relative-clause is present,

and so the question is only whether the garden-path effect might get stronger due to the relative clause.

When the proper name is modified by a relative clause with a dative relative pronoun, sentences like those in (12) result.

- (12) a. Ich weiß, daß Maria, **der** ich gerade begegnet bin, ein
 I know that M. who-DAT I just met am a
 Päckchen geschickt hat.
 parcel sent has
 'I know that Maria, who I just met, has sent a parcel.'
- b. Ich weiß, daß Maria, **der** ich gerade begegnet bin, ein
 I know that M. who-DAT I just met am a
 Päckchen geschickt wurde.
 parcel sent was.
 'I know that a parcel was sent to Maria, who just visited me.'

If Case attraction is a general phenomenon—and not restricted to the sentences discussed at the beginning of this chapter—then we expect it to occur in sentences like those in (12). If the proper name *Maria* attracts dative Case from the adjacent relative pronoun, it should turn into a Dative marked phrase itself. This would not be compatible with the clause final verbal complex *geschickt hat* in (12-a) which requires the proper to be the subject of the clause. Thus, if Case attraction occurs, (12-a) should become a garden-path sentence. Intuitively, this seems indeed to be the Case. Sentence (12-b), on the other hand, is a locally ambiguous OS-sentence which normally induces a garden-path effect because the HSPM will assign nominative instead of dative Case to the initial proper name on first-pass parsing. For such a sentence, attraction of dative Case by the proper name might actually eliminate the garden-path effect that is normally observed.

4.1 The Basic Findings: Experiment 1

The aim of Experiment 1 was to investigate the possible effects that might be exerted by a relative pronoun on its head DP.² To this end, Experiment 1 will test the six kinds of sentences in (10)–(12) using a speeded-grammaticality judgment procedure.

4.1.1 Method

Participants. 42 students of the University of Jena participated in Experiment 1. All subjects were native speakers of German. They either received course credits or were paid 5 DM for participating.

²This experiment was originally part of an unpublished manuscript, Bader (1997).

Materials. The material for Experiment 1 consisted of 30 sentences with each sentence appearing in one of six versions according to the two factors WORD ORDER (SO-order vs. OS-order) and STRUCTURE (without relative clause vs. relative clause with relative pronoun compatible with structural Case (*die*) vs. relative clause with dative relative pronoun (*der*)). A sample sentence is shown in Table 5.1.

Table 5.1. A complete stimulus set for Experiment 1. Note: All sentences in this table were introduced by the main clause *Man hat behauptet*, ('Someone claimed,')

SO-Structure	
Without Relative Clause	daß Anita die neuen Bücher sehr schnell geliefert hat. that A. the new books very quickly delivered has '... that Anita delivered the new books very quickly.'
Structural Relative Clause	daß Anita, die ich übrigens nächste Woche besuchen werde, that A. who I by-the-way next week visit will die neuen Bücher sehr schnell geliefert hat. the new books very quickly delivered has '... that Anita, who I will visit next week, delivered the new books very quickly.'
Dative Relative Clause	daß Anita, der ich übrigens letzte Woche begegnet bin, that A. who I by-the-way last week met am die neuen Bücher sehr schnell geliefert hat. the new books very quickly delivered has '... that Anita, who I met last week, delivered the new books very quickly.'
OS-Structure	
Without Relative Clause	daß Anita die neuen Bücher sehr schnell geliefert wurden. that A. the new books very quickly delivered were '... that the new books were delivered to Anita very quickly.'
Structural Relative Clause	daß Anita, die ich übrigens nächste Woche besuchen werde, that A. who I by-the-way next week visit will die neuen Bücher sehr schnell geliefert wurden. the new books very quickly delivered were '... that the new books were delivered to Anita, who I will visit next week, very quickly.'
Dative Relative Clause	daß Anita, der ich übrigens letzte Woche begegnet bin, that A. who I by-the-way last week met am die neuen Bücher sehr schnell geliefert wurden. the new books very quickly delivered were '... that the new books were delivered to Anita, who I met last week, very quickly.'

All sentences contained a feminine proper name, followed by an inanimate second DP. The sentences always contained the same main verb and were either in the active voice (condition SO-order) or in the passive voice (condition OS-order). For the two conditions with relative clauses, relative clauses were created which were either headed by a relative pronoun marked for structural Case (*die*) or by a dative-marked relative pronoun (*der*). All relative clauses were non-restrictive relative clauses. For a given sentence, the dative relative clause and the structural relative clause consisted of an equal number of words.

The experimental sentences were divided into six lists so that each list contained an equal number of sentences in each condition, but no more than one version of any sentence appeared in a single list. Each list of experimental sentences was embedded in a list of 98 filler sentences. These filler sentences consisted of a variety of sentence types. The order of presentation of experimental sentences was randomized individually for each subject.

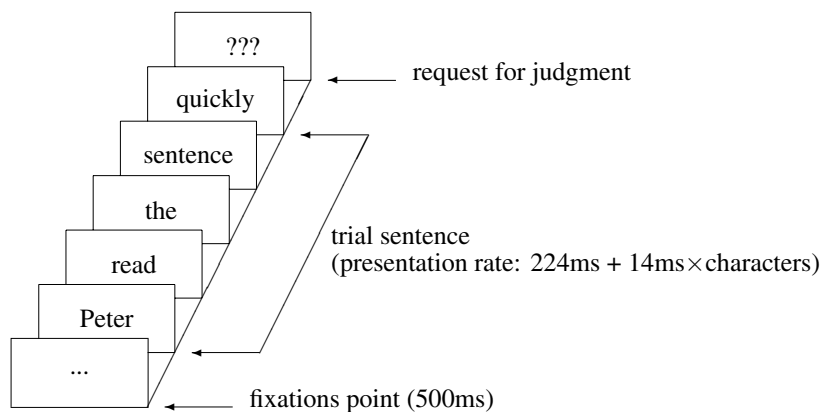


Figure 5.1. The method of speeded grammaticality judgments. The figure shows the consecutive frames that are presented to the participants on a computer screen during a single sentence trial.

Procedure. This experiment—as well as all other experiments reported in this monograph — used a speeded-grammaticality judgment procedure (cf. Figure 5.1 and explanation below). The experiment was run using the DMASTER software developed by K. Forster and J. Forster at Monash University and the University of Arizona.³ Subjects were seated in front of a computer monitor. They were told that they would be presented sentences on the screen and that

³DMASTR is a program for running under MS-DOS; its Windows-based successor is called DMDX. More information, as well as the program itself, can be obtained at the following website: "http://www.u.arizona.edu/kforster/dmdx/dmdx.htm".

their task was to judge the grammaticality of each sentence as quickly and accurately as possible. The concept of grammaticality was explained by examples. Subjects initiated each trial by pressing a foot-pedal. After pressing the foot-pedal, a fixation point appeared in the center of the screen for 1,050 milliseconds. Thereafter, the sentence appeared on the screen in a word by word fashion with each word appearing at the same position (mid-screen). Each word was presented for 224 milliseconds plus an additional 14 milliseconds for each character to compensate for length effects. There was no interval between words. Immediately after the last word of a sentence, three red question marks appeared on the screen, signaling to the subjects that they now were to make their judgment. Subjects indicated their judgment by pressing the left shift-key for ungrammatical and the right shift-key for grammatical sentences. If subjects did not respond within 2000 ms, a warning line *zu langsam* ('too slow') appeared on the screen and the trial was finished.

Prior to the experimental session, subjects received practice trials to ensure that they had understood the task. During the practice trials but not during the experimental session subjects received feedback as to the correctness of their judgments.

4.1.2 Results

Judgments. Table 5.2 shows the percentages of correct responses for Experiment 1. Two-way ANOVAS (2 word orders \times 3 structures) revealed that the factor structure was significant in the subject and item analysis ($F(2,82) = 7.77$, $p < .01$; $F(2,58) = 12.85$, $p < .01$). The factor word order was also significant in both analyses ($F(1,41) = 8.97$, $p < .01$; $F(1,29) = 5.25$, $p < .05$), as was the interaction between word order and structure ($F(1,2,82) = 15.16$, $p < .01$; $F(2,58) = 10.79$, $p < .01$).

The specific predictions derived above were tested by planned comparisons. Comparisons between active and passive clauses showed only one significant difference. Active sentences containing a dative relative clause received significantly less correct responses than passive sentences with a dative relative

Table 5.2. Percentages of Correct Judgments for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Without Relative Clause</i>	<i>Structural Relative Clause</i>	<i>Dative Relative Clause</i>
SO-Structure	80 (2.2)	78 (1.7)	56 (4.7)
OS-Structure	83 (1.9)	77 (2.3)	81 (2.1)

clause (56% versus 81%; $t_1(41) = 4.83$, $p < .01$; $t_2(29) = 3.69$, $p < .01$). Within active and passive clauses, the following differences were significant. Active sentences with a dative relative clause were judged as grammatical less often than active sentences with or without a structural relative clause (56% versus 79%; $t_1(82) = 5.74$, $p < .01$; $t_2(58) = 7.38$, $p < .01$). Passive sentences containing a structural relative clause received less correct responses than passive sentences containing no relative clause (77% versus 83%). This difference was not significant by subjects and marginal significant by items ($t_1(82) = 1.36$, $p > .1$; $t_2(82) = 1.74$, $p < .1$).

Table 5.3. Judgment Times for Correct Judgments (ms) for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Without Relative Clause</i>	<i>Structural Relative Clause</i>	<i>Dative Relative Clause</i>
Masculine	765 (50.2)	790 (53.6)	861 (61.8)
Feminine	857 (62.9)	924 (77.9)	790 (55.8)

Judgment times. Mean reaction times for correct answers are shown in Table 5.3. Two-way ANOVAS (2 word order \times 3 structures) showed that the factor structure was not significant ($F_1(2,82) = 2.09$, $p > .1$; $F_2(2,58) = 1.05$, $p > .1$). The factor word order was marginally significant in the item analysis and not significant in the subject analysis ($F_1(1,41) = 3.39$, $p < .1$; $F_2(1,29) = 2.43$, $p > .1$). The interaction between word order and structure was significant in both analyses ($F_1(2,82) = 4.00$, $p < .05$; $F_2(2,58) = 5.08$, $p < .01$).

Active-sentences without a relative clause needed less time to be judged as grammatical than passive-sentences without a relative clause (765 ms vs. 857 ms). This difference was marginally significant by subjects and not significant by items ($t_1(41) = 2.00$, $p < .1$; $t_2(41) = 1.6$, $p > .1$). Active sentences with a structural relative clause also needed less time to be judged as grammatical than passive sentences with a structural relative clause (790 ms vs. 924 ms). This difference was significant both by subjects and by items ($t_1(41) = 2.77$, $p < .01$; $t_2(41) = 2.35$, $p < .05$). A reverse effect was found for sentences with dative relative clause. Active sentences needed more time than passive sentences (861 ms vs. 790 ms), but this difference was not significant ($t_1(41) = 1.32$, $p > .1$; $t_2(41) = 1.33$, $p > .1$).

Considering reaction time differences within active and passive sentences, respectively, the following results were obtained. For active sentences, sentences with a structural relative clause did not differ from sentences without a relative clause (790 ms vs. 765 ms; both t 's < 1). The difference between

these two types of sentences and sentences with a dative relative clause was marginally significant by subjects and significant by items (778ms vs. 861ms; $t_1(82) = 1.97, p < .05$; $t_2(82) = 2.45, p < .01$). For passive sentences, sentences with a dative relative pronoun needed less time than sentences without a relative clause (790 ms vs. 857 ms), a difference that was not significant in the subject analysis and marginally significant in the item analysis ($t_1(82) = 1.65, p > 1$; $t_2(82) = 1.67, p < .1$). Sentences without a relative clause, in turn, needed less time than sentences with a structural relative clause (857 ms vs. 924 ms). This difference was significant by subjects and marginally significant by items ($t_1(82) = 2.06, p < .05$; $t_2(82) = 1.70, p < .1$).

4.1.3 Discussion

Experiment 1 has three major outcomes. First, SO-sentences containing a relative clause headed by a relative pronoun marked for dative Case elicited a robust garden-path effect. Since SO-sentences normally do not lead to garden-path effects, this finding must be attributed to a process of Case attraction which results in the head DP becoming dative marked under the influence of an overtly dative-marked relative pronoun. Second, locally ambiguous OS-sentences, which—as established in prior research—usually lead to garden-path effects, showed modulating influences of the relative pronoun that followed the clause-initial proper-name: In comparison to sentences without relative clause, which can be taken as the garden-path baseline, sentences with a relative clause bearing structural Case elicited a somewhat stronger garden-path effect whereas the effect was somewhat weaker for sentences with a dative relative Clause. Third, when comparing garden-path strength across the two type of word-orders, a striking difference is observable: For garden-path SO-sentences, that is, garden-path sentences due to attraction of dative Case, a rather strong garden-path effect was observed, as witnessed by only 56% correct answers. OS-sentences, in contrast, were judged at around 80%.

4.2 On the Origin of Case-Attraction Errors

Given the evidence discussed thus far, Case attraction could be seen as some kind of local ambiguity resolution by which a multiply Case-ambiguous noun or proper name is assigned the unambiguous Case of its immediate neighbor. Explanations along these lines have in fact been pursued in Bader (1996), Sauerland (1996), and Schlesewsky (1996). This would set Case attraction apart from number attraction because in number attraction—as shown by example (5)—the form which is overwritten by the plural is normally not number-ambiguous.

Thus, in order to determine whether Case and number attraction are similar phenomena—in the sense of both involving the erroneous percolation of a morpho-syntactic feature—a first prediction to test is the following.

(13) *Case Attraction Prediction 1*

Case attraction should occur not only in locally ambiguous sentences like (2) or the SO-sentences investigated in Experiment 1—that is, sentences in which the head noun is ambiguous and compatible with the Case attracted from the relative pronoun—but also in sentences in which the head noun is morphologically incompatible with the Case of the relative pronoun.

As discussed above, a further finding on number attraction in English has been an asymmetry between singular and plural. While the plural can overwrite the singular in number attraction errors, the reverse does not seem to occur. With respect to Case, we thus get a second prediction.

(14) *Case Attraction Prediction 2*

Inherent (here dative) Case might overwrite a structural Case but not vice versa. The reason is that feature sharing between an NP/DP (structural) and a KP (inherent) is likely to extend to phrase structure, and in terms of phrase structure the KP is more elaborate than the NP or DP. The difference within the structural Cases nominative and accusative should be comparatively smaller so that attraction of the accusative should occur less often and with less severe garden-path effects.

Evidence pertaining to these predictions has been adduced by Bader and Meng (1999) who obtained data on sentences in which the relative clause is attached to a DP which is unambiguously marked as a nominative subject or as a dative object. Examples are given in (15).

- (15) a. #Ich weiß, daß **der** Lehrer, **dem** ich gerade begegnet
 I know that the teacher-NOM who-DAT I just met
 bin, ein Päckchen geschickt hat.
 am a parcel sent has
 'I know that the teacher, who I just met, has sent a parcel.'
- b. Ich weiß, daß **dem** Lehrer, **der** mich gerade besucht hat, ein
 I know that the teacher who me just visited has a
 Päckchen geschickt wurde.
 parcel sent was.
 'I know that a parcel was sent to the teacher, who just visited me.'

The experiment revealed two results concerning sentences of this type.

- For SO-sentences in which the first DP was immediately followed by a dative relative pronoun, there was no difference whatsoever between sentences with a Case-ambiguous proper name (like sentence (12-a) but with a masculine proper name instead of a feminine one) and sentences with a DP

unambiguously marked for nominative Case (cf. (15-a)). In both sentence types, Case attraction seems to have occurred equally often. Both were judged as grammatical with roughly the same frequency and showed about the same reaction times for correct responses: 81% correct (versus 78% for the Case-ambiguous head noun); 627 ms mean reaction time (versus 648 ms for the Case-ambiguous head noun).

- Unambiguous OS-sentences containing a relative clause with a nominative relative pronoun as in (15-b) were judged as accurately and as fast as corresponding unambiguous OS-sentences without a relative clause. That is, these sentences did not lead to a garden-path effect, thereby differing sharply from their ambiguous counterparts.

In a nutshell, then, sentences like those in (15) allow two conclusions: First, Case attraction is not confined to situations in which the head DP is Case-ambiguous, and secondly, dative Case can overwrite structural Case but not vice versa. This is exactly what was predicted under the assumption that Case attraction—like number attraction of the sort shown in (5)—is a kind of erroneous but nevertheless structurally constrained process of feature percolation. Finding Case attraction even with DPs that are morphologically incompatible with the Case to be attracted rules out all hypotheses to the effect that Case attraction results from a kind of ambiguity resolution strategy used by the parser when confronted with a Case-ambiguous DP.

The second important point is that Case attraction in the relative clause constructions under discussion appears to be more or less confined to dative Case overwriting some structural Case. Accusative Case does not lead to a comparably strong garden-path effect. Bader and Meng (1999) includes an experiment which compares dative attraction with accusative attraction. Examples are given in (16) (main clauses are omitted but were part of the experiment).

- (16) a. ... daß Christian, **den** ich nächste Woche besuchen werde,
 that Christian who-ACC I next week visit will
 das Päckchen bis nach Hamburg nachgeschickt hat
 the parcel up to Hamburg sent has
 ‘... that Christian, who I will visit next week, sent the parcel all the
 way to Hamburg’
- b. ... daß Christian, **dem** ich erst kürzlich begegnet bin, das
 that Christian who-DAT I just recently met am the
 Päckchen bis nach Hamburg nachgeschickt hat
 parcel up to Hamburg sent has
 ‘... that Christian, who I had met just recently, sent the parcel all the
 way to Hamburg’

In terms of ambiguity and morphologically expressed Case, (16-a) and (16-b) are exactly alike. It could be expected that the unambiguous Case form *den* yields feature transfer to the Case-ambiguous proper name *Christian* in the same way as *dem* in (16-b), and that this leads to a conflict with the matrix clause's verb which requires nominative Case.

Speeded grammaticality judgments revealed, however, 84% correct responses in the accusative condition seen in (16-a). The nominative condition (*Christian, der-NOM ...*), not represented here, which was used as a baseline elicited 81% correct responses; there was no statistical difference. The dative condition seen in (16-b) led instead to a significant drop of correct judgments down to 70%. Thus, even if accusative Case had been attracted by the head noun in (16-a), this attraction cannot have had a strong influence on first-pass parsing.

In summary, we conclude that Case-attraction is not an ambiguity-resolution strategy but a kind of malfunctioning on part of the HSPM—a malfunctioning which nevertheless is structure-based. Its origin seems to rest in the feature sharing between “head NP” and the relative operator which, in German, pertains to features for number and person. The accident then consists in the extension of feature sharing to Case features. Given either the Case hierarchy in (9) or our own assumptions about the syntactic representation of the inherent Cases, we expect that the more marked or (in terms of features) “richer” form will overwrite the lesser marked or (in terms of features) “more impoverished” form. This leaves open whether the two structural Cases nominative and accusative can overwrite each other or not, or—more in line with (9)—whether the more marked Case accusative can overwrite the unmarked Case nominative. This question will be discussed in the next section.

5. Case Attraction—Syntax or Morphology?

So far, we have given no attention to an obvious difference between number and Case attraction. For number, there is only a two-way distinction in the languages that have played a role in investigations of number attraction, with plural being the marked and singular the unmarked value. In the Case system of German, in contrast, marked dative Case is opposed to two structural Cases, nominative and accusative.

The evidence reviewed in the preceding section has established that dative Case can erroneously be attracted by a DP originally bearing structural Case whereas the reverse does not happen. This of course leaves open the question what would happen if the head noun bears one of the two structural Cases and the relative pronoun the other one. That is, can the two structural Cases nominative and accusative overwrite each other in potential Case-attraction configurations?

This question is closely related to the more general question of how to explain the asymmetry in Case-attraction between dative Case and structural Case which

has been observed so far. There are at least two (not mutually exclusive) ways of accounting for the asymmetry.

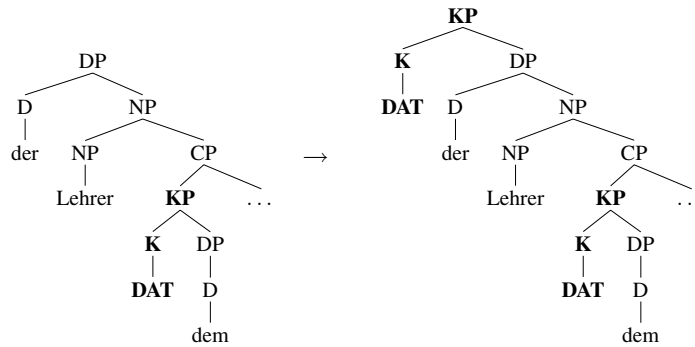
First, there could be a MORPHOLOGY-BASED ACCOUNT which follows the cline of markedness seen in the Case hierarchy in (9). Under such an account, we would expect that a less marked Case can be overwritten by a more marked Case. That is, we would expect that nominative Case can be overwritten by accusative or dative Case, and accusative Case can be overwritten by dative Case. What should not happen is that nominative Case overwrites any of the other Cases, or that accusative overwrites dative.

An alternative to a morphological account would be a SYNTAX-BASED ACCOUNT. According to a syntactic account, the main asymmetry holds between the structural Cases on the one hand and the lexical Case(s) on the other. As has been argued in chapter 3, the overt Case morphology seen in the dative Case can be taken as the exponent of an extra structural layer Kase Phrase (KP). Thus, NPs or DPs which bear one of the structural Cases nominative and accusative lack syntactic structure that must be present in lexical (inherent) Cases.

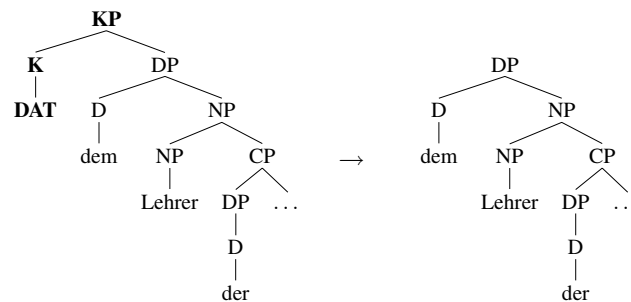
The morphology-based and the syntax-based approaches make different predictions. According to the first, unambiguous Case morphology as seen in the masculine singular forms of the relative pronoun—*den* (ACC) and *dem* (DAT)—should yield comparable attraction effects on a nominative head noun, the nominative being higher on the hierarchy than any other Case. According to the syntactic approach, the accusative should have either no effect or a much weaker effect than the dative. If the dative is represented as a KP, attraction will lead to a copying of the KP-shell onto the head noun. Under this assumption, finding a strong asymmetry between lexical and structural Case would fit well with suggestions according to which structure addition—but not structure retraction—lies within the normal computational capabilities of the HSPM. When dative Case is attracted from the relative pronoun to the head noun, the HSPM has to insert a KP on top of the DP containing the head noun (cf. (17)). Although this means that the CPPM has to be readjusted to some extent, readjustments involving the addition of structure are usually held to be relatively costfree.

In contrast, attraction of a structural Case feature to a DP which is marked for dative Case and therefore contained within a KP would involve the retraction of a piece of structure that is already part of the CPPM (cf. (18)). Retracting already existing information from the CPPM is usually not believed to be among the HSPM's parsing operations, and thus a KP should be immune from attraction effects.

(17)



(18)



If structural Case cannot overwrite dative Case because of the unwillingness on side of the parser to remove the KP-shell from the CPPM, there would, however, still be the possibility that the two structural Cases nominative and accusative might overwrite each other in configurations suitable to Case attraction. The Case hierarchy excludes the possibility that nominative is attracted to accusative, but it could be expected that accusative is attracted to nominative, and from the perspective of the morphological accounts it is even expected that the effect of accusative attraction is as strong as the effect of dative attraction. A first piece of evidence that accusative Case is not attracted by a DP bearing nominative Case has been presented at the end of the last section (cf. example (16)). In the remainder of this section, an experiment will be presented which can shed more light on the status of accusative attraction.

5.1 Experiment 2

The aim of Experiment 2 was to find out whether one structural Case can overwrite the other one. To this end, we will investigate locally ambiguous sentences as in (19).

- (19) a. ... dass Peter Δ die Kinder gelangweilt hat.
 that P. the children bored has
 ‘that Peter bored the children.’
- b. ... dass Peter Δ die Kinder gelangweilt haben.
 that P. the children bored have
 ‘that the children bored Peter.’

Sentence (19-a) has an SO-structure as signaled by the clause-final singular auxiliary. Due to the plural auxiliary in sentence (19-b), this second sentence must be given an OS-structure. The crucial question is what happens when a relative clause is inserted at the position marked by Δ in (19). In particular, will a relative clause headed by a relative pronoun marked for accusative Case turn the clause-initial proper name into an accusative DP—in the same way as a dative relative pronoun did in Experiment 1? The main effect that this should have is that the usually preferred SO-sentences should turn into garden-path sentences.

5.1.1 Method

Materials. For Experiment 2, 40 sentences were created, with each sentence appearing in eight versions, according to the two factors WORD ORDER (SO vs. OS) and STRUCTURE (unambiguous control vs. without relative clause vs. nominative relative clause vs. accusative relative clause). A complete sentence set is shown in Table 5.4.

Participants and Procedure. 42 students of the University of Jena participated in this experiment which used our standard speeded grammaticality judgments method introduced with the preceding experiment.

5.1.2 Results

Judgments. Table 5.5 shows the percentages of correct responses for Experiment 2. Two-way ANOVAS (2 word orders \times 4 structures) revealed a significant main effect of word-order ($F(1,71) = 215.13, p < .001$; $F(1,39) = 452.71, p < .001$), a significant main effect of structure ($F(3,213) = 112.10, p < .001$; $F(3,117) = 135.09, p < .001$), and a significant interaction between word-order and structure ($F(3,213) = 58.44, p < .001$; $F(3,117) = 70.73, p < .001$).

Planned comparisons showed that the mean for SO-sentences without relative clause differed significantly from the mean for SO-sentences with relative clause (92.5% vs. 84.5%; $t_1 = 3.43, p < .01$; $t_2 = 3.77, p < .01$). Neither the difference between unambiguous control sentences and ambiguous sentences without relative clauses was significant (94% vs. 91%; both p 's $> .2$), nor the crucial difference between SO-sentences with nominative relative clause and SO-sentences with accusative relative clause (86% vs. 83%; both p 's $> .2$).

Table 5.4. A complete stimulus set for Experiment 2

<i>Unambiguous Control</i>	Was Michael betrifft, so habe ich gehört, What M. concerns so have I heard daß er/ihn die Verwandten genervt hat/haben. that he/him the relatives annoyed has/have 'Concerning Michael, I have heard that he has annoyed the relatives.' or 'Concerning Michael, I have heard that the relatives have annoyed him.'
<i>Without relative clause</i>	Ich habe gehört, daß Michael die Verwandten genervt hat/haben. I have heard that M. the relatives annoyed has/have 'I have heard that Michael has annoyed the relatives.' or 'I have heard that the relatives have annoyed Michael.'
<i>Nominative relative clause</i>	Ich habe gehört, daß Michael, der mich übrigens I have heard that M. who me by-the-way bald besuchen will, die Verwandten genervt hat/haben. soon visit want the relatives annoyed has/have 'I have heard that Michael, who—by the way—wants to visit me soon, has annoyed the relatives.' or 'I have heard that the relatives have annoyed Michael, who—by the way—wants to visit me soon.'
<i>Accusative relative clause</i>	Ich habe gehört, daß Michael, den ich übrigens I have heard that M. who I by-the-way bald besuchen will, die Verwandten genervt hat/haben. soon visit want the relatives annoyed has/have 'I have heard that Michael, who—by the way—I want to visit soon, has annoyed the relatives.' or 'I have heard that the relatives have annoyed Michael, who—by the way—I want to visit soon.'

Table 5.5. Percentage of Correct Judgments for Experiment 2 (Standard Errors by Subjects in Parentheses)

	<i>Unambiguous Control</i>	<i>Without relative clause</i>	<i>Nominative relative clause</i>	<i>Accusative relative clause</i>
<i>Subject-Object</i>	94 (1.2)	91 (1.6)	86 (1.9)	83 (2.6)
<i>Object-Subject</i>	91 (1.6)	43 (3.8)	28 (3.4)	40 (3.7)

For OS-sentences, planned comparisons showed that ambiguous sentences without relative clause were judged worse than unambiguous control sentences

(43% vs. 91%; $t_1 = 15.07$, $p < .01$; $t_2 = 16.58$, $p < .01$). Ambiguous sentences without relative clause did not differ significantly from ambiguous sentences with accusative relative clause (43% vs. 91%; $t_1 = .95$, n.s.; $t_2 = 1.05$, n.s.), and ambiguous sentences with nominative relative clause were judged worse than ambiguous sentences with accusative relative clause (28% vs. 40%; $t_1 = 3.21$, $p < .01$; $t_2 = 4.12$, $p < .01$).

Table 5.6. Mean Reaction Times (ms) to Make Correct Judgments for Experiment 2 (Standard Errors by Subjects in Parentheses)

	<i>Unambiguous Control</i>	<i>Without relative clause</i>	<i>Nominative relative clause</i>	<i>Accusative relative clause</i>
<i>Subject-Object</i>	542 (26.3)	565 (28.1)	590 (28.5)	569 (26.3)
<i>Object-Subject</i>	605 (27.2)	938 (41.19)	1000 (54.1)	947 (43.2)

Judgment times. Mean reaction times for correct answers are shown in Table 5.6. Because of empty cells, 36 subjects and 3 sentences had to be excluded from the analysis of variance. Two-way ANOVAS (2 word orders \times 4 structures) revealed a significant main effect of word-order ($F(1,35) = 84.09$, $p < .001$; $F(1,36) = 96.60$, $p < .001$), a significant main effect of structure ($F(3,105) = 32.51$, $p < .001$; $F(3,108) = 18.83$, $p < .001$), and a significant interaction between word-order and structure ($F(3,105) = 19.95$, $p < .001$; $F(3,108) = 11.57$, $p < .001$).

Planned comparisons showed that there were no significant differences for SO-sentences. For OS-sentences, unambiguous control sentences were judged as correct substantially faster than ambiguous sentences without relative clause (605ms vs. 938ms; $t_1 = 8.91$, $p < .01$; $t_2 = 6.49$, $p < .01$). Ambiguous sentences without relative clause did not differ significantly from ambiguous sentences with accusative relative clauses (938ms vs. 947ms; $t_1 < 1$; $t_2 = 1.13$, n.s.). The difference between sentences with accusative and sentences with nominative relative clause was only significant in the subject analysis (947ms vs. 1000ms; $t_1 = 3.18$, $p < .01$; $t < 1$).

5.1.3 Discussion

Experiment 2 has two main findings. First, there seems to be no effect of accusative attraction on the processing of SO-sentences: Introducing a relative clause with the unambiguous relative pronoun *den* yielded 83% correct responses which is not significantly lower than the 86% correct responses for sentences containing the nominative relative pronoun *der*. The second finding concerns sentences with OS-structure, that is, with the structure that is usu-

ally dispreferred on first-pass parsing. This dispreference is clearly visible in the results of Experiment 2. Locally ambiguous OS-sentences received 43% correct answers, which is indicative of a quite substantial garden-path effect. For OS-sentences with a relative clause, the case on the relative clause clearly mattered. OS-sentences with an accusative relative pronoun were basically on a par with OS-sentences without relative clause; OS-sentences with a nominative relative clause were judged even worse and received only 28% correct answers.

On first-sight, this might argue for a Case-attraction effect on OS-sentences. However, there is also a different interpretation according to which the introduction of a relative clause into OS-sentences enhances the already strong garden-path effect. Such length effects on garden-path recovery have also been found for other local ambiguities (cf. Frazier and Rayner, 1982; Ferreira and Henderson, 1991). This interpretation is supported by the finding of a drop in accuracy even for SO-sentences with a nominative relative pronoun. The observed difference between OS-sentences with nominative and accusative relative pronoun can then be seen as a second-pass effect instead of a first-pass attraction effect. Garden-path recovery for the sentences under consideration will involve the HSPM “looking back” to the initial DP in order to change its syntactic function from subject to object. It might well be at this stage of processing that a relative pronoun adjacent to the initial DP leads to interference effects—to negative effects when the relative pronoun is marked for nominative Case and to positive effects when the relative pronoun is marked for accusative Case.

In summary, we conclude that there is either no attraction of accusative Case at all, or that the attraction of accusative Case is such a rare event that it has no noticeable consequences for the HSPM.

6. Summary

Case attraction is a widespread phenomenon in languages which has received attention in both philology and linguistics. It normally concerns examples in which some morphological Case X appears on an unexpected DP due to a local context that contains another occurrence of X. The attraction phenomena from German which have been reported in this chapter are somewhat different and have entered the discussion only recently. In the examples under discussion there is no phonetic copying of morphological Case but rather mental attraction of Case from a relative pronoun to the NP or DP to which the relative clause is attached. So we are dealing with so-called INVERSE (or regressive) attraction. This form of attraction shows similarity with number attraction. Both processes are likely to rest on parsing accidents by which a feature is erroneously transferred. In relative constructions the grammar of German requires matching between head NP/DP and the relative pronoun in terms of number and gender but not Case. For the phenomena under consideration the conclusion was that

the process of feature matching may by accident also include features for Case. This conclusion echoes the classical analysis of Grimm (1866). Perhaps the strongest evidence in favor of it is the fact that in comprehension mental Case attraction may overwrite unambiguous Case morphology.

The identification of Case attraction as an erroneous process does not imply that it lacks structure. The contrary is the case. It could be observed that attraction always follows a certain direction which is provided by the Case hierarchy (cf. (9)). By this, a more marked Case on the hierarchy may overwrite a less marked Case but not the other way around. According to this finding, attraction can be explained essentially by morphological markedness. In German, the nominative is the least marked (or null) Case by showing the minimum amount of morphological distinctness, it is followed by the accusative which shows more, which in turn is followed by the dative and the genitive which show maximal distinctions. There are, however, reasons to reject an explanation in terms of morphology. Although morphology is a useful guide, it seems to be only the phonetic manifestation of the syntax of Case. As we have shown, Case attraction cannot be reduced to ambiguity resolution. We have already mentioned that dative Case is frequently attracted by unambiguous nominatives. The other important point is that a morphological account cannot explain the difference between dative attraction and accusative attraction.

In comparison to this, no clear evidence for accusative attraction exists. Given that even with the unambiguous Case form *den* ('who-ACC'), accusative attraction could not be traced experimentally, a purely morphological account as well as the ambiguity-resolution account cannot be correct. By syntactic criteria, nominative and accusative Case form a natural class by virtue of being structural Cases, whereas dative Case is a lexical or inherent Case. The grammar of German provides strong evidence for the correctness of this distinction (cf. the review in chapter 3, section 3.4). While the structural Cases are licensed via agreement with functional vocabulary associated with the verb, the lexical Cases rely on their own functional vocabulary which we have identified in chapter 3 as K (for Kase). If we are correct, the dative (but not the nominative or the accusative) is a KP. Mental attraction of dative Case during parsing causes the attracting NP/DP to turn into a KP as well. As a consequence, the attraction of dative induces a phrase structural change in the input.

This enables us to explain the garden-path effects of dative attraction straightforwardly: Accidental attraction of the dative enriches the unfolding representation with structure that may turn out to be incompatible with further input. The necessary repair involves removal of the KP-shell from the head-DP. Removal of already existing structure is independently known as highly unfavorable. Accidental attraction of the KP may also prevent the HSPM from being garden-pathed. This is the case when the up-coming input requires the head-DP to be a dative.

Chapter 6

A MODEL OF LINKING AND CHECKING

1. Introduction

In his 1994 review of the HSPM, Mitchell pointed out that a complete theory of the HSPM cannot stop with the processes that construct phrase-structure representations. In addition to such processes (the *ASSEMBLY PROCESSES* in Mitchell's terminology), the HSPM must include procedures for continuously checking the ongoing phrase-structure representation with respect to a range of well-formedness requirements, such as the agreement between a verb and its subject, the proper distribution of Case features, and the compatibility between noun-phrases and the thematic roles assigned to them. With respect to these checking *PROCESSES*, Mitchell (1994: 402) raised three important questions:

- (1) a. Do checking operations operate without delay, and are there different kinds of tests applied in a consistent order?
- b. When a test indicates that the current structural hypothesis is not acceptable, can the information derived from this test be used to guide the processes of reanalysis?
- c. Can the substructures from a rejected analysis be kept so that they can be built into a new structure?

Beginning with this chapter, we will develop an explicit model of the post-assembly processes alluded to by Mitchell, although we will use a slightly different terminology. We will speak of checking only in connection with Case- and agreement-features, and use the term linking for all processes involved in associating arguments with slots in the verb's argument structure or theta-grid. There are two reasons for making this terminological distinction. First, it is closer to the way how these terms are used within the theory of grammar.

Second, and more importantly, in the theory that we will propose checking is crucially mediated by linking, and it is therefore important to hold the two apart. This claim of our theory was already embedded in the overall architecture shown in Figure 6.1 (repeated from the introduction).

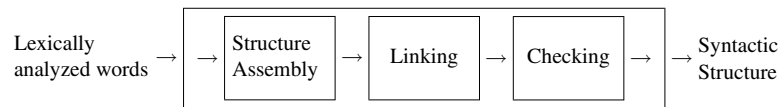


Figure 6.1. A model of the HSPM

Our answer to the first question raised by Mitchell (1994) will thus be that the operations within the HSPM that are responsible for linking DPs within the CPPM to slots within the verb's argument structure precede the processes that check the syntactic structure for agreement and Case features.

Feature checking can, of course, lead to a negative result, indicating that the structure built on the first pass has to be revised. How it is revised is addressed by Mitchell's second and third question. In essence, these questions foreshadowed the diagnosis model of Fodor and Inoue (1994; 1998). To recapitulate shortly what has been said in chapter 2 when introducing the diagnosis model, garden-path recovery in this model proceeds by repairing the CPPM and not by reparsing the falsely analyzed input string. Since this implies that prior structure is not simply discarded, the third question in (1) receives a positive answer within the diagnosis model. Which repair operations have to be taken is determined by a diagnostic reasoning which starts with the temporary ungrammaticality that signals the garden-path. From there, a chain of local adjustments is set into motion which, if successful, will transform the original CPPM into the correct analysis of the input. Thus, the diagnosis model gives a positive answer also to the second question in (1).

The model of linking and checking that we will introduce in this chapter and elaborate in the following chapters is a diagnosis model in the spirit of Fodor and Inoue. While our model will differ in several respects from the original diagnosis model, it will follow it insofar as giving positive answers to the second and the third question in (1). With respect to the second question in particular—the question whether information obtained during linking and checking can be used for purposes of reanalysis—our claim will be that the linking and checking operations of the HSPM act like a diagnostic device, performing certain diagnostic tasks as an automatic by-product of their normal mode of operation. However, the diagnostic capabilities of the linking and checking routines are severely constrained, leading to a partition of the set of garden-path sentences into the following two classes:

- Garden-path sentences for which the revision needed to arrive at the correct structure is delivered for free by the normal linking and checking operations.
- Garden-path sentences for which the correct syntactic structure has to be computed by an elaborate process of diagnostic reasoning.

These two classes correspond to two of the major divisions in garden-path strength that emerged in our review of the literature on syntactic ambiguity resolution in German: (i) Base-generated versus filler-gap OS-sentences and (ii) wh-sentences with Case-disambiguation versus wh-sentences with number disambiguation. In a nutshell, then, our claim will be that for certain types of garden-path effects found with syntactic function ambiguities, diagnosis is an automatic by-product of the normal linking and checking operations, whereas for other garden-path effects the HSPM has to rely on more complex search processes in order to find an alternative syntactic structure.

The presentation of our model of linking and checking will proceed as follows. In the first part of this chapter, we will present the LINKING-BASED CHECKING ALGORITHM (LBCA) which comprises both the linking and checking operations that are part of the processing of every sentence, as well as those diagnosis processes which follow for free from the initial linking and checking. Initially, we will only consider sentences with clause-final disambiguation. After the LBCA has been introduced in section 2, sections 3 through 6 will report a series of experiments that take a closer look at how arguments are linked during language comprehension. Sections 7 and 8 will show how the LBCA generalizes to ambiguous sentences which are disambiguated already before encountering the verb and its argument structure.

2. The Linking and Checking Algorithm

This section will introduce the linking and checking algorithm and show how it explains one of the major distinctions in garden-path strength observed in syntactic-function ambiguities, namely the distinction between base-generated and filler-gap subject-object ambiguities. For purposes of illustration, a filler-gap and a base-generated subject-object ambiguity are repeated in (2) and (3), respectively. The verb *unterstützen* is a typical verb with two structural arguments, as indicated in the argument structure given in (2-a). Verbs of this kind display the canonical subject-before-object word-order as base-order. Subject-object ambiguities with such verbs lead to strong garden-paths if disambiguated toward the OS-structure by the clause final verb (cf. (2-b) and (2-c)).

- (2) a. *unterstützen*: (x, y)
 b. (Ich will wissen), welche Lehrerin die Eltern unterstützt.
 I want know which teacher the parents supports
 ‘I want to know which teacher supports the parents’

- c. #(Ich will wissen), welche Lehrerin die Eltern unterstützen.
 I want know which teacher the parents support
 'I want to know which teacher the parents support.'

In contrast to the verb *unterstützen* and as indicated in (3-a), the verb *gefallen* has a single structural argument *x* (the target-of-emotion) and a further argument *y* (the experiencer) which is diacritically marked for dative Case. As a psych-verb, *gefallen* displays a base-generated OS-order when the target of emotion is inanimate. Verbs like *gefallen* participate in subject-object ambiguities as in (3), which, when disambiguated toward the OS-structure, result in only minor garden-path effects.

- (3) a. */gefallen/* (*x*, *y*)
 |
 DAT
 b. (Keiner wußte,) daß Britta das Buch las.
 Nobody knew that Britta-NOM the book-ACC read
 'Nobody knew that Britta was reading the book.'
 c. #(Keiner wußte,) daß Britta das Buch gefiel.
 Nobody knew that Britta-DAT the book-NOM pleased
 'Nobody knew that the book pleased Britta'

2.1 The Linking-Based Checking Algorithm

Figure 6.2 on next page shows the Linking-Based Checking Algorithm (LBCA) which we propose to account for several of the important garden-path strength differences within the class of syntactic function ambiguities. The LBCA is meant to apply to the incrementally constructed CPPM in such a way that it is triggered each time an argument or an argument-taking element (i.e., a word providing an argument structure) is entered into the CPPM. However, for ease of exposition, we will initially only consider how the LBCA applies in verb-final clauses after the verb has been encountered and the lexical information associated with it has been retrieved from the mental lexicon. How the LBCA works in other situations, for example main clauses with the verb in second position, will be discussed in section 8.

The LBCA consists of two steps. The first step is responsible for linking DPs within the CPPM to argument positions within the verb's argument structure. The second step deals with features: Step 2A checks each relevant feature for correctness. If the CPPM contains only correct features, the structure will be accepted immediately. If, however, a feature mismatch is detected at step 2A, step 2B is invoked in order to repair the mismatch by a local feature correction on the offending DP, if possible. If no local feature correction is possible, the output of the LBCA will be a syntactic structure which is still marked as ungrammatical. Reanalysis procedures outside of the LBCA will then have

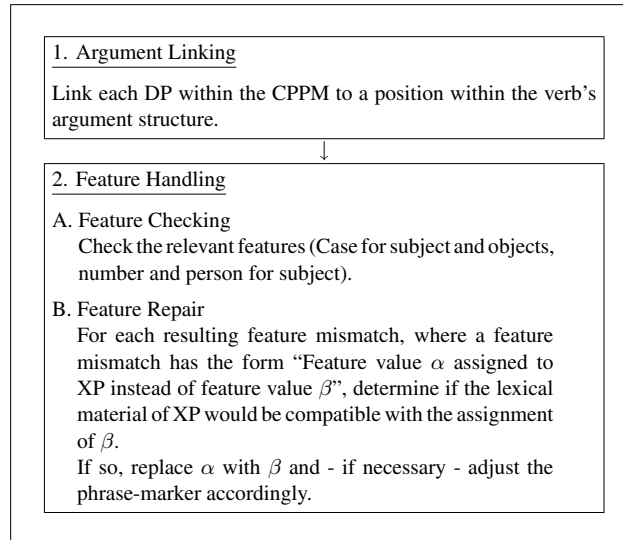


Figure 6.2. The Linking-Based Checking Algorithm (LBCA)

to be invoked in order to remove the remaining ungrammaticality (or, if not possible, to classify the sentence as ultimately ungrammatical).

For verb-final sentences, the LBCA comes into play when the clause-final verb is encountered.¹ At this point of processing, the HSPM receives the lexical information associated with the verb. As outlined in chapter 3, verbs are associated with different pieces of information: The argument structure which specifies the number and types of arguments, the lexical-conceptual structure which partially determines the base-order among the arguments, and, for finite verbs, inflectional information like number and person. This is the information which is available to the HSPM when projecting the information contained in the argument structure onto the CPPM in order to correctly assign the thematic roles associated with the particular verb. The question then is how the HSPM makes use of this information.

As the examples discussed thus far have amply demonstrated, the HSPM cannot take all potentially information freely into account. Otherwise, no garden-path effects at all would be expected in subject-object ambiguities. For example, if number features could be used freely in linking, a sentence like (2-c) should

¹It should be noticed that this is not in conflict with the strictly serial architecture of the parser that we have defended earlier. The LBCA is an algorithm that operates on the phrase structure that has been developed up to each point at which an argument or a verb is encountered.

not cause any difficulties. After all, the number information on the verb unambiguously signals which DP is the subject (and, by exclusion, which one is the object). An HSPM with unlimited access to all potentially relevant information would therefore have no problems at all to deduce the correct assignment of subject and object role to the DPs within the sentence. The fact that a sentence like (2-c) causes a substantial garden-path effect thus clearly shows that the information used to achieve the initial linking must be highly restricted.

We therefore hypothesize that the HSPM is severely constrained with respect to the information used when initially linking DPs to argument slots. In particular, we assume that during the first step of the LBCA the HSPM has only access to argument structure and lexical-conceptual information provided by the verb and Case information contained within the CPPM. This assumption appears in the ARGUMENT LINKING PRINCIPLE given in (4) which states how argumental DPs within the CPPM are linked to the verb's argument structure during the first step of the LBCA.

(4) *Argument Linking Principle*

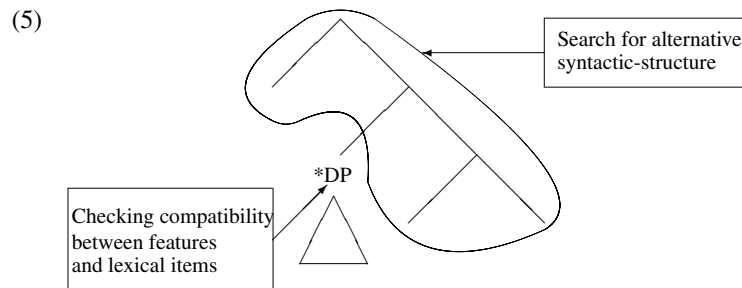
- a. Link the CPPM's nominative marked DP to the highest structural argument, and the CPPM's object DP(s) to the remaining argument(s).
- b. If this leads to a conflict with respect to animacy, and if reversing the linking eliminates the conflict, reverse the linking.

After the HSPM has applied the Argument Linking Principle, the Case features of each DP can be checked. Besides argument structure information, finite verbs also provide certain agreement features (number and person) which will be checked against the respective features of the subject. Checking of Case and agreement features is accomplished by step 2A of the LBCA.

If the features contained within the CPPM match the Case features required by the argument structure, and subject and finite verb agree in their respective features, processing will proceed smoothly. If there is a mismatch, however, the HSPM is faced with the task of finding an alternative syntactic analysis. According to the LBCA, the HSPM accomplishes this task by engaging into processes of diagnosis, of which there are two fundamentally different kinds: local processes situated at step 2B of the LBCA, and non-local processes which come into play only if the prior local processes fail. During step 2B, the HSPM will determine whether an offending DP which has been assigned Case α instead of Case β on first-pass parsing is morphologically compatible with Case β . This is supposed to be a completely local and automatic process because the HSPM has only to check whether the lexical items dominated by the DP under consideration allow for alternative feature assignments. If the HSPM can figure out that they can, and this was the only mismatch detected during step 2A, the offending feature can simply be replaced by the correct one, and processing

can again proceed smoothly. If a local feature correction is not possible, then the HSPM will have to search for a new syntactic structure by taking non-local information into account, that is, information outside the DP which caused the mismatch.

Graphically, the difference between local feature corrections and non-local searches for alternative syntactic structures is depicted in (5). In (5), the CPPM contains a DP-node incurring some kind of feature violation (as indicated by the asterisk in front of it). As shown by (5), the local search space is confined to material dominated by the DP-node itself. The non-local search space, in contrast, is constituted by the complete tree containing the DP under consideration.²



Base-generated and filler-gap OS garden-path sentences crucially differ from each other in that the former can be automatically revised within the LBCA (namely at step 2B) whereas revision in the latter is dependent on procedures outside of the LBCA. To demonstrate how this difference arises, we will now show step by step how the garden-path sentences (2-b) and (3-b) are processed according to the LBCA.

2.2 Application of the LBCA to Base-generated OS-Sentences

Consider first sentence (3-b), repeated here for convenience.

- (6) (Keiner wußte,) daß Britta das Buch gefiel.
 Nobody knew that Britta-DAT the book-NOM pleased
 ‘Nobody knew that the book pleased Britta.’

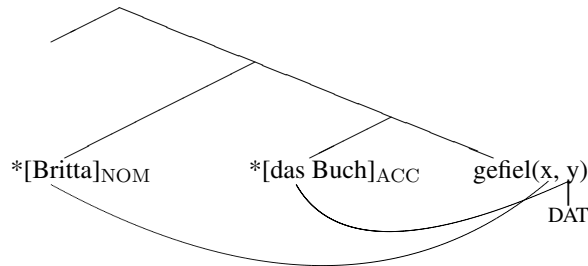
After encountering the clause final verb, the argument structure of the verb *gefiel* (‘pleased’) becomes available to the HSPM. The argument structure of this verb specifies two arguments: an experiencer bearing dative Case and a target of

²In many cases—including all cases considered in this book—the search space is the minimal clause containing the offending DP. However, there are examples where the search space extends to a higher clause.

emotion bearing nominative Case. The experiencer is constrained to be realized by an animate (perhaps only human) DP whereas the target of emotion can be either animate or inanimate. Given this information, the Argument Linking Principle applies as follows.

The CPPM computed so far contains two DPs. Due to the Case Preference Principle proposed in chapter 4, the first DP is marked for nominative and the second DP for accusative. According to the first clause of the Argument Linking Principle, the HSPM will first try to link the target-of-emotion argument (the only and thereby also highest structural argument in the argument-structure of *gefiel*) to the first, nominative-marked DP *Britta*, and the experiencer argument to the second, accusative-marked DP *das Buch* ('the book'). Since this particular linking pattern leads to an animacy violation—*das Buch* is inanimate and therefore cannot act as an experiencer—the second clause of the Argument Linking Principle requires the HSPM to reverse the initial linking. The resulting representation is shown in (7-a).

(7) a. Resulting Structure after Step 1 and Step 2A:



b. Step 2B:

- DAT → Britta? ☹
- NOM → [das Buch]? ☹

An inspection of (7-a) shows that the linking between CPPM and argument structure is now well-formed in semantic terms but not in syntactic terms. When the Case features required by the argument structure are compared to the Case features in the CPPM, two Case violations show up: The first DP bears nominative Case in the CPPM instead of dative Case (as required by the verb); the second DP bears accusative instead of nominative Case.

At this point, step 2B of the LBCA applies. This step is depicted in (7-b). For the two offending DPs, the HSPM has to determine whether these DPs would also be compatible with the Case features required by the argument structure. That is, it has to check whether the DP *Britta* can morphologically license dative Case and whether the DP *ein Buch* is compatible with nominative Case. For

both DPs, the answer is positive and determined without much effort.³ The only thing that now remains to be done by the HSPM is to actually replace the Case features assigned on first-pass parsing by the Case features prescribed by the argument structure of the clause final verb.

In summary, then, we propose that the ease of processing a locally ambiguous sentence like (7), which terminates in a verb with underlying OS-word order, is a function of two factors:

- The verb's argument structure transparently signals to the HSPM which revision operations are necessary in deriving the correct OS-structure. The HSPM only has to guarantee that the indicated revision operations are morphologically licit.
- Determining whether the lexical items involved allow for alternative feature assignments does not pose any particular problems in (7). That is, step 2B of the LBCA is easy to accomplish in sentences of this type.

The first factor is an immediate consequence of how argument linking and feature checking have been implemented within the LBCA. The second factor, in contrast, does not follow from the LBCA alone. By itself, the LBCA only requires that the HSPM makes sure that exchanging one syntactic feature by another one is licit given the lexical material of the DP that gave rise to the feature mismatch. This is an indispensable processing step because otherwise the HSPM could easily come up with a syntactic structure which is in no way licensed by the given input. For example, without this extra step of checking the lexical material the HSPM would have no way to distinguish between a locally ambiguous sentence as in (7) and a downright ungrammatical sentence as in (8), where the ungrammaticality of (8) is due to the fact that *die* in *die Lehrerin* ('the teacher') is not compatible with dative Case.

(8) *(Keiner wußte,) daß die Lehrerin das Buch gefiel.
 Nobody knew that the-NOM/ACC teacher the book-NOM pleased

An important question therefore is how the HSPM determines whether changing the syntactic features of a DP is lexically licit or not. According to the diagnosis model proposed by Fodor and Inoue (1998), reaccessing the lexicon is an operation that can be performed without any difficulties as long as this operation is transparently prompted by prior diagnostic processes. However, as we will show in great detail in chapters 7 and 8, the available evidence on syntactic function ambiguities argues for a different conclusion: Reaccessing

³Recall that *Britta* being a proper name does not show overt inflection for dative Case. Our assumption was that this induces N-to-D raising, and that D would establish the proper license as a dative; cf. chapter 3.

in garden-path strength indicates that it is much easier for the HSPM to assign accusative Case to a formerly nominative-marked DP than to assign dative Case, despite the fact that the particular revision operations are transparently signaled in both sentences.

One difference between (9-a) and (9-b) is of course that the process of making the former subject a dative object involves an additional piece of repair, namely the insertion of a KP. In the case of accusative objects, this particular repair operation is not necessary. However, there is reason to assume that this difference is not a major source of the greater processing difficulty of dative-object sentences in comparison to accusative-object sentences. On the theoretical side, one reason for this assumption is that inserting nodes into the CPPM is normally rather easy for the HSPM, even during reanalysis as long as the necessary operations are easily deducible during diagnosis (cf. Fodor and Inoue, 1998; Gorrell, 1995; Sturt and Crocker, 1998). On the empirical side, this assumption gains support from the observation that in many cases in which a KP has to be inserted on reanalysis, the resulting garden-path effect is only a very modest one, not noticeable consciously.

Instead, we propose that the observed difference in processing difficulty has to be traced back to the fact that there are tighter morpho-syntactic restrictions on the assignment of dative Case than on the assignment of structural Case (cf. chapter 3). Based on the observation that dative Case is in need of a morphological license, Bader et al. (1996) have proposed that assigning dative Case on reanalysis obligatorily triggers a process of lexical reaccess in order to guarantee that the lexical items under consideration are indeed able to license dative Case. That lexical reaccess is particularly difficult for a phrase like *Wessen Mutter*, as witnessed by the results of Bader et al. (2000), is probably due to the fact that dative Case is only indirectly licensed for such phrases (cf. Bayer et al., 2001, and chapter 3). In contrast to the assignment of dative Case, assignment of structural Case during reanalysis has been proposed to proceed without lexical reaccess, at least for lexical items which are underspecified for Case and therefore compatible with structural Case in general. Switching from nominative to accusative Case in (9-a) is therefore more or less cost-free.

To sum up thus far, the temporary mismatch that ensues during the processing of locally ambiguous base-generated OS sentences transparently signals to the HSPM how the CPPM has to be repaired in order to arrive at a well-formed syntactic analysis. In this sense, the repair of such a sentence is delivered for free by the processes which are responsible for linking and checking, and the resulting garden-path effects are normally rather weak. Stronger garden-path effects will only be observed when the HSPM encounters difficulties in determining whether the necessary corrections are morphologically licensed or not.

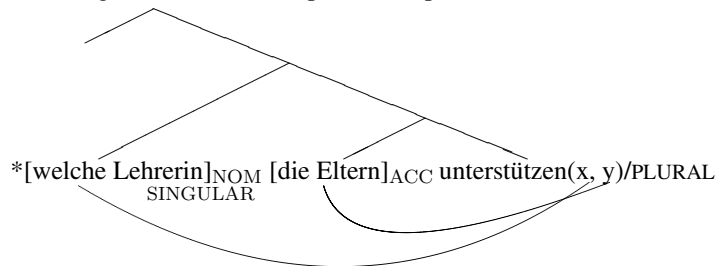
2.3 Application of the LBCA to Derived OS-sentences

Let us now turn to the processing of sentences in which the OS-structure is derived by movement of the object, as in sentence (2-b), which is repeated in (12).

- (12) (Ich will wissen), welche Lehrerin die Eltern unterstützen.
 I want know which teacher the parents support
 'I want to know which teacher the parents support.'

The argument structure provided by the verb *unterstützen* specifies again two structural arguments; the first one will receive nominative Case and the second one accusative Case. Given this argument structure, applying the Argument Linking Principle to the CPPM that has been computed for sentence (12) on first pass parsing will result in the situation depicted in (13). Besides Case features, (13) also shows the number features of the verb and the two DPs contained within the CPPM.

- (13) a. Resulting Structure after Step 1 and Step 2A:



- b. Step 2B:
- PLUR \longrightarrow [welche Lehrerin]? \ominus
 - SING \longrightarrow [unterstützen]? \ominus

In contrast to sentence (7), applying the first clause of the Argument Linking Principle for sentence (12) immediately leads to a representation which is well-formed both with respect to the semantic requirements of the individual argument roles and with respect to the Case features required by the verb. Nevertheless, the resulting representation is not well-formed. It contains a feature mismatch, namely with respect to the number features of the subject and the verb. Given that the nominative-marked DP *welche Lehrerin* is a singular DP, the verb should also be marked for singular. Since it is not, a violation of subject-verb agreement is present in (13-a).

The next step the HSPM has to take consists in determining whether the offending DP could also be a plural DP, or whether the finite verb might also be singular. Since the DP *welche Lehrerin* is definitely a singular DP, and the verb

is definitely a plural verb, step 2B of the LBCA will not be sufficient to deliver the intended syntactic structure for sentence (12). Thus, the mismatch arising in (12) cannot be remedied within the LBCA by a local feature-changing operation. Instead, processes outside of the LBCA will have to be invoked, processes that have access to non-local information, information outside the offending DP. For example, the HSPM will have to take into account that the second DP, the object in the first-pass analysis, is a plural DP and therefore could serve as the subject of the clause-final plural verb. In short, sentence (12) contains a NEGATIVE SYMPTOM in the sense of Fodor and Inoue (1994): The number mismatch between the presumed subject, the first DP, and the clause-final verb tells the HSPM that something has gone wrong, but it does not indicate in any straightforward way how things might improve.

For the base-generated OS-sentence (7), the initial linking at step 1 caused a Case mismatch on both the first and the second DP. For the filler-gap OS-sentence in (12), in contrast, a number mismatch with regard to the agreement between subject and finite verb resulted. This does not mean, however, that there is a simple correlation between reanalysis stage and type of disambiguation. As witnessed by the next pair of examples, a filler-gap OS-sentence may not only cause a subject-verb-agreement violation but also a Case violation (cf. Bader, 1996).

- (14) a. daß Max_i sogar die Lehrerin unterstützt hat.
 that Max-NOM even the teacher-ACC supported has
 ‘that Max supported even the teacher.’
 b. daß Max_i sogar die Lehrerin t_i geholfen hat.
 that Max-DAT even the teacher-NOM helped has
 ‘that even the teacher helped Max.’

During the first pass through the sentences in (14), the HSPM will assign nominative Case to the first and accusative Case to the second DP. This Case assignment is compatible with the clause final verb in (14-a) because *unterstützen* (‘to support’) is a verb requiring an accusative object. In (14-b), in contrast, a Case violation will result because the verb *helfen* (‘to help’), like the verb *gefallen* (‘to please’), assigns dative Case to its object. Superficially, (14-b) therefore looks rather similar to (7). In particular, the need of assigning an OS-structure to (14-b) follows from the fact that of the two DPs, only the first one is compatible with dative Case whereas the second one can receive either nominative or accusative Case, but not dative Case. However, in contrast to *gefallen*, *helfen* is a verb with canonical SO-word order. We therefore get (15) as the result of linking and checking.

- (15) CPPM: * $[\text{Max}]_{\text{NOM}}$ $[\text{die Lehrerin}]_{\text{ACC}}$ geholfen hat (x, y)
 Required: NOM DAT DAT
- Step 2B:
 • $\text{DAT} \longrightarrow [\text{die Lehrerin}]? \ominus$

(15) contains a single mismatch: The second DP should bear dative Case instead of accusative Case. In contrast to what we saw in connection with the base-generated OS-sentence (7), the Case mismatch in (15) cannot be remedied by simply exchanging the incorrect accusative Case by the required dative Case. For morphological reasons, the DP *die Lehrerin* cannot be assigned dative Case. The Case-mismatch in (14-b) therefore cannot be undone already at step 2B of the LBCA. Instead, as was the case for the filler-gap sentence disambiguated by subject-verb agreement, a more elaborate search becomes necessary in order to find the correct OS-structure, a search that will involve the complete clause dominating the two DPs in question.

In summary, the garden-path sentences in (12) and (14-b) illustrate what happens when—due to local ambiguity—a sentence with a derived OS-structure is assigned an SO-structure on first-pass parsing. For such sentences, linking and feature checking do not result in a transparent mismatch configuration that directly signals to the HSPM how to arrive at the correct structure. Instead, a more elaborate diagnostic process will be necessary to determine the repair operations that will transform the initial structure into the correct structure. In the model proposed here, these diagnostic processes are attributed to processes outside of the LBCA, and thus outside of the scope of this book (cf. the final chapter of this book for some considerations concerning diagnostic processes outside of the LBCA). As already shown by a comparison of the sentences in (12) and (14-b), different feature constellations can give rise to diagnostic processes outside the LBCA: a violation of subject-verb agreement for (12), a Case violation for (14-b). If the processes supposed to occur after the LBCA are indeed of a diagnostic nature, then we should expect that the particular violation signaling the need for revision should affect the strength of the resulting garden-path effect. Empirical evidence that this is indeed the case can be found in Bader (in preparation).

2.4 Summary

This concludes our first run through the Linking-Based Checking Algorithm that we propose to be responsible for linking and checking within the HSPM. According to the LBCA, the HSPM first links the DPs contained in the CPPM to slots in the verb's argument structure and then checks the relevant feature of each argument. In addition to linking and checking, the LBCA also takes

care for local feature repairs when the checking procedures indicate a mismatch. For the syntactic function ambiguities considered so far, the LBCA successfully predicts when diagnosis will proceed in a transparent, costfree way and when not:

- For base-generated OS-sentences, linking and feature checking automatically tell the HSPM how the CPPM has to be repaired.
- For OS-sentences derived by movement, in contrast, linking and feature checking do not readily deliver the information necessary to arrive at the correct structure; instead, the HSPM has to rely on a more elaborate search for an alternative analysis.

Despite the LBCA's success in accounting for the examples discussed thus far, we are not yet done, given that our aim is to arrive at a comprehensive model of how syntactic function ambiguities are processed by the human parsing mechanism. Each of the two steps of the LBCA is still in need of further elaboration, as are the processes that are presumed to occur if the LBCA does not lead to a successful reanalysis. In the rest of this chapter, we will concentrate entirely on the first step of the LBCA—the linking step—deferring open questions with regard to processes following the first step to the upcoming chapters. With regard to the initial linking step there are two topics to consider:

(i) The Argument Linking Principle as formulated in (5) has two peculiar properties: First, it attributes a special role to the subject insofar as the subject is linked first (cf. clause one of the Argument Linking Principle). Second, animacy features of the arguments of a verb play a crucial role in the Argument Linking Principle insofar as an animacy mismatch is assumed to lead to a quick, automatic reversal of the very first linking (cf. clause two of the Argument Linking Principle). These properties lead to empirical predictions which will be tested in sections 3 and 4.

(ii) So far, we have only shown how the LBCA handles sentences in which the arguments precede the verb, that is, in sentences disambiguated by a clause-final main verb or an immediately following auxiliary. However, as our overview of syntactic function ambiguities in chapter 4 has shown, some syntactic function ambiguities are disambiguated way before the main verb with its thematic information is encountered, and, crucially, such syntactic function ambiguities also lead to garden-path effects systematically varying in strength. In verb-second clauses, for example, disambiguation might be achieved already by an auxiliary in verb-second position. Furthermore, in both verb-second and verb-final clauses, Case morphology on a DP might lead to disambiguation in advance of encountering the main verb with its associated argument structure. Sections 7 and 8 will address the question as to how the HSPM handles clauses where a

local ambiguity is resolved in advance of the main verb, that is, before argument structure information becomes available.

3. Arriving at the Initial Linking: Experiments 1 and 2

The very first action that the HSPM has to take after it had accessed the verb's argument structure is specified by the first clause of the Argument Linking Principle which requires the HSPM to link the CPPM's nominative-marked DP to the highest structural argument and the CPPM's object-DP to the remaining argument (cf. (5)). According to this part of the Argument Linking Principle, the initial linking directly reflects the assignment of syntactic functions during first-pass parsing, with the subject playing a special role. This special role comes about because a DP assigned nominative Case on first-pass parsing will be linked to the highest structural argument—which corresponds to the subject in a finite clause, whereas a DP not specified for nominative Case will be linked to the remaining slot in the argument structure, independent of whether this leads to a Case-mismatch or not. Furthermore, the first part of the Argument Linking Principle does not make any reference to specific semantic properties associated with the verb. Such properties play a role only in the second clause of the Argument Linking Principle, and there only in a very restricted way, namely in terms of animacy features.

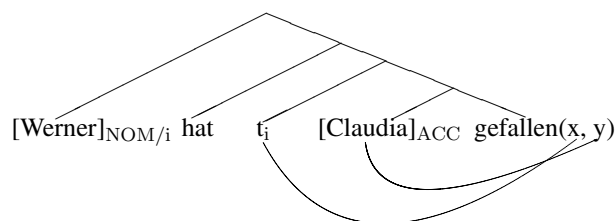
Given these properties of the Argument Linking Principle, consider how the HSPM will process a sentence like (16) which is both syntactically and semantically ambiguous in a global way, and which contains a verb which does not impose any particular order among its two arguments.

- (16) Werner hat Claudia gefallen.
 Werner has Claudia pleased
 Either 'Werner pleased Claudia.' or 'Claudia pleased Werner.'

According to the first-pass preferences introduced in chapter 4, the first DP in (16) will be assigned nominative and the second DP accusative Case (cf. (17)). When the HSPM processes the verb *gefallen* at the end of the sentence, it receives an argument structure with a structural argument and an argument lexically specified for dative Case. According to the first clause of the Argument Linking Principle, the DP marked for nominative will be linked to the structural argument slot of *gefallen* and the DP marked for accusative to the argument slot lexically specified for dative Case. That is, the sentence will receive an SO-structure despite the fact that this leads to a Case-mismatch on the object. Furthermore, as argued in chapter 3, there is no determinate ordering between the two arguments of a verb like *gefallen* when it is used with two animate arguments. As with the ensuing Case-mismatch on the object, this indeterminacy with regard to the ordering of the arguments should have no effect

on the result of the HSPM's initial linking. Since there is no clash involving animacy features, the initial linking produced by the first step of the Argument Linking Principle will also be the final one.

(17) Resulting Structure after Step 1 and Step 2A:



In summary, the Argument Linking Principle predicts that a clear-cut preference for the SO-structure should be found when people read globally ambiguous sentences like (16). This prediction—which will be tested in Experiment 1—can be contrasted with a prediction concerning sentences like (18).

(18) Wahrscheinlich gefiel Werner Claudia.
 Probably pleased Werner Claudia
 Either 'Werner probably pleased Claudia'
 or 'Claudia probably pleased Werner'

(18) differs from (16) in two ways: First, in (18) the main verb is located in C^0 as a result of switching from a composite (perfect) to a non-composite (past) tense form. Second, both arguments are located below C^0 in the middle field while SpecCP has been filled by an adverbial. The joint effect of these two changes is that the main verb now precedes its arguments, in contrast to all other sentences considered in this chapter in which the verb followed its arguments.

So far, syntactic-function ambiguities with the main verb preceding its arguments have not received much attention. One experiment that has investigated such sentences is Experiment 3 of Scheepers et al. (2000). This experiment, which used sentences with nominative-accusative psych-verbs, found that locally ambiguous OS-sentences were at a disadvantage in comparison to locally ambiguous SO-sentences, in agreement with the general subject-object preference found in German. However, due to the lack of unambiguous sentences it is not possible to determine from the experiment by Scheepers et al. whether ambiguous SO-sentences were always assigned an SO-structure on the first pass—which would result in no difference between ambiguous and unambiguous SO-sentences,—or whether an SO-structure was assigned only in the majority of cases—which would result in a disadvantage for ambiguous in comparison to unambiguous SO-sentences. Note that almost all experi-

ments in which the main verb did not precede its arguments found evidence for the former pattern—no difference at all between ambiguous and unambiguous SO-sentences, suggesting that when no verb information is present before the arguments are processed an SO-structure is computed without exception.

While sentences with the verb in verb-second position—thus preceding its arguments—have not received much attention in research on syntactic-function ambiguities, Konieczny, Hemforth, Scheepers and Strube (1997) have shown that having the verb in verb-second position matters for the resolution of PP-attachment ambiguities. Furthermore, the more general question of whether verb-information can guide syntactic ambiguity resolution has generated quite a lot of experimental research (for overviews, cf. Mitchell, 1994; Tanenhaus and Trueswell, 1995). While no consensus has yet been reached as to how this question should be answered, given the evidence in favor of verb-related effects we have tentatively hypothesize that for sentences like (18) the verb might well have an influence, with the result that if there still is a subject-before-object preference, it should be weaker than for sentences as in (16).

Since the sentences in (16) and (18) are globally ambiguous, first-pass preferences cannot be tested in the usual way, that is, by determining which disambiguation of a syntactic ambiguity leads to a garden-path effect. However, it is possible to fit these sentences into the usual experimental garden-path design without destroying the crucial global ambiguity, namely by adding some material which disambiguates after the sentence itself has been read. One way to achieve this for sentence (16) is shown in (19) (for (18), things would work in a parallel manner). In (19), an elliptical adjunct has been appended to the clause. By containing an unambiguously Case-marked DP, this elliptical adjunct disambiguates the globally ambiguous initial clause either towards the SO- or the OS-structure.

- (19) a. Werner hat nicht nur Claudia gefallen, sondern auch ihr
 Werner has not only Claudia pleased, but also her-NOM
 Bruder.
 brother
 'Not only Claudia pleased Werner, but also her brother did.'
- b. Werner hat nicht nur Claudia gefallen, sondern auch ihrem
 Werner has not only Claudia pleased, but also her-DAT
 Bruder.
 brother
 'Werner pleased not only Claudia, but also her brother'

Making use of the experimental manipulation shown in (19), Experiment 1 and Experiment 2 will test the predictions that our theory makes for the sentences in (16) and (18).

3.1 Experiment 1

3.1.1 Method

Materials. 16 sentence quartets were constructed on the model of sentences in (19-a) and (19-b). A complete sentence quartet is shown in Table 6.1. Sentences had either an SO- or an OS-structure, and they were either ambiguous or unambiguous. All sentences consisted of a main clause followed by a DP introduced by *sondern auch* ('but also'). This sentence-final DP was construed with the second DP which was always preceded by the words *nicht nur* ('not only'). In ambiguous sentences, the main clause contained two Case-ambiguous proper names and was therefore compatible with both an SO- and an OS-reading. Disambiguation was achieved by the sentence-final DP which was overtly inflected for either nominative or dative Case. In unambiguous sentences, the first DP of the main clause was a masculine definite DP inflected for either nominative or dative Case.

Table 6.1. A complete stimulus set for Experiment 1

Subject-Object	
Unambiguous	Der Besucher hat nicht nur Sabine imponiert, The visitor-NOM has not only S. impressed sondern auch ihrem Opa but also her grandpa-DAT 'The visitor impressed not only Sabine, but also her grandpa.'
Ambiguous	Erwin hat nicht nur Sabine imponiert, sondern auch ihrem Opa E. has not only S. impressed but also her grandpa-DAT 'Erwin impressed not only Sabine, but also her grandpa.'
Object-Subject	
Unambiguous	Dem Besucher hat nicht nur Sabine imponiert, The visitor-DAT has not only S. impressed sondern auch ihr Opa but also her grandpa-NOM 'Not only Sabine impressed the visitor, but also her grandpa.'
Ambiguous	Erwin hat nicht nur Sabine imponiert, E. has not only S. impressed sondern auch ihr Opa but also her grandpa-NOM 'Not only Sabine impressed Erwin, but also her grandpa.'

Eight different verbs were used in Experiment 1. As shown in (20), half of them selected *haben* as perfect-auxiliary and the other half *sein*.

- (20) a. Verbs selecting *haben* ('to have') as perfect-auxiliary:
imponieren ('to impress'), *gefallen* ('to please'), *missfallen* ('to dis-
 please'), *fehlen* ('to miss')
- b. Verbs selecting *sein* ('to be') as perfect-auxiliary:
entgegenreten ('to oppose'), *zuvorkommen* ('to forestall; to antici-
 pate'), *auffallen* ('to strike s.o.; to catch s.o.'s eye'), *begegnen* ('to
 meet')

Participants and Procedure. 16 students of the University of Jena participated in this experiment which used our standard procedure of speeded grammaticality judgments.

3.1.2 Results

Judgments. Table 6.2 shows the percentages of correct responses for Experiment 1. Two-way ANOVAS (2 word orders \times 2 types of first DP) revealed a significant main effect of word order ($F(1,15) = 15.04$, $p < .01$; $F(1,15) = 50.86$, $p < .01$), a significant effect of type of first DP ($F(1,15) = 39.28$, $p < .01$; $F(1,15) = 25.79$, $p < .01$), and a significant interaction between word order and type of first-DP ($F(1,15) = 18.35$, $p < .01$; $F(1,15) = 49.08$, $p < .01$). The difference between verbs selecting *haben* as their perfect auxiliary and verbs selecting *sein* had no significant effect.

Table 6.2. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Subject-Object</i>		<i>Object-Subject</i>	
	<i>Unambiguous</i>	<i>Ambiguous</i>	<i>Unambiguous</i>	<i>Ambiguous</i>
Percentage correct	95 (2.6)	91 (4.2)	94 (3.0)	50 (7.1)
Judgment time	612 (43.9)	579 (47.6)	627 (49.9)	896 (69.6)

Judgment times. Mean reaction times for correct answers are also shown in Table 6.2. Because of empty cells, two subjects had to be excluded from the analysis of variance. Two-way ANOVAS (2 word orders \times 2 types of first DP) revealed a significant main effect of word order ($F(1,13) = 9.18$, $p < .05$; $F(1,15) = 14.15$, $p < .01$), an effect of type of first DP which was marginally significant in the subject and significant in the item analysis ($F(1,13) = 3.92$, $p < .1$; $F(1,15) = 4.81$, $p < .05$), and a significant interaction between word order and type of first-DP ($F(1,13) = 6.31$, $p < .05$; $F(1,15) = 7.55$, $p < .05$).

3.1.3 Discussion

The major result obtained in Experiment 1 is that globally ambiguous sentences disambiguated toward the OS-structure produced a severe garden-path effect whereas disambiguation toward the SO-reading did not lead to any sign of a garden-path effect. This finding of an SO-preference despite the fact that the verbs used in Experiment 1 allow for the base-generation of either an SO- or an OS-structure provides clear evidence for the particular interplay of first-pass parsing preferences and argument linking on encountering the clause-final main verb postulated by our theory. In particular, it provides evidence for our assumption that the initial assignment of an SO-structure is not changed for the mere reason that a verb can take both SO and OS as base-order.

3.2 Experiment 2

3.2.1 Method

Participants and Procedure. 32 students of the Universities of Jena and Konstanz participated in this experiment which used our standard procedure of speeded grammaticality judgments.

Materials. 16 sentence quartets were constructed for Experiment 2 (cf. Table 6.3 on the next page for a sample sentence). The design of this experiment was the same as the one for the preceding experiment, with the following differences. First, all sentences were in the past tense so that the main verb was always located in the verb-second position. Because three of the verbs selecting *sein* that were used in Experiment 1 are verbs with separable prefix, only the four verbs that select *haben* were used in Experiment 2 (cf. (20-a)). Each verb was used in four sentences. Furthermore, all sentences started with an adverbial phrase, and the two arguments of the verb therefore always followed the verb.

3.2.2 Results

Judgments. Table 6.4 on the next page shows the percentages of correct responses for Experiment 2. The only significant effect revealed by two-way ANOVAS (2 word orders \times 2 types of first DP) was the effect of first DP ($F(1,31) = 15.06$, $p < .01$; $F(1,15) = 11.75$, $p < .01$). The main effect of word order (both F-values < 1) and the interaction between first DP and word order ($F(1,31) = 1.19$, n.s.; $F(1,15) = 0.51$, n.s.) were not significant.

Judgment times. Mean reaction times for correct answers are also shown in Table 6.4. Because of empty cells, one subject and one sentence had to be excluded from the analysis of variance. Two-way ANOVAS (2 word orders \times 2 types of first DP) again revealed a significant main effect of first DP ($F(1,30) = 21.20$, $p < .01$; $F(1,14) = 25.02$, $p < .01$) but neither a main effect of word order nor an interaction between first DP and word order (all f-values < 1).

Table 6.3. A complete stimulus set for Experiment 2

Subject-Object	
Unambiguous	Wahrscheinlich imponierte der Besucher nicht nur Sabine, Probably impressed the visitor-NOM not only S. sondern auch ihrem Opa but also her grandpa-DAT 'The visitor probably impressed not only Sabine, but also her grandpa.'
Ambiguous	Wahrscheinlich imponierte Erwin nicht nur Sabine, Probably impressed E. not only S. sondern auch ihrem Opa but also her grandpa-DAT 'Erwin probably impressed not only Sabine, but also her grandpa.'
Object-Subject	
Unambiguous	Wahrscheinlich imponierte dem Besucher nicht nur Sabine Probably impressed the visitor-DAT not only S. sondern auch ihr Opa but also her grandpa-NOM 'Probably not only Sabine impressed the visitor, but also her grandpa.'
Ambiguous	Wahrscheinlich imponierte Erwin nicht nur Sabine Probably impressed E. not only S. sondern auch ihr Opa but also her grandpa-NOM 'Probably not only Sabine impressed Erwin, but also her grandpa.'

Table 6.4. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 2 (Standard Errors by Subjects in Parentheses)

	<i>Subject-Object</i>		<i>Object-Subject</i>	
	<i>Unambiguous</i>	<i>Ambiguous</i>	<i>Unambiguous</i>	<i>Ambiguous</i>
Percentage correct	88 (3.36)	80 (3.62)	89 (3.71)	74 (4.41)
Judgment time	529 (46.3)	719 (52.7)	547 (39.3)	688 (54.7)

3.2.3 Discussion

The outcome of Experiment 2 differs markedly from the outcome of Experiment 1: As shown by a comparison between ambiguous and unambiguous sentences,

a garden-path effect resulted not only for ambiguous sentences with OS-word order, but also for sentences with SO-word order. Although the strength of the garden-path was numerically stronger for OS- than for SO-sentences, this difference was not corroborated in the statistical analysis. Furthermore, the garden-path effects found in Experiment 2 were substantially weaker than the garden-path effect found for ambiguous OS-sentences in Experiment 1.

These findings are of particular interest given the sparseness of data on sentences with the main verb preceding its arguments. The main conclusion to be drawn from these findings is that when a verb compatible with base-generated SO as well as base-generated OS-structure precedes its arguments, the HSPM does not always assign the otherwise preferred SO-structure but sometimes also the OS-structure. These results thus add to the existing evidence that verb information is an important determinant for on-line language comprehension. Furthermore, when considering the results of Experiment 1 and Experiment 2 in conjunction, we get strong support for our assumptions that when arguments enter the CPPM in advance of any verbal information, default parsing principles apply, and that the syntactic structure assigned on the first pass cannot be overridden by later verb-information.

4. Argument Linking and Garden-Path Recovery: Experiments 3 and 4

The Argument Linking Principle as part of the first step of the LBCA draws a sharp distinction between base-generated OS garden-path sentences as in (21) and filler-gap OS garden-path sentences as in (23) (this sentence is a filler-gap OS-sentence with disambiguation by Case (cf. (14-b)). Argument linking as implemented in the LBCA implies that the base-generated OS-sentence (21) leads to the linking pattern shown in (22), whereas the filler-gap OS-sentence (23) leads to the linking pattern in (24).

(21) *Base-generated OS garden-path sentence:*

daß Max das Gedicht gefallen hat.
that Max-DAT the poem-NOM pleased has
'that the poem pleased Max'

(22) *Linking pattern of a base-generated OS-sentence*

CPPM: [DP1 Max]_{nom} [DP2 das Gedicht]_{acc} gefallen hat (x, y)
Required *DAT *NOM DAT

STEP 2B:

- DAT → [Max]? ☹
- NOM → [das Gedicht]? ☹

- (23) *Filler-gap OS garden-path sentence*
 daß Max_i die Lehrerin t_i geholfen hat.
 that Max-DAT the teacher-NOM helped has
 ‘that the teacher helped Max.’
- (24) *Linking pattern of a filler-gap OS-sentence*
 CPPM: [DP₁ Max]_{nom} [DP₂ die Lehrerin]_{acc} geholfen hat (x, y)
 | | |
 Required NOM *DAT DAT
- STEP 2B:
 • DAT → [die Lehrerin]? ☹

For the base-generated OS-sentence, the linking in (22) transparently signals what needs to be done in order to arrive at the correct OS-structure. For the filler-gap OS-sentence, in contrast, the initial linking in (24) does not yet deliver the information necessary for computing the desired OS-structure. This difference comes about because the animacy constraint on the experiencer argument of *gefallen* implies that in (21) the first DP must be linked to the dative slot in the argument structure whereas the second DP must be linked to the structural argument slot, the one corresponding to the target of emotion. For (23) with the verb *helfen* and two animate arguments, in contrast, animacy is of no help.

Note that in this scenario, the distinction between base-generating an OS-structure and deriving an OS-structure by movement per se does not play any role for how sentences like (21) and (23) are processed. This is so because in these sentences the two oppositions under consideration (base-generated versus derived by movement and animacy-constraints on linking versus no animacy-constraints) are confounded. The question therefore arises what happens when these two oppositions are not confounded. In particular, how do base-generated sentences containing two animate DPs compare to the two types of sentences considered so far? A sample sentence with base-generated OS-structure and two animate DPs is provided in (25)

- (25) daß Max die Lehrerin gefallen hat.
 that Max-DAT the teacher-NOM pleased has
 ‘that the teacher pleased Max.’

Sentence (25) again contains the verb *gefallen*. As shown in chapter 3, this verb allows the base-generation of both an SO- and an OS-structure when both the subject and the object are animate.

As the discussion for Experiment 1 has already shown, our theory predicts a clear-cut subject-object preference for such a sentence, and therefore a garden-path effect given that the sentence is in fact disambiguated toward the OS-

structure. The question is how the strength of this garden-path effect fares in comparison with the garden-path effects caused by the superficially similar sentences (21) and (23). First of all, sentence (25) with its two animate DPs should cause a substantially stronger garden-path effect than sentence (21) with an animate and an inanimate DP. Although both sentences end with the same verb *gefallen* and therefore allow for the base-generation of the OS-structure, according to the Argument Linking Principle only (21) will result in a linking pattern which makes an automatic repair by the LBCA possible (cf. the linking pattern in (22)). (25), in contrast, will result in the same linking pattern as the filler-gap sentence (23). Therefore, it can only be repaired with the help of processes which go beyond the LBCA.

While the LBCA will treat sentences like (23) and (25) alike, there is nevertheless reason to assume that the reanalysis processes which follow the LBCA and which are responsible for finding the correct structure for these sentences will be different in the two cases. In particular, the garden-path effect caused by the base-generated sentence (25) should not be as strong as the one caused by the filler-gap sentence (23) if the claims in chapter 3 were correct. As we saw when discussing the various factors regulating word order in German in chapter 3, verbs like *gefallen* ('to please') allow for the base-generation of the OS-structure whereas verbs like *helfen* ('to help'), when used with an animate subject, do not. This has, first of all, consequences for the information or focus structure of these sentences. When the object has been base-generated in front of the subject the focus structure is unmarked. That is, such a sentence can be used as an out-of-the-blue utterance. If, however the object has been moved in front of the subject, and it is a definite DP or a proper name, the result is a sentence with a marked focus structure which cannot be used as an out-of-the-blue utterance but needs a more specific context for pragmatic licensing (cf. chapter 3). This difference alone might contribute to any finding that sentences like (23) elicit a stronger garden-path effect than sentences like (25) (for experimental evidence on this point, cf. Bader and Meng, 1999).

However, since we are not interested in properties of focus-structure at this point, but in properties of argument-structure, we will try to keep the focus structure of the examples constant as far as possible. We can achieve this by using a focus particle to the immediate left of the subject DP. Introducing a focus particle in front of the subject has the consequence that all three sentences have the same focus structure, namely a focus structure with narrow focus on the subject. This is exactly the focus structure required by OS-sentences derived by movement. As shown in Bader (under revision), garden-path strength in OS-sentences is substantially reduced when, due to the presence of a focus particle in front of the subject, participants already have computed the correct focus structure during first-pass parsing.

Even under this manipulation, a difference between (23) and (25) should show up. In particular, the diagnostic processes responsible for reanalysis in these sentences should take into account whether a verb allows for a base-generated OS-structure or not. After all, when trying to find an alternative syntactic structure, the HSPM can be expected to make use of the information that the verb in sentence (25) is compatible with a base-generated OS-structure when reasoning about alternative syntactic analyses. The same is not possible for sentence (23), because for such a sentence, only the SO-structure can be base-generated whereas the OS-structure must be derived by movement. The verb itself is therefore of no help for the HSPM in the process of establishing the correct OS-structure.

4.1 Experiment 3

The aim of Experiment 3 was to test for the three-way contrast given by sentences such as (21), (23), and (25). Experiment 3 consists of two parts. In Experiment 3A, only sentences with base-generated OS-structure will be investigated, and the comparison will be between sentences with an animate subject (i.e., both DPs animate) and sentences with an inanimate subject (i.e., one DP animate, the second inanimate) ((21) versus (25)). In Experiment 3B, animacy will be held constant and the comparison will be between base-generated OS-sentences and derived OS-sentences ((23) versus (25)). The reason for splitting Experiment 3 up in this way derives from the fact that the number of verbs allowing for base-generated OS-sentences is already small, and the subset of OS-verbs which allow for both an animate and inanimate subject is even smaller.

4.1.1 Experiment 3A: Method

Participants and Procedure. 32 students of the University of Jena participated in this experiment which used our standard speeded grammaticality judgments method.

Materials. Experiment 3A will test whether the animacy of the subject-DP has an effect on the processing of OS-sentences ending in an OS-verb. 20 sentence quartets were constructed according to the two factors ambiguity (ambiguous versus unambiguous) and animacy of the second DP (animate second DP versus inanimate second DP) (cf. Table 6.5 for a complete stimulus set).

The sentences with animate subject were similar to the sentences used in Experiment 3A for the condition OS-verb, the only difference being that instead of 10 different OS-verbs only the 5 verbs selecting *haben* as auxiliary were used (cf. (26-a)). All these verbs allow for either an animate or an inanimate subject. Sentences with an inanimate subject were obtained from sentences with an animate subject by simply replacing the animate subject DP by an inanimate one.

Table 6.5. A complete stimulus set for Experiment 3A. Note: All clauses were introduced by the main clause *Ich habe gehört* ('I have heard')

First DP animate, second DP inanimate	
Unambiguous	daß dem Direktor auch das neue Büro mißfallen hat. that the director-DAT also the new office displeased has 'that the new office too displeased the director.'
Ambiguous	daß Anita auch das neue Büro mißfallen hat. that A. also the new office displeased has 'that the new office too displeased Anita.'
Both DPs animate	
Unambiguous	daß dem Direktor auch die neue Kollegin mißfallen hat. that the director-DAT also the new colleague displeased has 'that the new colleague too displeased the director.'
Ambiguous	daß Anita auch die neue Kollegin mißfallen hat. that A. also the new colleague displeased has 'that the new colleague too displeased Anita.'

Table 6.6. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 3A (Standard Errors by Subjects in Parentheses)

	<i>First DP animate, second DP inanimate</i>		<i>Both DPs animate</i>	
	<i>Unambiguous</i>	<i>Ambiguous</i>	<i>Unambiguous</i>	<i>Ambiguous</i>
Percentage correct	97 (1.3)	90 (2.2)	94 (1.8)	67 (4.8)
Judgment time	477 (35.8)	599 (40.6)	498 (39.4)	743 (56.1)

The resulting 20 sentence quartets were distributed over four lists, with an equal number of each of the four versions. Only one version of each sentence was included within a given list. The experimental sentences were randomized individually for each subject and were presented embedded within a list of 134 filler sentences.

4.1.2 Experiment 3A: Results

Judgments. Table 6.6 shows the percentages of correct responses for Experiment 3A. Two-way ANOVAS (2 types of first DP \times 2 types of second DP)

revealed a significant main effect of type of first DP ($F(1,31) = 27.02$, $p < .01$; $F(1,19) = 38.97$, $p > .01$), a significant main effect of type of second DP ($F(1,31) = 29.90$, $p < .01$; $F(1,19) = 15.82$, $p < .01$) and a significant interaction between type of first DP and type of second DP ($F(1,31) = 23.46$, $p < .01$; $F(1,19) = 17.67$, $p < .01$).

Judgment times. Judgment times for correct responses are shown in Table 6.6. Because of empty cells, one subject had to be excluded from the analysis. Two-way ANOVAS (2 types of first DP \times 2 types of second DP) revealed a significant main effect of type of first DP ($F(1,30) = 45.63$, $p < .01$; $F(1,19) = 36.18$, $p > .01$). The main effect of type of second DP was significant in the subject but only marginally significant in the item analysis ($F(1,30) = 11.02$, $p < .01$; $F(1,19) = 3.83$, $p < .1$). The interaction between type of first DP and type of second DP was only significant in the subject analysis ($F(1,30) = 4.25$, $p < .05$; $F(1,19) = 2.82$, $p = .11$).

4.1.3 Experiment 3B: Method

Participants and Procedure. 32 students of the University of Jena participated in this experiment which used our standard speeded grammaticality judgments method

Materials. Experiment 3B will test whether OS-sentences with SO-verbs and OS-sentences with OS-verbs still differ from each other when both arguments are animate. 20 sentence quartets were constructed according to the model sentences in (23) and (25) (cf. Table 6.7 for a complete stimulus quartet). All sentences consisted of a main clause followed by an embedded clause. The embedded clause always contained two DPs. The first DP was either a proper name (condition ambiguous) or a definite masculine DP unambiguously inflected for dative Case (condition unambiguous). The second DP, which was always introduced by a focus particle in order to enhance pragmatic felicity, was a definite feminine DP ambiguous between nominative and accusative Case. All sentences were in the perfect tense, ending in a sequence of a main verb followed by an auxiliary.

In the condition OS-verb, the 10 verbs shown in (26) were used. Half of the verbs in (26) select a form of *sein* ('to be') as perfect auxiliary, the other half a form of *haben* ('to have'). This manipulation was included in order to test whether the processing of OS-sentences with base-generated OS-structure is affected by which auxiliary (*haben* or *sein*) the clause final OS-verb selects. A possible difference might show up because verbs selecting a form of *sein* are unaccusative ("ergative") but verbs selecting *haben* are not (cf. Grewendorf, 1989).

Table 6.7. A complete stimulus set for Experiment 3B. Note: All clauses were introduced by the main clause *Ich kann mir gar nicht vorstellen* ('I can't imagine')

SO-Verb	
Unambiguous	daß dem Direktor sogar die Lehrerin widersprochen hat. that the director-DAT even the teacher objected has 'that even the teacher objected to the director.'
Ambiguous	daß Max sogar die Lehrerin widersprochen hat. that M. even the teacher objected has 'that even the teacher objected to Max.'
OS-Verb	
Unambiguous	daß dem Direktor sogar die Lehrerin imponiert hat. that the director-DAT even the teacher impressed has 'that even the teacher impressed the director.'
Ambiguous	daß Max sogar die Lehrerin imponiert hat. that M. even the teacher impressed has 'that even the teacher impressed Max.'

(26) OS-Verbs used in Experiment 3B

- a. Verbs selecting *haben* ('have') as perfect-auxiliary:
imponieren ('to impress'), *gefallen* ('to please'), *missfallen* ('to displease'), *fehlen* ('to miss'), *passen* ('to fit, to suit')
- b. Verbs selecting *sein* ("be") as perfect-auxiliary:
ausweichen ('make way (for); to dodge'), *entgegenreten* ('to oppose'), *zuvorkommen* ('to forestall; to anticipate'), *auffallen* ('to strike; to catch s.o.'s eye'), *vorauslaufen* ('to go on ahead of s.o.')

In the condition SO-verb, the 18 verbs shown in (27) were used. Two verbs were used twice (as indicated by a 2 in brackets).

- (27) *absagen* ('to tell s.o. that one is unable to ...'), *aufauern* ('to waylay s.o.; to lie in wait for s.o. '), *beipflichten* ('to agree with s.o. '), *danken* ('to thank s.o. '), *drohen* ('to threaten s.o.; to menace s.o. '), *gratulieren* ('to congratulate s.o. '), *helfen* ('to help s.o. '), *kondolieren* ('to condole with s.o. '), *mißtrauen* ('to distrust/mistrust s.o. '); *nachschauen* ('to follow s.o. with one's eyes; to gaze after s.o. '), *nachtrauern* (2) ('to mourn for s.o.; to grieve for s.o. '), *schreiben* (2) ('to write'), *vertrauen* ('to trust s.o. '), *verzeihen* ('to forgive'), *weiterhelfen* ('to help s.o. on'), *widersprechen* ('to contradict s.o. '), *zuhören* ('to listen to s.o. '), *zustimmen* ('to agree with s.o.')

The experimental sentences were divided into four lists, with an equal number of each of the four versions. Only one version of each sentence was included within a given list. The experimental sentences were randomized individually for each subject and were presented embedded within a list of 126 filler sentences.

4.1.4 Experiment 3B: Results

Judgments. Table 6.8 shows the percentages of correct responses for Experiment 3B. Two-way ANOVAS (2 verb types \times 2 types of first DP) revealed that the factor verb type was only significant in the subject analysis but not significant in the item analysis ($F(1,23) = 4.26, p = .05$; $F(1,19) = 2.40, p > .1$). The factor ambiguity was significant both in the subject and the item analysis ($F(1,23) = 64.44, p < .01$; $F(1,19) = 63.92, p < .01$). The interaction between verb type and ambiguity was also significant in both analyses ($F(1,23) = 7.22, p < .05$; $F(1,19) = 8.05, p > .01$).

Table 6.8. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 3B (Standard Errors by Subjects in Parentheses)

	<i>SO-Verb</i>		<i>OS-Verb</i>	
	<i>Unambiguous</i>	<i>Ambiguous</i>	<i>Unambiguous</i>	<i>Ambiguous</i>
Percentage correct	94 (2.2)	45 (6.2)	91 (3.2)	63 (5.2)
Judgment time	581 (44.4)	930 (98.7)	606 (48.8)	858 (73.3)

The perfect auxiliary selected by the OS-verbs had no significant effects. For ambiguous sentences, both sentences with OS-verb selecting *haben* and sentences with OS-verb selecting *sein* received 63% correct answers. For unambiguous sentences, sentences with OS-verb selecting *haben* received 88% correct answer and sentences with OS-verb selecting *sein* 94% but this difference was not significant.

Judgment times. Response times for correct judgments are also shown in Table 6.8. For the analysis of variance, three subjects had to be excluded because of empty cells. Two-way ANOVAS (2 verb types \times 2 types of first DP) revealed a significant main effect of ambiguity ($F(1,20) = 41.28, p < .01$; $F(1,19) = 23.14, p < .01$). The main effect of verb type and the interaction between verb type and ambiguity were not significant (all F-values < 1).

4.1.5 Discussion

Besides adding to the already large body of evidence showing that locally ambiguous OS-sentences of all sorts induce garden-path effects, Experiment 3 establishes the following rank-order with regard to garden-path strength:

- *OS-verb, first DP animate/second DP inanimate*
Sentences like (21) cause only a very slight garden-path effect.
- *OS-verb, both DPs animate*
Sentences like (25) are almost in the middle between the two extreme cases.
- *SO-verb, both DPs animate*
Sentences like (23) cause a rather severe garden-path effect.

In addition to this rank order, Experiment 3 also found support for the assumption that for purposes of sentence comprehension it makes no difference whether an OS-verb selects *haben* or *sein* as its perfect auxiliary. No significant difference between the two types of verbs showed up in Experiment 3A.

The rank order with respect to garden-path strength that was found in Experiment 3 confirms the predictions derived at the outset. First, the processing of sentences with base-generated OS-structure was heavily dependent on the animacy features of the argumental DPs. Whereas base-generated OS-sentences with an animate and an inanimate argument only caused a slight garden-path effect, comparable sentences with two animate arguments produced a substantial garden-path effect. Since the two sentences always contained the same verb, finding such a difference lends strong support to the particular formulation of the Argument Linking Principle in (5). According to the Argument Linking Principle, linking in sentences with an animate and an inanimate argument leads to a pattern that immediately signals to the HSPM how to proceed with the reanalysis process. Linking in sentences with two animate DPs, in contrast, does not provide this kind of help, and the sentences are therefore substantially harder to revise.

In summary, Experiment 3 provides clear evidence for our account of argument linking as embedded in the Argument Linking Principle and the LBCA. Furthermore, Experiment 3 provides evidence for a processing difference between base-generated and filler-gap OS-sentences even when exactly the same DP-arguments are involved. However, as pointed out in the introduction to Experiment 3, one might have a certain concern with this experiment given the confound of argument structure properties and focus-structure properties. While we tried to eliminate any differences with respect to the latter by always inserting a focus particle in front of the second DP, to be on the safe side, Experiment 4 will provide a further test of this finding before we enter a more detailed discussion of it.

4.2 Experiment 4

Experiment 4 will compare sentences like (28) with sentences like (29). Both sentences contain an accusative object followed by the subject. Like the verb *helfen* ('to help'), the verb *besuchen* ('to visit') in sentence (28) is underlyingly SO. Like the verb *gefallen* ('to please'), the verb *nerven* ('to annoy') in sentence (29) is indeterminate between SO and OS when used with two animate DPs.

(28) Maria sagte, daß sie die Lehrerinnen besucht haben.
 Maria said that she/her the teachers visited have
 'Maria said that the teachers visited her.'

(29) Maria sagte, daß sie die Lehrerinnen genervt haben.
 Maria said that she/her the teachers annoyed have
 'Maria said that the teachers annoyed her.'

In contrast to the sentences used in Experiment 3, there can be no confounding with focus-structure properties in (28) and (29) because the object is a pronoun, and such pronouns can freely precede the subject without any consequence for the focus structure of the sentence. As before, our argument-structure based account of diagnosis predicts that (28) should produce a stronger garden-path effect than (29).

4.2.1 Method

Participants and Procedure. 30 students of the University of Jena participated in this experiment which used our standard speeded grammaticality judgments method.

Materials. 20 sentence quartets were constructed for Experiment 4, according to the two factors word-order (SO versus OS) and verb-type (action-verb versus psych-verb) (cf. Table 6.9 for a complete stimulus set).

All sentences consisted of a main clause and an embedded clause, with the experimental manipulations confined to the embedded clause. The embedded clauses always contained two arguments. The first one was the pronoun *sie* which had a proper name within the main clause as antecedent. The following argument was an animate plural DP. All sentences were disambiguated by the number marking on the finite auxiliary either toward an SO- or an OS-structure.

4.2.2 Results

Judgments. Table 6.10 shows the percentages of correct responses for Experiment 4. Two-way ANOVAS (2 word-orders \times 2 verb-types) revealed a significant main effect of word-order ($F(1,29) = 16.57, p < .01$; $F(1,19) = 25.14, p > .01$) whereas the main effect of verb-type was not significant (both F-values < 1). Further, there was a significant interaction between word-order and verb-type ($F(1,29) = 14.43, p < .01$; $F(1,19) = 12.53, p < .01$).

Table 6.9. A complete stimulus set for Experiment 4. Note: All clauses in this table were introduced by the main clause *Cornelia hat erzählt* ('Cornelia told')

Action-Verb	
Subj < Obj	daß sie einige ihrer Verwandten an Weihnachten besucht hat. that she some her relatives at Christmas visited has 'that she visited some of her relatives at Christmas.'
Obj < Subj	daß sie einige ihrer Verwandten an Weihnachten besucht haben. that her some her relatives at Christmas visited have 'that some of her relatives visited her at Christmas.'
Psych-Verb	
Subj < Obj	daß sie einige ihrer Verwandten an Weihnachten genervt hat. that she some her relatives at Christmas annoyed has 'that she annoyed some of her relatives at Christmas.'
Obj < Subj	daß sie einige ihrer Verwandten an Weihnachten genervt haben. that her some her relatives at Christmas annoyed have 'that some of her relatives annoyed her at Christmas.'

Table 6.10. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 4 (Standard Errors by Subjects in Parentheses)

	Action-Verb		Psych-Verb	
	Subj < Obj	Obj < Subj	Subj < Obj	Obj < Subj
Percentage correct	94 (1.9)	62 (4.0)	81 (3.2)	73 (3.6)
Judgment time	704 (34.5)	1030 (54.5)	713 (35.3)	907 (53.2)

Judgment times. The judgment times for correct responses are also shown in Table 6.10. In the subject analysis, two participants had to be excluded because of empty cells. Two-way ANOVAS (2 word-orders \times 2 verb-types) revealed a significant main effect of word-order ($F(1,27) = 53.66$, $p < .01$; $F(1,19) = 31.12$, $p > .01$). The main effect of verb-type was not significant ($F(1,27) = 2.13$, $p > .1$; $F(1,19) = .43$). The interaction between word-order and verb-type was only marginally significant in the subject analysis and not significant in the item analysis ($F(1,27) = 3.06$, $p < .1$; $F(1,19) = 1.11$, $p > .1$).

4.2.3 Discussion

The results of Experiment 4 have replicated the finding of Experiment 3B that base-generated OS-sentences are easier to reanalyze than OS-sentences derived by movement, even when exactly the same arguments are involved. We can therefore conclude that garden-path recovery is mediated by argument-structure properties that go beyond simple animacy constraints on a verb's arguments. As pointed out in the discussion preceding these experiments, these argument-structure properties—which basically concern the question of whether a verb is compatible with a base-generated OS-structure or not—affect diagnostic processes which lie outside the LBCA. We therefore postpone a further discussion of this finding to the final chapter which will contain a short discussion of diagnostic processes outside of the LBCA, and simply note here that the findings obtained in Experiment 3B and Experiment 4 provide strong evidence for the general claim that the reanalysis processes of the HSPM are highly sensitive to argument-structure properties.

5. The Primacy of Case: Experiment 5

Given the importance that we attribute to argument linking for purposes of garden-path recovery, a natural question that might arise at this point concerns the status of thematic roles. In the theory that we have developed so far, thematic roles are neither involved in first- nor in second-pass parsing. For first-pass parsing, we have argued in chapter 4 that preferences observed for syntactic-function ambiguities are the joint product of the Minimal Chain Principle, Simplicity, and the Case Preference Principle. These principles refer to phrase-structure configurations and Case features, but not to thematic roles. For second-pass parsing, we have hypothesized the LBCA and the Argument Linking Principle which jointly imply that argument structures play a crucial role during garden-path recovery. Particular thematic roles, however, are not involved.

Our position on thematic roles contrasts with theories claiming that the HSPM assigns thematic roles already in advance of the clause-final verb when processing a verb-final sentence (cf. Bornkessel et al., 2003; Carlson and Tanenhaus, 1988; MacDonald et al., 1994b). Since the thematic role of an argument cannot generally be determined when the verb has not yet been seen, role assignment in advance of the verb will have to proceed on a default basis. Default assignments of thematic roles can later turn out to be false, in which case a thematic reanalysis will be called for (cf. Bornkessel et al., 2003, for further discussion of thematic reanalysis).

To investigate the role of thematic roles for purposes of reanalysis, we will take advantage of the fact that an ambiguous sentence fragment like that in (30) cannot only continue with the perfect auxiliary *hat* and the passive auxiliary

wurde, as in the sentences discussed so far, but also with the quasi-auxiliary *bekam*. All three possible continuations are shown in (31).

- (30) ... daß Fritz eine Postkarte geschickt ...
 that Fritz a postcard sent
- (31) a. *Active*
 daß Fritz eine Postkarte geschickt HAT (*has*).
 ‘that Fritz has sent a postcard’
- b. *Active/Recipient Passive*
 daß Fritz eine Postkarte geschickt BEKAM (*got*)
 lit. ‘that Fritz got a postcard sent’ / ‘that Fritz was sent a postcard’
- c. *Passive*
 daß Fritz eine Postkarte geschickt WURDE (*was*)
 ‘that a postcard was sent to Fritz’

Sentence (31-a) is both semantically and syntactically an active clause. Sentence (31-c) is both semantically and syntactically a passive clause. Sentence (31-b), finally, is syntactically an active sentence but semantically a passive sentence. It shares its syntactic structure with (31-a) but its meaning with (31-c). This kind of construction is called *RECIPIENT PASSIVE* because the recipient is promoted to subject. In contrast to the almost unrestricted productivity of the regular passive, the use of the quasi-auxiliary *bekommen* together with a ditransitive verb to form a recipient passive underlies strong semantic restrictions (cf. Wegener, 1985).

The distribution of case and thematic roles within the sentences in (31) is shown in (32).

- (32) a. daß NOM ACC / AGENT THEME geschickt HAT.
 b. daß NOM ACC / RECIPIENT THEME geschickt BEKAM.
 c. daß DAT NOM / RECIPIENT THEME geschickt WURDE.

If thematic roles are not assigned in advance of the verb, as we assume here, processing sentences with recipient passive, that is, sentences ending in *bekam*, should cause no problems whatsoever for the HSPM. On the initial pass, the correct syntactic functions will be assigned to unambiguous sentences on the basis of unambiguous case morphology and to ambiguous sentences due to Simplicity and the Case Preference Principle. No syntactic reanalysis will thus be called for. If furthermore thematic roles are not assigned in advance of the verb, no thematic reanalysis will be necessary either. In summary, sentences ending in *bekam* should not show any sign of a garden-path effect under the theory presented here.

In contrast, if thematic roles are assigned prior to the clause-final verb, a garden-path effect is expected for sentences ending in *bekam*. This garden-path

effect should be independent of the Case-ambiguity of the DPs involved. If agent is the preferred role for an animate DP and theme the preferred role for an inanimate DP as long as this assignment is compatible with the DPs' Case morphology, the agent role should be assigned to the first DP and the theme role to the second DP when the HSPM is processing an ambiguous sentence fragment like *daß Fritz eine Postkarte* or an unambiguous sentence fragment like *daß er eine Postkarte*. On encountering *bekam*, the initial assignment of agent to the first NP must be changed to recipient. This is exactly the same reanalysis that would be necessary for ambiguous passive sentences if thematic roles are assigned in advance of the verb. Sentences ending in *bekam* in general and locally ambiguous sentence ending in *wurde* should thus show evidence for a garden-path effect. This effect might be stronger for sentences ending in *wurde* because they will also involve a revision of the initial case assignment.

To summarize, for sentences ending in *bekam* different predictions emerge depending on whether or not thematic roles are assigned before the verb is encountered. According to the theory presented here, thematic roles are not assigned in advance of the verb. Thus, no reanalysis whatsoever will be necessary for either ambiguous or unambiguous sentences ending in *bekam*, and such sentences should therefore not show any sign of a garden-path effect. If, on the other hand, thematic roles are already assigned before the verb is encountered, the HSPM will have to revise its initial decisions for sentences ending in *bekam*. In consequence, it is predicted that such sentences should show garden-path effects.

5.1 Method

Participants and Procedure. 36 students of the University of Jena participated in this experiment which used our standard procedure of speeded grammaticality judgments.

Materials. 30 sentences were created, with each sentence appearing in six versions according to the two experimental variables auxiliary (*hat* versus *wurde* versus *bekam*) and ambiguity (ambiguous versus unambiguous). A complete sample item from Experiment 5 is shown in Table 6.11.

All ambiguous sentences of Experiment 5 contained masculine proper names. For unambiguous sentences ending in *hat*, this proper name was replaced by the unambiguously nominative-marked pronoun *er*, with a concomitant change in the main clause. For sentences ending in *wurde*, the auxiliary *hat* in the sentences ending in *hat* was replaced by *wurde*. In addition, the pronoun *er* was replaced by the pronoun *ihm*, which is unambiguously marked for dative case, in order to create unambiguous sentences. Finally, by replacing the auxiliary *hat* with the quasi-auxiliary *bekam*, sentences ending in *bekam* were created. As was the case for unambiguous sentences ending in *hat*, unambiguous sentences ending in *bekam* contained the pronoun *er*.

Table 6.11. A complete stimulus set for Experiment 5. Note: Ambiguous clauses were introduced by the main clause *Am Wochenende wurde erzählt* ('On the weekend, it was told'); unambiguous clauses were introduced by the main clause *Peter hat am Wochenende erzählt* ('On the weekend, Peter told').

Active (<i>hat</i>)	
Ambiguous	daß Peter beim letzten Treffen eine Stelle angeboten hat . that Peter at last meeting a job offered has '... that Peter offered a job at the last meeting'
Unambiguous	daß er beim letzten Treffen eine Stelle angeboten hat . that he at last meeting a job offered has '... that Peter offered a job at the last meeting'
Active/Recipient Passive (<i>bekam</i>)	
Ambiguous	daß Peter beim letzten Treffen eine Stelle angeboten bekam . that Peter at last meeting a job offered got '... that Peter was offered a job at the last meeting'
Unambiguous	daß er beim letzten Treffen eine Stelle angeboten bekam . that he at last meeting a job offered got '... that he was offered a job at the last meeting'
Passive (<i>wurde</i>)	
Ambiguous	daß Peter beim letzten Treffen eine Stelle angeboten wurde . that Peter at last meeting a job offered was '... that a job was offered to Peter at the last meeting'
Unambiguous	daß ihm beim letzten Treffen eine Stelle angeboten wurde . that him at last meeting a job offered was '... that a job was offered to him at the last meeting'

From the experimental sentences, six sentence lists were created which contained an equal number of sentences within each condition but with each sentence appearing in only one of its six versions. The experimental lists were embedded in a list of 94 filler sentences which were of a variety of syntactic constructions. Some of the filler sentences came from experiments unrelated to the present experiment. The experimental sentences were randomized individually for each subject.

5.2 Results

Judgments. The percentages of correct judgments for Experiment 5 are shown in Table 6.12. The factor auxiliary was significant in both the subject and the item analysis ($F(1,2,70) = 13.36, p < .01$; $F(2,58) = 8.10, p < .01$). The factor ambiguity was not significant in either analysis ($F(1,35) = .87, F(1,29) = 1.02$). The interaction between auxiliary and ambiguity was significant in both

Table 6.12. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 5 (Standard Errors by Subjects in Parentheses)

	Active		Active/Recipient Passive		Passive	
	Ambig.	Unambig.	Ambig.	Unambig.	Ambig.	Unambig.
Percentage correct	78 (3.3)	72 (3.6)	93 (1.9)	89 (2.2)	75 (3.7)	92 (2.2)
Judgment time	793 (39.2)	810 (42.6)	681 (37.2)	685 (37.4)	862 (50.4)	657 (36.8)

subject and item analysis ($F(1,2,70) = 11.08, p < .01$; $F(2,2,58) = 16.15, p < .01$).

Planned comparisons showed that ambiguous sentences ending in *wurde* received significantly less grammatical responses than unambiguous sentences ending in *wurde* (75% vs. 92%; $t(35) = 4.39, p < .01$; $t(29) = 4.76, p < .01$). In contrast, the difference between ambiguous and unambiguous sentences ending in *hat* was not reliable (78% vs. 72%; $t(35) = 1.61, p > .1$; $t(29) = 1.74, p > .1$), nor was the difference between ambiguous and unambiguous sentences ending in *bekam* (93% vs. 89%; $t(35) = 1.17, p > .1$; $t(29) = 1.27, p > .1$). Considering only unambiguous sentences, sentences ending in *wurde* did not differ from sentences ending in *bekam* (92% vs. 89%; both t 's < 1), but these two kinds of sentences received significantly more grammatical responses compared to sentences ending in *hat* (91% vs. 72%; $t(58) = 4.81, p < .01$; $t(58) = 3.75, p < .01$).

Judgment Times. Reaction times for correct responses are also shown in Table 6.12. The factor auxiliary was significant in the subject analysis and the item analysis ($F(1,2,70) = 10.46, p < .01$; $F(2,2,58) = 10.29, p < .01$). The factor ambiguity was significant by subjects and marginally significant by items ($F(1,35) = 8.06, p < .01$; $F(1,29) = 3.96, p < .1$). The interaction between auxiliary and ambiguity was significant in both analyses ($F(1,2,70) = 15.24, p < .01$; $F(2,2,58) = 5.92, p < .01$).

Planned comparisons showed that ambiguous sentences ending in *wurde* took significantly more time than unambiguous sentences ending in *wurde* (862 ms vs. 657 ms; $t(35) = 5.74, p < .01$; $t(29) = 4.05, p < .01$). In contrast, there was no significant difference between ambiguous and unambiguous sentences for either the *hat*-condition (793 vs. 810; both t 's < 1) or the *bekam*-condition (681 ms vs. 685 ms; both t 's < 1). Considering only unambiguous sentences, sentences ending in *wurde* and sentences ending in *bekam* again did not differ from each other (657 ms vs. 685 ms; both t 's < 1) but differed from sentences

ending in *hat* (671ms vs. 810 ms) ($t_1(70) = 4.26, p < .01$; $t_2(58) = 4.26, p < .01$).

5.3 Discussion

The results of Experiment 5 do not provide any evidence that thematic roles have to be revised on encountering the clause-final verb. Sentences ending in *bekam*, which are crucial for probing the putative effects of thematic revisions, did not show any sign of a garden-path effect. In particular, these sentences received very high percentages of correct answers, and they did not differ from unambiguous passive sentences with which they share their meaning. Ambiguous passive clauses, which involve a syntactic revision, provided unequivocal evidence for garden-path effects.

Our results thus argue against the notion of thematic reanalysis as proposed in Bornkessel et al. (2003). Instead, they argue that thematic roles are not assigned in advance of the verb, with the consequence that nothing needs to be changed when a sentence is disambiguated by *bekam*. In summary, Experiment 5 allows the conclusion that garden-path recovery does not involve the retraction of initial thematic role assignments. This is in line with prior results reported by Frazier (1990a) who found no evidence for an immediate thematic assignment in English nominalizations.

A further finding of Experiment 5 is that active sentences were at a clear disadvantage in comparison to unambiguous passive sentences. This disadvantage, which has been observed several times before (e.g., Meng and Bader, 2000b) can be related to the way the experimental sentences, which always contained two arguments, are derived from active sentences with three arguments. In sentences ending with *hat*, the dative argument is simply omitted. This is possible since the dative argument of many ditransitive verbs is optional. However, sometimes the result of omitting the dative object might nevertheless lead to reduced acceptability, especially given that all sentences were presented out of context. For sentences ending in *bekam* or *wurde*, the situation is different. For both types of sentences, the subject argument of the ditransitive verb is suppressed by a lexical-syntactic operation, and the resulting two-argument-sentences are fully acceptable, therefore leading to high percentages of correct responses.

6. Preliminary Summary: Argument Linking and the HSPM

The preceding five experiments have tested predictions stemming from the first step of the Linking-Based Checking Algorithm (LBCA). This step, which is responsible for the linking of argumental phrases within the CPPM to slots

in the verb's argument structure, proceeds according to the Argument Linking Principle repeated below.

(33) *Argument Linking Principle*

- a. Link the CPPM's nominative marked DP to the highest structural argument, and the CPPM's object DP to the remaining argument.
- b. If this leads to a conflict with respect to animacy, and reversing the linking eliminates the conflict, reverse the linking.

In a nutshell, the Argument Linking Principle amounts to the claim that initial assignments of syntactic functions (via the Minimal Chain Principle and the Case Preference Principle) are kept unless overridden by animacy information. Experiment 1 through Experiment 5 have provided several pieces of evidence in favor of our conception of argument linking.⁴

Note that we have included the clause "and reversing the linking eliminates the conflict" to also account for the strong intuition one has about semantically odd sentences such as (34). The intuition is that the first DP is the subject and the second DP the object. That is, when there are two inanimate DPs instead of two animate ones, one seems to stick to the word order given by the usual default preferences for Case assignment.

- (34) daß das Buch das Journal angerufen hat.
 that the book the journal called has
 '... that the book called the journal.'

Before going on to show that the theory developed so far generalizes straightforwardly to sentences which are not disambiguated by the clause-final verb, we would like to discuss two remaining points, one concerning the use of semantic information in the initial linking step of the LBCA and another one concerning sentences with three nominal arguments.

An important feature of the Argument Linking Principle in (33) is that it makes reference to the notion of animacy. This is a semantic notion, and as such it might be suspicious within a theory which claims to be a theory of the syntactic processes involved in human parsing. However, it can easily be shown that in its initial linking of DPs to argument slots, the HSPM does not make use of any arbitrary semantic information, but only of a very restricted one such as animacy, which, as we have seen earlier, plays a direct role in the formulation of certain syntactic regularities. Consider, for example, the globally ambiguous sentence in (35).

⁴The importance of animacy for the processing of syntactic-function ambiguities has also been demonstrated for Dutch; cf. Lamers and de Hoop (2005), Mak et al. (2002).

- (35) Die Gans schiebt Mutti in den Ofen.
 The goose puts mom into the oven
 Either ‘Mom puts the goose into the oven’
 or ‘The goose puts mom into the oven’

Syntactically, this sentence allows for both an SO- and an OS-analysis. Semantically, however, only the OS-reading leads to a meaningful reading vis-à-vis our knowledge of the world. Nevertheless, when reading this sentence, there is a strong tendency to compute the SO-structure on first-pass parsing, with the result that one is puzzled by the sentence’s meaning.

This clearly suggests that the HSPM links the first DP to the subject theta-role and the second DP to the object theta-role without first considering whether this particular linking leads to a semantically coherent reading. Experimental evidence for this claim has been provided by Schriefers, Friederici and Kühn (1995) who investigated sentences like (36) and (37).

- (36) Semantically neutral
- a. Das ist die Managerin, die die Arbeiterinnen gesehen hat.
 That is the manager who the workers seen has
 ‘That is the manager who has seen the workers.’
 - b. Das sind die Arbeiterinnen, die die Managerin gesehen hat.
 That are the workers who the manager seen has
 ‘That are the workers who the manager has seen.’
- (37) Positive semantic bias
- a. Das ist die Managerin, die die Arbeiterinnen entlassen hat.
 That is the manager who the workers fired has
 ‘That is the manager who has fired the workers.’
 - b. Das sind die Arbeiterinnen, die die Managerin entlassen hat.
 That are the workers who the manager fired has
 ‘That are the workers who the manager has fired.’

The sentences in (36) are semantically neutral; the sentences in (37) are semantically biased towards the ultimately correct reading. Nevertheless, the OS-sentences ((36-b) and (37-b)) lead to garden-path effects of approximately equal strength. This means that when the clause-final verb is encountered in these sentences, the semantic information is not used to quickly effect the linking that would immediately lead to the correct reading (that is, linking *manager* to the subject role and *workers* to the object role). This finding clearly shows that the HSPM does not use the type of semantic knowledge inherent in (37-b)—basically world knowledge—in its initial linking, in contrast to the locally circumscribed animacy information which, as we have seen, is used. In other words, the HSPM seems to use exactly such pieces of semantic knowledge

which are also used by the grammar in defining linking patterns.⁵ Instead of posing a challenge to the concept of an informationally encapsulated HSPM, our results therefore lead to an important refinement of this notion.

If this account is on the right track, we predict that for globally ambiguous sentences it should be rather difficult to get at the grammatically licit OS-structure. This prediction seems to be true. While it is not impossible to understand a sentence like (38-a) as meaning that it is Maria who loved Fritz, this is only possible with some conscious effort whereas it is quite easy to get at this meaning if the sentence is morphologically disambiguated as in (38-b).

- (38) a. dass Fritz Maria geliebt hat.
 that F. M. loved has
 Either ‘that Maria loved Fritz.’ or ‘that Fritz loved Maria.’
 b. dass den Fritz Maria geliebt hat.
 that the-ACC F. M. loved has
 ‘that Maria loved Fritz.’

As a final point, let us take a look at sentences with a ditransitive verb and three argument DPs. For most ditransitive verbs, subject and dative object are restricted to animate DPs whereas the accusative object (normally a theme) is typically confined to inanimate DPs. An example illustrating this is given in (39).

- (39) dass Fritz Maria Postkarten geschrieben hat.
 that F. M. postcards written has

All three DPs in (39) are compatible with nominative, accusative, and dative Case. Nevertheless, there is a very strong intuition that this sentence is assigned the structure “NOM>DAT>ACC”. The meaning therefore is *Fritz sent Mary postcards*. How does this intuition fit into the model developed so far? According to the first-pass principles introduced in chapter 4, the first DP *Fritz* will be assigned nominative Case. The next DP *Maria* will then receive accusative Case, in accordance with Simplicity. For the third DP, therefore, only dative Case remains to be assigned. This, of course, would be a semantically awkward linking pattern. It is not impossible, because a few verbs exist which have an inanimate dative object and an animate accusative object (cf. chapter 3). Nevertheless, it seems reasonable that the HSPM will replace the initial accusative assignment to *Maria* with the assignment of dative Case on the fly, that is, before encountering the clause-final verb. Linking after the clause-final verb has been read would then be a trivial task.

⁵This impression is corroborated by the fact that animacy plays a central role in the grammars of numerous languages of the world; cf. Comrie (1989) for illustration and discussion.

A small subset of ditransitive verbs can occur where both objects are animate, as illustrated by the example in (40). As explained in chapter 3, no definite order is defined if both objects are animate, as is true for psych-verbs with two animate arguments.

- (40) daß Werner Fritz Maria vorgestellt hat.
 that W. F. M. introduced has

For such a sentence, our first-pass principles predict a structure ‘NOM ACC DAT’ according to which (40) means *Werner has introduced Fritz to Maria*. The first DP is assigned nominative Case because of the Case Preference Principle; the second DP is then assigned accusative because of Structural Simplicity, and the third DP finally receives dative Case because this is the only Case left. On encountering the clause-final verb, the initial assignment of syntactic functions does not lead to any conflict with verb-specific information (the verb *vorstellen* can take three animate NPs, and no ordering is defined between the objects when both are animate). The initial assignment should therefore be identical with the ultimate outcome of processing this sentence.

Intuitively, it is clear that the first DP is the subject, and this is of course also what is to be expected given what is known about first-pass preferences for syntactic-function ambiguities. There is also an intuition that the accusative object precedes the dative object in such sentences. To test whether this intuition is borne out experimentally, Bader, Häussler and Bayer (2004) conducted several experiments that made use of the same logic as Experiment 1 by using globally ambiguous sentences disambiguated by a correlative contrastive phrase. In one of their experiments, sentences of the type shown in (41) were tested.

- (41) a. Ich glaube, daß man Fritz nicht nur Maria vorgestellt hat, sondern
 I believe that one F. not only M. introduced has but
 auch ihrer Mutter.
 also her mother-DAT
 ‘I believe that one introduced Fritz not only to Maria, but also to her mother.’
 b. Ich glaube, daß man Fritz nicht nur Maria vorgestellt hat, sondern
 I believe that one F. not only M. introduced has but
 auch ihre Mutter.
 also her mother-ACC
 ‘I believe that one introduced not only Maria to Fritz, but also her mother’

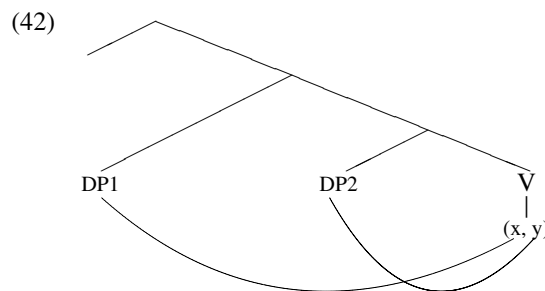
The sentences in (41) contain an unambiguous subject (due to the fact that *man* can never be a non-subject) and two ambiguous objects. In (41-a), the order must be accusative object before dative object because the clause-final

correlative phrase is overtly marked for dative Case. In (41-b), the order is dative object before accusative object. The experiment used the same speeded-grammaticality judgment procedure that is used throughout this book, and it also contained unambiguous control sentences for the two types of sentences shown in (41). For ACC-DAT sentences, there was no significant difference between locally ambiguous sentences like (41-a) and corresponding unambiguous sentences. For DAT-ACC sentences, in contrast, a strong garden-path effect showed up: While unambiguous control sentences were judged as grammatical with 82%, locally ambiguous sentences like (41-b) received only 48% correct answers. This pattern, which was also obtained in several different types of sentences with two ambiguous objects, shows a clear preference for accusative object preceding dative object, as predicted by our first-pass principles.

In summary, sentences with three nominal arguments (a subject and two objects) are treated basically the same way as sentences with two nominal arguments (a subject and a single object): When animacy does not put any constraints on argument linking, the HSPM uses Case information for linking-purposes. Given the first-pass parsing principles discussed in chapter 4, this results in a preference for NOM > ACC > DAT in sentences like (41). If, on the other hand, linking is constrained by animacy, as in the common situation with an animate dative DP and an inanimate accusative DP, these constraints are taken into account directly, and the correct linking is therefore easily determined.

7. Argument Linking and Sentence Memory

The task of the HSPM in the linking process is graphically depicted in (42), and the question we have to answer is this: How does the HSPM link the DPs contained in the CPPM to their respective argument structure slots after having encountered the clause final verb with its argument structure (x, y)? That is, how are the connecting lines computed which are depicted in (42)?



So far, we have considered this question only under the perspective of the information used by the HSPM in effecting the linking between DPs and argu-

ment slots. Finding out which information the HSPM uses was the aim of the preceding experiments. Note, however, that the task of linking, as depicted in (42), also raises another question: How does the HSPM know which DPs the CPPM contains? This is a question which can easily be overlooked, because we (as the authors or the readers) can take the CPPM as a whole into view. This is not so, however, for the HSPM. From a strictly online processing perspective, we have to care about how the HSPM gets access to parts of the CPPM which were constructed way before the clause-final verb with its argument structure is encountered.

Since accessing the DPs contained in the CPPM is a prerequisite for linking, let us consider this topic in some detail. An illuminating discussion of how the HSPM accesses parts of the CPPM is found in McElree (2000). McElree considers two mechanisms for retrieving DPs from the CPPM. Both mechanisms have independently been proposed for retrieving information from memory systems. The first mechanism is a *SEARCH PROCESS* of the sort proposed for certain types of short-term memory tasks (for example, memory scanning in the Sternberg paradigm). A major property of a search process is that the time needed for a search is a function of the amount of material which intervenes between the start and the end point of the search. This time, which is called *ACCESSABILITY* by McElree, has to be distinguished from the probability of successful retrieval of the information which is searched for. The probability of successful retrieval is called *AVAILABILITY*.

The second mechanism for retrieving information is a *DIRECT-ACCESS MECHANISM* (sometimes also called a *CONTENT-ADDRESSABLE MEMORY*). A direct-access mechanism allows for the direct retrieval of memory representations given appropriate retrieval cues. Long-term memory is usually considered to be such a memory. When a particular piece of information from long-term memory is required (for example, the date of birth of some friend), it is not necessary to search the whole memory system (which, given the amount of information stored in long-term memory, would probably take quite some time). Instead, the information can be accessed directly given the retrieval cues (the name of the friend in our example). Within a direct-access memory system, different representations might vary in their availability but might nevertheless be accessible within the same amount of time.

In order to determine whether the HSPM accesses information from the CPPM by a search process or directly by means of a content-addressable mechanism, McElree (2000) investigated filler-gap constructions such as those in (43).

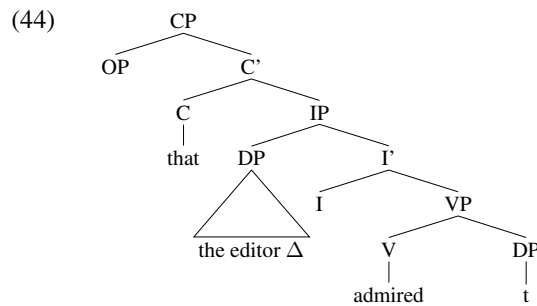
- (43) a. This was the book that the editor admired / *amused.
 b. This was the book that the editor who the receptionist married admired / *amused.

- c. This was the book that the editor who the receptionist who quit married admired / *amused.

In (43), the HSPM must postulate a trace after the sentence-final verb (*admired* or *amused*) and ultimately associate this trace with the DP *the book*. As part of this association, the HSPM must access the content of this DP; otherwise, the correct meaning could not be computed in case the sentence ends with *admire*, and the semantic incongruity could not be detected in the case of *amused*.

Using a speed-accuracy tradeoff procedure, McElree (2000) found that the three sentences in (43) do differ in terms of probability of successful retrieval—this probability decreases with length—but not in terms of retrieval speed. That is, independently of how much material intervened, retrieval time seems to remain constant. This finding indicates that the HSPM retrieves DPs from the CPPM via a direct-access mechanism and not via a search process.

An obvious objection to this conclusion is that if the CPPM was searched in a hierarchical manner, all three sentences in (43) would be on a par. This can be seen by looking at the tree given in (44), where OP stands for the empty operator that mediates the relationship between the head noun (*editor*) and the trace in object position of *admired*.



All additional material differentiating between the three sentences is contained in the DP starting with *the editor*, at the place marked by Δ . This means that in all three examples the same amount of hierarchical structure intervenes between the trace and its antecedent (namely VP, I', IP, C', CP, beginning from the bottom). A hierarchical search, that is, a search process searching along the main projection line, would therefore treat the three sentences in (43) in one and the same way.

To counter this objection, McElree also cites results for sentences like those in (45).

- (45) a. The writer knew this was *the essay* that the editor had admired.

- b. This was *the essay* that [_{IP} the writer [_{I'} [_{VP} knew the editor had admired.]]]

(45-b) differs from (45-a) not only in the amount of words intervening between gap and antecedent but also in the amount of intervening structure (due to the three additional projections IP, I', and VP indicated in (45-b)). Nevertheless, these sentences again did not differ in terms of accessibility, strengthening the conclusions drawn from examples like (43).

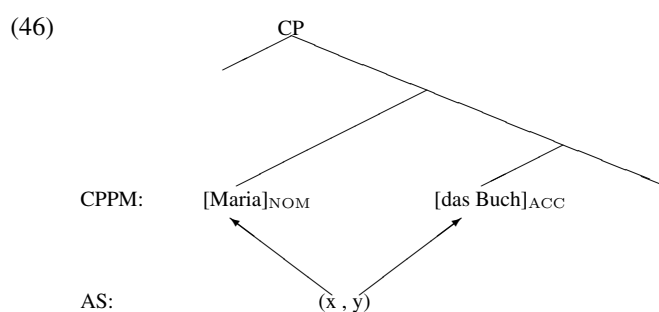
The results of McElree (2000) suggest that the HSPM can get direct access to XPs contained within the CPPM. The next question is then what mediates this direct memory retrieval. For the sentences in (43) and (45), an active filler in the sense of the Active Filler Hypothesis proposed in Frazier (1987) (cf. our discussion in chapter 4) had to be retrieved. Such a filler might be stored in the special kind of 'Hold'-store originally proposed for parsing with Augmented Transition Networks (ATNs) (cf. Winograd, 1983).

To our knowledge, evidence for a content-addressable mechanism underlying access to the CPPM seems to be restricted to experimental findings reported in McElree (2000) and McElree et al. (2003). However, since a content-addressable mechanism for accessing the CPPM makes a lot more sense in computational terms than a search process (and with some hindsight as to following sections and chapters), we will tentatively assume that such a memory mechanism is used by the HSPM.⁶ In particular, let us assume that the HSPM accesses argumental XPs in this way. The question then arises what kind of structure the HSPM uses for the purpose of accessing argumental XPs within the CPPM. An obvious answer would be that this function is subserved by the argument structure of the verb itself: each argument structure slot could contain a pointer pointing at the XP it is linked with. If the HSPM then needs to get access to the subject, for example, it could retrieve the subject DP directly using this pointer, and a computational expensive search process would be superfluous.

An apparent problem with this proposal is that in many cases, the verb's argument structure becomes available only after its arguments have been inserted into the CPPM. This is clearly so in the verb-final sentences we have been discussing throughout this chapter. However, this is only an apparent problem. After all, the argument structure of a verb is simply a list of the grammatical functions a verb requires, mediating between the syntactic and the lexical-conceptual level of representation. We will therefore assume that, when inserting a phrase with a particular syntactic function into the CPPM, the HSPM registers this phrase in an argument structure which is incrementally expanded

⁶The idea that the HSPM accesses the CPPM via a content-addressable mechanism is also a main assumption of the model which has been proposed by Van Dyke and Lewis (2003) and Lewis and Vasishth (2005).

as new arguments are encountered. This idea is graphically depicted in (46) for a sentence with a subject and an accusative object.



(46) should be interpreted as follows: When the HSPM inserts a DP marked for nominative Case (either by default or due to morphological reasons), it also introduces a slot for a corresponding structural argument (x) in the developing argument structure, where this slot points to the nominative-marked DP in the CPPM. Similar considerations hold for the accusative marked second DP which triggers the insertion of a second structural argument (y). Note that the argument structure shown in (46) makes certain information contained in the CPPM more explicit and easier accessible, but it does not introduce any new information. After all, introducing a nominative marked DP into the CPPM amounts to the hypothesis that the sentence contains a highest structural argument, and similarly for dative and accusative DPs. These hypotheses are simply made explicit by the linking mechanism displayed in (46).

To sum up this section, based on the evidence presented by McElree (2000) and McElree et al. (2003) we have hypothesized that concurrently with the developing CPPM the HSPM incrementally constructs an argument-structure which serves as a direct-access mechanism for retrieving information from the CPPM. In verb-final clauses, this argument-structure (which simply lists the various arguments identified thus far) is already constructed in advance of the verb, and thus has to be unified with the verb's actual argument structure. For now, this proposal is based only on some suggestive evidence proposed by McElree and colleagues, in combination with the computational plausibility of the mechanism. Its empirical pay-off will be seen in the next section, as well as at several points in following chapters.

8. Disambiguation in Advance of the Verb

As a consequence of how the LBCA links arguments to argument structure positions, a simple correlation showed up for the examples considered so far: Base-generated garden-path sentences were cured by the local, linking-and-

feature checking step 2B of the LBCA. Filler-gap garden-path sentences, in contrast, could not be reanalyzed by a local repair and were therefore subject to a more elaborate search for an alternative syntactic structure. This might have led to the impression that the LBCA is nothing more than a complicated way of stating that the HSPM treats base-generated and filler-gap sentences in different ways (cf. Bader, 1996, for a claim in this direction). However, this impression is not correct. As we will show now, whether revision occurs at stage 2B or stage 3 of the LBCA is not a function of the syntactic structure of a sentence alone. Instead, one and the same syntactic revision might be handled by either step 2B of the LBCA or outside of the LBCA, depending on the particular feature mismatch which signals the garden-path. This claim derives from findings about sentences not disambiguated by the verb in clause-final position, and the aim of this section will therefore be twofold: to show how one and the same ambiguity can be resolved either within or outside of the LBCA, depending on the means by which disambiguation is achieved, and to show how the LBCA generalizes to sentences not disambiguated at the clause-final verb.

Recall from chapter 4, where we reviewed the psycholinguistic literature on syntactic function ambiguities, that an important generalization with respect to garden-path strength involved wh-questions with different surface structures and different types of disambiguation. A first relevant example is the one given in (47) (repeated from chapter 4).

- (47) a. #Welche Tante besuchten die Jungen gestern?
 which aunt visited-PLUR the boys yesterday
 ‘Which aunt did the boys visit yesterday?’
 b. #Welche Tante besuchte der Junge gestern?
 which aunt visited the boy-NOM yesterday
 ‘Which aunt did the boy visit yesterday?’

Syntactically, (47-a) and (47-b) are on a par. Both sentences are main clauses in which the object has been moved to the sentence initial SpecCP position. What differs between (47-a) and (47-b) are the means by which the OS-structure is signaled to the HSPM. In (47-a), the verb is marked for plural. Since the only plural-DP in this sentence is the second one, the first DP must be the object and the second one the subject. In (47-b), both DPs are singular, but the second DP is unambiguously marked for nominative Case, so again the sentence receives an OS-structure.

The sentences in (47) differ from the sentences considered so far in that disambiguation is not achieved by the verb in clause-final position. The same is true for two other types of wh-questions which have been the subject of extensive experimental investigation. First, sentences like those in (48) differ only minimally from those in (47) in that they contain a composite tense form: the clause-second position is filled by the finite auxiliary whereas the content-

providing main verb is located in clause-final position. This means that—in contrast to all other sentences considered so far—the main verb’s argument structure is not available at the point of disambiguation.

- (48) a. #Welche Tante haben die Jungen gestern besucht?
 which aunt have-PLUR the boys yesterday visited
 ‘Which aunt have the boys visited yesterday?’
 b. #Welche Tante hat der Junge gestern besucht?
 which aunt has the boy-NOM yesterday visited
 ‘Which aunt has the boy visited yesterday?’

The sentences in (49) illustrate the different devices by which disambiguation is achieved in embedded clauses: via subject-verb agreement and via Case-morphology.

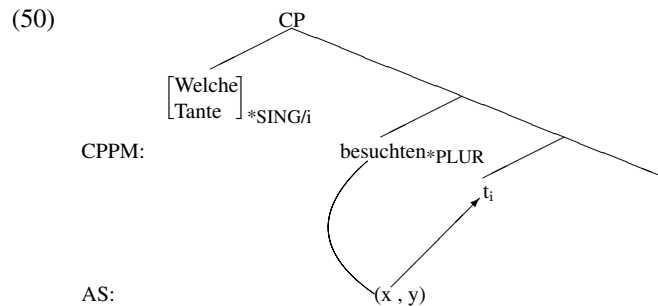
- (49) a. #Ich will wissen, welche Tante die Jungen gestern besucht
 I want know which aunt the boys yesterday visited
 haben.
 have-PLUR
 ‘I want to know which aunt the boys have visited yesterday’
 b. #Ich will wissen, welche Tante der Junge gestern besucht
 I want know which aunt the boy-NOM yesterday visited
 hat.
 has
 ‘I want to know which aunt the boy has visited yesterday’

In terms of its syntactic structure, sentence (49-a) is identical to the filler-gap sentences disambiguated by subject-verb agreement discussed at the beginning of this chapter (cf. example (3)). Sentence (49-b), in contrast, is a verb-final sentence disambiguated by the Case-morphology on the second, unambiguously nominative-marked DP *der Junge*. (49-b) is thus disambiguated at a point where no verbal information whatsoever has been encountered yet.

Experimental investigations of sentences like those in (47), (48) and (49) have revealed a robust generalization: Sentences disambiguated by agreement features on the verb ((47-a), (48-a), (49-a)) produce significantly stronger garden-path effects than sentences disambiguated by unambiguous Case marking on the second DP ((47-b), (48-b), (49-b)) (cf. Meng and Bader, 2000a; Meng and Bader, 2000b). As we will show now, this difference can be explained in the same way as the difference between base-generated and filler-gap garden-path sentences disambiguated by a clause-final verb: Garden-path sentences with DP-disambiguation can be reanalyzed by an automatic feature correction at step 2B of the LBCA; garden-path sentences with verb-disambiguation, in con-

trast, trigger a different and, in fact, more complex search for an alternative syntactic structure.

The tree in (50) shows the result of argument linking and feature checking after the verb has been processed in sentence (47-a) (using the indexing function of the argument structure developed in the preceding section).



In (50), the first and only DP *welche Tante* has been linked to the first argument of *besuchen* which is a canonical SO-verb. Since the first DP has been assigned nominative Case due to the first-pass preferences at work in subject-object ambiguities, this means that feature checking for Case gives a positive result. Feature checking for number, in contrast, reveals a mismatch since the DP *welche Tante* is marked for singular but the verb requires a plural subject. Furthermore, since *welche Tante* can only be a singular DP and *besuchten* only a plural verb, a simple feature correction at step 2B of the LBCA is not possible. Instead, a more laborious search process becomes necessary in order to find out that the first DP is not the subject but the object.

Sentence (47-a) contrasts with sentence (47-b), in which the crucial disambiguating information is provided by the Case morphology on the second DP. The situation obtaining for this sentence after the verb has been integrated into the CPPM looks basically as in (50), the only difference being that for sentence (47-b) integrating the verb into the CPPM does not lead to any kind of mismatch, and therefore does not trigger any revisions.

Revisions become necessary only after the second DP has been attached to the ongoing structure. Given that the second DP is unambiguously marked for nominative Case but the CPPM already contains a DP bearing this Case, the question arises which of the two nominative marked phrases should be blamed for the ensuing ungrammaticality. There are two possibilities, depending on whether the HSPM is giving more weight to the structure already computed or to the input it is currently analyzing.

- If the structure already computed is given priority (cf. Konieczny, 1996; Schlewsky, 1996), after insertion of the first DP as a nominative DP,

encountering the verb *besuchen* will set up an expectation that an accusative object will follow. The second DP must be taken to be this object since there is no other role for it. However, the second DP is marked for nominative Case, and the HSPM will thus register a Case-violation on this DP.

- If the input currently under analysis is given priority, the HSPM will take the unambiguous nominative marking on the second DP at face value and will thus analyze this DP as the subject of the clause. That is, it will remove the first DP from the external argument slot and link the second DP to this slot instead. As a result of this relinking, the first DP now has to be linked to the accusative argument of *besuchen*, thereby creating a mismatch given that the first DP had been assigned nominative Case on first-pass parsing.

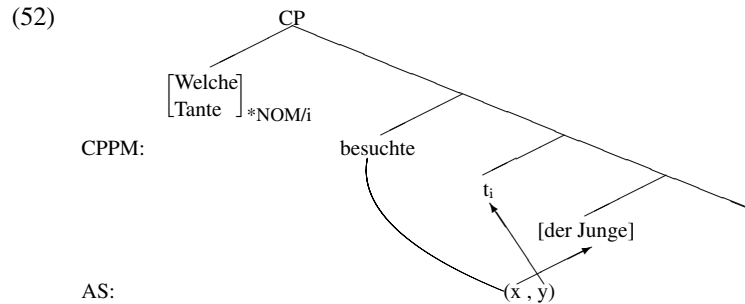
The LBCA as such does not tell us what the result of inserting the second DP into the CPPM will be. Let us therefore turn to an experiment reported in Meng and Bader (2000b) which was run in order to decide between the two options under consideration. This experiment investigated ungrammatical sentences like (51). In (51), both the first and the second DP are unambiguously marked for nominative Case. As with (47-b), the HSPM can register the Case violation once the second DP is encountered.

- (51) *Welcher Junge besuchte der Onkel?
Which-NOM boy visited the-NOM uncle

If the current input gets priority, attaching the second DP (51) should have the effect that this DP is linked to the nominative-marked agent role. In consequence, the first DP will be linked to the accusative-marked patient role, resulting in a Case violation on this DP. On the other hand, if the structure computed thus far gets priority, the Case violation should be located on the second DP.

In order to obtain information about which of the two DPs readers perceive as leading to a Case mismatch, Meng and Bader (2000b) had participants read sentences like (51) with the additional tasks of first judging the sentences as to their grammaticality and then repeating the sentences in a corrected form. Most of the corrections turned the first DP into an accusative marked DP, suggesting that the error with sentences like (51) is indeed perceived to be located on the first DP, as predicted by the assumption that the current input gets priority.

The experimental evidence thus argues that inserting the second DP of a sentence like (51) into the CPPM leads to a Case violation on the first DP in that this DP is marked for nominative Case in the CPPM whereas it should bear accusative Case according to the argument structure. This means that a representation like the one shown in (52) will be computed on encountering the second DP in a sentence like (47-b). Note that (52) also contains the trace of the *wh*-phrase in SpecCP, and that linking is stated with respect to the trace, not with respect to the moved phrase.



Given the representation shown in (52), it is clear that the remaining mismatch can be cured by the feature correction step 2B of the LBCA. After the HSPM has computed (52), its only remaining task is to determine whether the first DP is compatible with accusative Case. The answer to this question is yes because the initial DP is morphologically compatible with both nominative and accusative Case. The offending nominative feature can therefore be replaced by accusative and reanalysis will be completed immediately at step 2B of the LBCA.

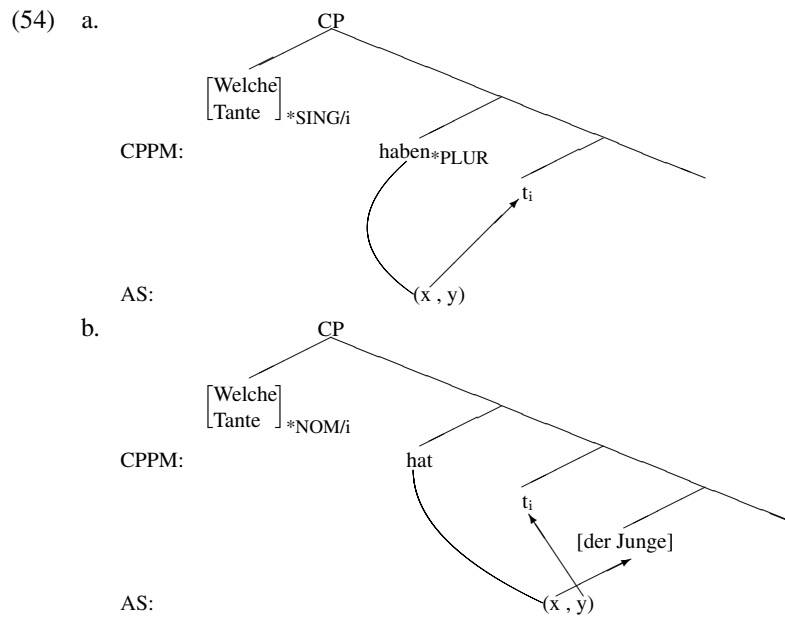
In summary, the difference in garden-path strength between sentences like (47-a) (disambiguation by a number feature on the verb) and sentences like (47-b) (disambiguation by Case morphology on a second DP) follows automatically from the workings of the LBCA. For sentences disambiguated by Case-morphology on the second DP, giving priority to the Case morphology of the DP currently under analysis has the consequence that the ensuing Case error is located on the initial, ambiguous DP. The Case mismatch can therefore easily be corrected by step 2B of the LBCA. In other words, reanalysis in such sentences is basically delivered for free by the way linking works. For sentences disambiguated by verb-agreement, in contrast, the feature mismatch resulting from linking cannot already be repaired at step 2B of the LBCA. There is no way of simply exchanging any of the incorrect number features. As a result, processes beyond the LBCA will have to be invoked, leading to a more complicated search for an alternative syntactic structure. We have thus derived that the relationship between disambiguation by subject-verb agreement and disambiguation by Case morphology for main-clause wh-questions mirrors the relationship seen before between base-generated and filler-gap verb-final sentences: Easy garden-path sentences are successfully reanalyzed by feature corrections at step 2B of the LBCA; for difficult garden-path sentences, in contrast, step 2B does not lead to a successful revision, and processes outside of the LBCA will have to be invoked.

The machinery introduced so far also captures the two remaining sentence types exhibiting a difference between verb-disambiguation and DP-disambigu-

ation, namely main clauses with an auxiliary in clause-second position and verb-final sentences. Let us begin with main clause questions like (53) (repeated from above) in which the verb-second position is filled by a finite auxiliary and the main verb is in clause final position.

- (53) a. #Welche Tante haben die Jungen gestern besucht?
 which aunt have the boys yesterday visited
 ‘Which aunt have the boys visited yesterday?’
 b. #Welche Tante hat der Junge gestern besucht?
 which aunt has the boy yesterday visited
 ‘Which aunt has the boy visited yesterday?’

The representations which result from the initial linking step of the LBCA for the sentences in (53-a) and (53-b) are shown in (54-a) and (54-b), respectively.



As one can see by comparing the representations shown in (54-a) and (54-b) with those for the corresponding sentences with the main verb in clause-second position ((50) and (52), respectively), there is no difference except that the verb-second position is filled differentially in the two sentences. Main clause wh-questions are therefore treated alike by the LBCA whether the verb-second position contains a main verb or an auxiliary. This is as it should be, given that the difference between disambiguation by subject-verb agreement and disambiguation by Case morphology has been shown to have its effect on garden-path

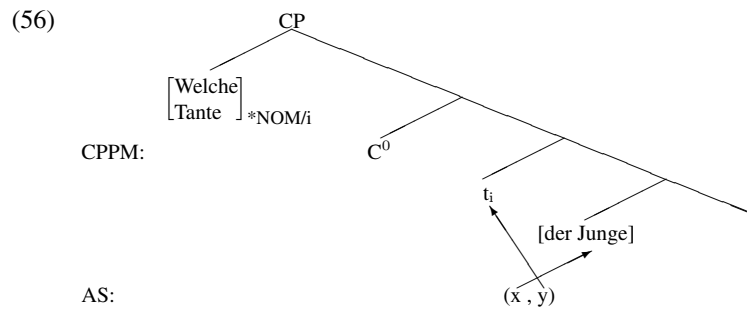
recovery (difficult for the former case, easy for the latter) independent of the main-verb versus auxiliary distinction.

The final type of contrast concerns verb-final sentences like (55) (repeated from above).

- (55) a. #Ich will wissen, welche Tante die Jungen gestern besucht haben.
 I want know which aunt the boys yesterday visited have
 'I want to know which aunt the boys have visited yesterday'
- b. #Ich will wissen, welche Tante der Junge gestern besucht hat.
 I want know which aunt the boy yesterday visited has
 'I want to know which aunt the boy has visited yesterday'

Sentence (55-a), where disambiguation is achieved by number information on the finite verb, is the type of filler-gap sentence that was already treated above when we discussed the difference between filler-gap and base-generated OS sentences (cf. section 2). As was shown there, such sentences cannot be repaired by a simple feature correction at step 2B of the LBCA but instead trigger a global search for an alternative syntactic structure. We can therefore claim that all sentences involving disambiguation by verbal agreement features are treated uniformly by the LBCA.

What remains to be shown is how sentence (55-b) with disambiguation by Case-morphology on the second DP is processed by the HSPM. According to what we saw for main clauses disambiguated in the same way (cf. (53-b)), we should expect that a sentence like (55-b) can be cured by a simple feature correction at step 2B of the LBCA. That this is indeed the case can be seen in (56), which shows the result of linking for a sentence like (55-b).



This is again the configuration we saw above for the other two types of wh-questions disambiguated by Case-morphology on the second DP. As above, the

mismatch can therefore be cured by a simple feature correction, and the ensuing garden-path effect is only a modest one.

Summarizing this section, we have seen that the LBCA straightforwardly accounts for the finding that in *wh*-questions of the sort considered here, disambiguation by subject-verb agreement leads to a substantially stronger garden-path effect than disambiguation by unambiguous Case morphology on a second DP, both in direct and indirect *wh*-questions. Only one additional assumption was necessary to derive this generalization from the LBCA, an assumption concerning the treatment of unambiguous Case-information by the HSPM. Based on empirical findings by Meng and Bader (2000b), we assumed that the HSPM, when encountering a DP unambiguously marked for nominative Case, relies on the Case marking of this DP even if the CPPM already contains a nominative marked DP introduced at some earlier point of processing. As a result of this, the error in structures with two nominative marked DPs is blamed on the first DP, not on the second one.

Note finally that this section has revealed a first pay-off of our assumption that argument structures serve as an index to arguments within the CPPM (as part of a content-addressable memory mechanism) and that—prior to encountering the verb with its argument structure—argument slots are incrementally added when the respective arguments are encountered. Given these assumptions concerning the representation of sentences by the HSPM, a unified approach of the sentences discussed in this chapter became possible: Disambiguating by Case and disambiguating by Case morphology always work the same, independently of the position of the verb in the surface structure.

9. Summary: On Linking and Checking

We started this chapter with three questions that were raised by Mitchell (1994) with regard to the linking and checking operations that follow the assembly of phrase-structure representations (these questions are repeated below; note that checking in Mitchell's sense comprises both linking and checking in our terms). We are now in a position to answer these three questions.

- (57)
- a. Do checking operations operate without delay, and are there different kinds of tests applied in a consistent order?
 - b. When a test indicates that the current structural hypothesis is not acceptable, can the information derived from this test be used to guide the processes of reanalysis?
 - c. Can the substructures from a rejected analysis be kept so that they can be built into a new structure?

All three questions receive positive answers according to our theory. As for question (57-a), linking and checking are assumed to apply without delay, in

the order given. Question (57-b) again receives a positive answer. As we have shown in detail, the information derived from linking and checking plays an important role in guiding the HSPM's reanalysis routines. For a subset of subject-object ambiguities, the LBCA (that is, the HSPM's linking and checking operations) deliver the information necessary to transform the initial analysis into the correct analysis for free. These are ambiguities which normally cause only very slight garden-path effects. Subject-object ambiguities which are not automatically reanalyzed by the LBCA usually cause stronger garden-path effects. Question (57-c), finally, is answered positively because the HSPM is assumed to keep structure as far as possible and to make only those changes which have been identified to be necessary. For those ambiguities which are reanalyzed by the LBCA itself, for example, all substructures will be left intact, and the only repair operations are changing Case features, embedding a DP into a KP, or inserting a trace which was not there before.

Chapter 7

CASE CHECKING AND THE HSPM I: ON LEXICAL REACCESS

1. Introduction

According to the Linking-Based Checking Algorithm (LBCA) that we have introduced in the preceding chapter (repeated in Figure 7.1 on the next page), the first task of the HSPM after having linked a DP to an argument structure slot consists of checking whether the DP has the feature values required by its argument structure position or not. Should feature checking result in a mismatch, the next task of the HSPM will be to determine whether or not the CPPM can be locally repaired by replacing the incorrect feature(s) by the correct one(s) (possibly with some automatic readjustments of the CPPM). These two closely related tasks—feature checking and feature repair—comprise the second step of the LBCA.

As the discussion so far has shown, repairing the CPPM by locally replacing offending features on step 2 of the LBCA is usually associated with only minor garden-path effects—garden-path effects which are normally not perceived consciously. Garden-path sentences for which the feature handling step of the LBCA does not lead to the desired result, in contrast, often give rise to noticeable processing difficulties.

A typical sentence for which step 2 alone leads to successful reanalysis is repeated in (1). On first-pass parsing, the first DP in such a sentence is assigned nominative Case and the second DP accusative Case.

- (1) Ich glaube, daß Maria gestern ein Buch geschickt wurde.
I believe that Maria yesterday a book sent was
'I believe that a book was sent to the Maria yesterday.'

On encountering the clause-final passivized verb with its requirement of a dative object followed by the subject, the HSPM will detect two Case violations: The

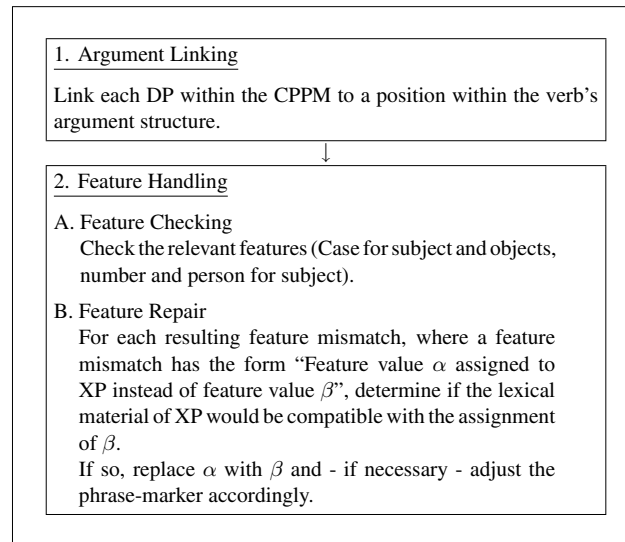


Figure 7.1. The Linking-Based Checking Algorithm (LBCA)

first DP, *Maria*, is specified for nominative instead of dative Case; the second DP, *ein Päckchen*, is specified for accusative Case instead of nominative. For both DPs, the respective lexical items are compatible with the Case requirements of the verb. The SO-structure assigned to a sentence like (1) on first-pass parsing can thus be transformed to the OS-structure required by the verb by two rather simple feature corrections. Accordingly, sentences of this type give rise to only modest garden-path effects.

Given this account, a new question arises immediately: How does the HSPM decide whether or not an offending feature specification can give way to the correct one? Clearly, just noticing that sentence (1) could be cured by assigning dative Case to the first DP and nominative to the second DP is not sufficient. The HSPM also has to determine whether the DPs involved are morphologically compatible with the required Case revisions. Otherwise, the HSPM would be unable to distinguish between a locally ambiguous sentence—which is ungrammatical only temporarily, before reanalysis has taken place—and a corresponding ungrammatical sentence, which is permanently ungrammatical.

What we therefore need is a detailed theory of how the HSPM checks Case features, including the task of determining whether a given Case violation can be cured or not. Developing such a theory is the aim of this and the following chapter. In doing so, we will draw on some of our earlier work (cf. Bader, 2000; Meng and Bader, 2000b), which has provided first insights into the HSPM's

Case checking procedures. In particular, this work has produced a number of experimental results which suggest that the HSPM responds with different actions to different types of Case mismatch. We will argue in the next section that these actions are firmly rooted in the grammar of Case as it was outlined in chapter 3.

In addition to specifying how Case checking by the HSPM depends on the grammar of Case, a complete theory of the HSPM's feature checking routines will also have to address the question of how sentences are represented in short-term or working memory. This question is particularly pressing for the sentences at hand, given that Case checking is usually initiated at the clause-final verb and therefore dependent on having access to structures which were built up at a prior point during the ongoing analysis and then held in some kind of short-term store. For example, after the HSPM has processed the clause-final verb in a sentence like (1), it needs to retrieve the two DPs *Maria* and *ein Buch* from the short-term store in order to determine whether they are compatible with the syntactic repair operations called for by the verb.

In summary, a comprehensive theory of the Case checking procedures used by the HSPM will have to specify both the operations responsible for Case checking as well as the memory mechanisms subserving these operations. The former task—specifying the HSPM's Case checking operations—will be the subject of the current chapter. Relating these operations to working memory mechanisms will be the topic of the next chapter. Building on earlier experimental work, we will argue in section 2 that different types of checking operations are invoked depending on the particular Case mismatch involved. The remaining sections 4-6 will present three experiments that have tested the major predictions which follow from our hypothesized Case checking operations.

2. Case Checking within the HSPM

In this section we will begin to develop an explicit theory of how the HSPM checks and repairs Case features. As a start, consider again the garden-path sentence in (1), which is repeated in (2-a), together with an ungrammatical counterpart.

- (2) a. Ich glaube, daß Maria ein Buch geschickt wurde.
 I believe that Maria a book sent was
 'I believe that a book was sent to Maria.'
- b. *Ich glaube, daß die (ok: der) Tante ein Buch geschickt wurde.
 I believe that the aunt a book sent was

The ungrammaticality of the sentence in (2-b) stems from the fact that its first DP, the DP *die Tante*, is compatible with both nominative and accusative Case, but not with dative Case, which would be required by the clause-final verbal

complex *geschickt wurde*. All experiments to be reported later in this chapter will be variations on the sentences in (2).

On first-pass parsing, the HSPM will assign nominative Case to the first DP and accusative Case to the second DP in both (2-a) and (2-b). After argument-structure linking and Case checking, the state depicted in (3) will therefore result.

(3)	CPPM:	*[Maria/ die Tante] _{nom}	*[ein Buch] _{acc}	geschickt wurde <x, y>
		DAT	NOM	DAT
	Required Case:			

As can be seen in (3), independent of the particular lexical material making up the first DP, Case checking results in two Case violations: The first DP bears nominative instead of dative Case; the second DP bears accusative instead of nominative Case. Since we assume that the HSPM is a strictly serial mechanism, the simple fact that the syntactic structure built so far has resulted in a violation of the rules of grammar does not tell the HSPM whether this violation is due to a locally ambiguous input string which has been misparsed, or to an ungrammatical input string for which no grammatically licit parse is available. In other words, violations do not come classified as either temporary violations which can be repaired or permanent violations which cannot. This implies that the HSPM has to start a process of diagnosis each time it has detected a violation. Whether this is a temporary or a permanent violation will become clear as a side effect of the diagnosis process. If some means to cure the violation are found, the violation was a temporary one; if none are found, the violation was a permanent one.

When we apply this reasoning to the sentences in (2), we see that the HSPM has to figure out two pieces of information before it can decide that the locally ambiguous sentence (2-a) can be repaired whereas the ungrammatical sentence (2-b) cannot: First, the initial DP in (2-a) (the proper name *Maria*) can license dative Case but the initial DP in (2-b) (the definite DP *die Tante*) cannot. Next, the second DP is compatible with nominative Case (this only matters for the locally ambiguous sentence (2-a)). The question then is how the HSPM can access these pieces of information.

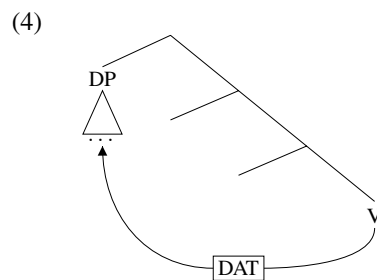
In prior work (cf. Bader et al., 1996; Meng and Bader, 2000b) we have suggested that the answer to this question depends on the particular type of Case violation. In accordance with our account of the German Case system, we will distinguish the three violation types which are listed below. As the linking pattern in (3) has shown, the sentences in (2) contain violations of the first and third type. An example illustrating the second type will be given later.

- $\text{DAT} \rightarrow \text{DP}[\text{NOM}/\text{ACC}]$
Dative Case has to be assigned to a DP which was assigned structural Case on first-pass parsing
- $\text{NOM}/\text{ACC} \rightarrow \text{KP}[\text{DAT}]$
Structural Case has to be assigned to a DP which has been embedded in a dative KP-shell on first-pass parsing
- $\text{NOM} \rightarrow \text{DP}[\text{ACC}]$ or $\text{ACC} \rightarrow \text{DP}[\text{NOM}]$
One of the two structural Cases has to be assigned to a DP which was assigned the other structural Case on first-pass parsing

We will now consider these three types of Case violation in turn.

2.1 Inserting a KP versus Retracting a KP

(4) shows the phrase-structural configuration which gives rise to violations of the first type: nominative/accusative has been assigned on first-pass parsing but the verb requires dative Case.



In (4), a DP bearing structural Case (either nominative or accusative) has been inserted into the CPPM on first-pass parsing. On encountering the verb, this decision turns out to be false: The DP has to be assigned dative Case instead of structural Case in order to arrive at a grammatical structure. For violations of this type, we propose that the information needed to discriminate between a merely temporary violation and a permanent one is not part of the CPPM itself. Instead, we propose the *LEXICAL REACCESS HYPOTHESIS* presented in (5) (cf. Bader et al., 1996; Bader, 2000).

- (5) *The Lexical Reaccess Hypothesis*
When the HSPM has to decide during second-pass parsing whether dative Case can be assigned to a DP that has been assigned structural Case on first-pass parsing, the lexicon has to be reaccessed in order to determine whether or not the lexical material dominated by the DP is capable of licensing dative Case.

The configuration in (4) concerns the DP *Maria* in (2-a) and the DP *die Lehrerin* in (2-b). In order to repair the violation exhibited by this configuration, a KP-shell would have to be inserted. Given the morphological Case system of German, the lexical item *Maria* can license a KP, but the lexical item *die* cannot. This type of information must be contained within the mental lexicon, but, according to our hypothesis, it is not contained within the CPPM. Thus, the HSPM cannot figure out whether configuration (4) can be repaired or not by just inspecting the CPPM; instead, the relevant information has to be retrieved from the mental lexicon.

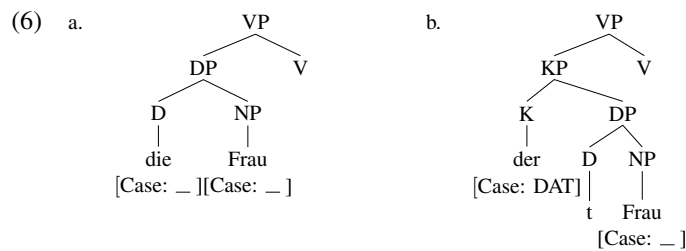
Given the grammar of Case of German, it is to be expected that the HSPM does not encode whether a DP that has been assigned structural Case on first-pass parsing might also be compatible with dative Case or not. To see this, let us recall two main generalizations about Case in German:

- A phrase with N- or D-features is not in need of any morphological Case exponent in order to appear in a position to which nominative or accusative Case is assigned.
- Assignment of dative Case usually depends on a morphological Case exponent.

In other words, a DP can bear structural Case as long as it is not explicitly specified otherwise, but it can bear dative Case only if explicitly specified so.

To capture these regularities, we make the following two assumptions about the representation of Case-bearing lexical items. Tree structures illustrating these assumptions are shown in (6).

- A DP which is compatible with structural Case in general remains unspecified.
- A nominal item can license dative Case only if it is morphologically specified so.



When Case features are underspecified as in (6-a), the dominating DP has to be a subject or a direct object. Since we have assumed throughout that the representations which are computed by the HSPM for a given sentence are

exactly those specified by the mental grammar, it is natural to assume that the HSPM initiates a process of lexical reaccess on encountering configuration (4). Nevertheless, this is not a necessary assumption, and therefore in need of empirical evidence. As we will show next, there are already some suggestive pieces of experimental evidence in favor of the Lexical Reaccess Hypothesis. A more thorough experimental investigation of this hypothesis will follow later in this chapter.

The Lexical Reaccess Hypothesis was first proposed after the rather surprising discovery that even such a harmless looking ambiguity as the one between accusative and dative object can give rise to garden-path effects (cf. Bader et al., 1996, and section 3 of chapter 4). Two relevant examples from chapter 4 are repeated in (7) and (8).

- (7) a. Menschen, die in Not sind, sollte man helfen.
 people-DAT who in distress are should one help
 ‘One should help people who are in distress.’
 b. Menschen, die in Not sind, sollte man unterstützen.
 people-ACC who in distress are should one support
 ‘One should support people who are in distress.’
- (8) a. Man sollte Menschen helfen, die in Not sind.
 One should people-DAT help who in distress are
 ‘One should help people who are in distress.’
 b. Man sollte Menschen unterstützen, die in Not sind.
 One should people-ACC support who in distress are
 ‘One should help people who are in distress.’

In (7), the locally ambiguous object-DP *Menschen* is in sentence-initial position and therefore at some distance from the point of disambiguation, which is the clause-final main verb. In (8), the ambiguous object-DP is contained within the middle-field directly in front of the disambiguating main verb; furthermore, the relative clause modifying the object-DP has been extraposed in order to minimize the distance between point of ambiguity and point of disambiguation.

As shown in Bader et al. (1996), the assignment of accusative Case is preferred to the assignment of dative Case on first-pass parsing and therefore a garden-path effect results in both (7-a) and (8-a). With minimal distance between ambiguous object and disambiguating verb, as in (8-a), this is a very mild garden-path effect which can only be detected experimentally. With increased distance, as in (7-a), the garden-path effect becomes stronger and is sometimes even consciously detectable.

Based on these findings, Bader et al. (1996) proposed the Lexical Reaccess Hypothesis in order to explain both why sentences of this kind cause measurable garden-path effects at all, and why the strength of the observed garden-path

effect depends on the distance between the point of ambiguity and the point of disambiguation.¹ As our point of departure we noted that the syntactic changes to the phrase-marker built up so far are too simple to give rise to noticeable processing difficulties. One and the same repair operation would have to be invoked for both (7) and (8), which would incorrectly predict that (7) and (8) should be on a par with respect to garden-path strength. For these reasons, we hypothesized that it is not the syntactic repair operation by itself which is the major cause of the resulting processing difficulties, but the need to reaccess the lexicon in order to check whether the necessary feature readjustment is morphologically licit or not. This interpretation of the data was supported by the fact that garden-path sentences of type (7-a) elicited an N400, which is an indicator of additional lexical processing, but not a P600, an indicator of syntactic reanalysis.

In essence, this makes the strength of the garden-path in such sentences a function of the lexical ambiguity inherent in a word like *Menschen*. This item can be taken from the lexicon with either no Case specified, or with dative Case specified.² On first-pass parsing, the first option is taken, and the second option then has to be retrieved on second-pass parsing. That the later operation can be difficult is well-known from the literature on lexical ambiguity resolution. Duffy, Morris and Rayner (1988), for example, investigated sentences like (9).

- (9) Of course the band was her favorite because it had such a beautiful engraving.

This sentence contains the lexically ambiguous word *band*. On reading this word, the dominant meaning “music band” is selected. This initial selection has to be revised when processing the disambiguating subordinate clause, leading to processing difficulties: reading times for the disambiguating region are longer for ambiguous sentences than for control sentences with *gold* replacing *band*.

Furthermore, following an earlier proposal by Ferreira and Henderson (1991), we proposed that the garden-path effect caused by (7-a) is substantially stronger than the one caused by (8-a) because the activation of the lexical entry for the noun *Menschen*, that is, the noun for which lexical reaccess has to be invoked, is much smaller in (7-a) than in (8-a) at the point in time where lexical reaccess

¹For sentences like those in (8), Bader et al. (1996) actually relied on intuitive data which were experimentally supported only later.

²That is, *Menschen* as object of an accusative verb and *Menschen* as object of a dative verb are different lexical items in the enumeration in the sense of Chomsky (1995). This does, of course, not mean that there have to be two lexical entries. There can still be single lexical entry, for example with some form of paradigm structure, from which it follows that *Menschen* can enter the derivation under two different descriptions.

is triggered.³ This latter proposal follows under the common assumption that a lexical entry gets activated when it is accessed, with the activation then decaying over time. Given that a substantial amount of time elapses between encountering the noun *Menschen* and the disambiguating verb in (7-a), whereas these two items are adjacent in (8-a), the difference in garden-path strength follows.

A second piece of evidence in favor of the lexical reaccess hypothesis comes from the processing of downright ungrammatical sentences. To recapitulate, our claim is that the HSPM automatically invokes a process of lexical reaccess given the configuration in (4)—the configuration where dative Case has to be assigned to a DP which has been assigned structural Case on the first pass. The purpose of lexical reaccess consists in determining whether it is morphologically licit to insert a KP above the offending DP or not. This implies that at the point where lexical reaccess is triggered, the HSPM does not yet know whether it is dealing with a locally ambiguous sentence—such that the Case violation is only a temporary one—or with an ungrammatical sentence—such that the Case violation persists as a permanent one. A decision between these two options will become possible only after lexical reaccess has been completed.

Two ungrammatical sentences which are thus predicted to trigger lexical reaccess are given in (10) ((10-a) is repeated from above).

- (10) a. *daß die (ok: der) Tante ein Buch geschickt wurde.
 that the aunt a book sent was
 b. *daß der (ok: dem) Onkel ein Buch geschickt wurde.
 that the uncle a book sent was

(10-a) and (10-b) differ from each other only in that the offending first DP is a feminine DP in (10-a) but a masculine DP in (10-b) (*die Tante* vs. *der Onkel*). This difference does not affect the syntactic structure that is assigned to such sentences on the first pass. The HSPM will assign a SO-structure of the sort shown in (3) to both sentences on the first pass. The clause-final verb requires that this structure is dismissed in favor of one with a dative object followed by the subject, but the HSPM cannot make the necessary changes without violating rules of the grammar because the first DP in these sentences is not compatible with dative Case.

Ungrammatical passive sentences like those in (10) have been the subject of several experiments (e.g., Meng and Bader, 2000). In all of these experiments—with the exception of one which we will consider shortly—the DP which was assigned nominative Case on the first pass instead of dative Case was a feminine DP, as the one in (10-a). For ungrammatical passive sentences with a feminine

³As discussed in chapter 4, experimental evidence for this claim has been provided by Scheepers, Hemforth, and Konieczny (1997), although these authors have explained the difference in terms of topicalization vs. non-topicalization.

first DP, the experimental evidence shows that readers are rather error-prone when they have to judge the well-formedness of such sentences under time pressure. The percentage of sentences correctly judged as ungrammatical usually has been around 60% for this type of ungrammaticality.

The one experiment that did not include sentences with a feminine first DP (cf. (10-a)) but also sentences with a masculine first DP (cf. (10-b)) is Experiment 2 of Bader et al. (2000). As shown in Table 7.1, the feminine definite article *die* and the masculine definite article *der* (which were the only Case marked elements in the DPs under consideration) differ in that the former is ambiguous between nominative and accusative whereas the latter is unambiguous.

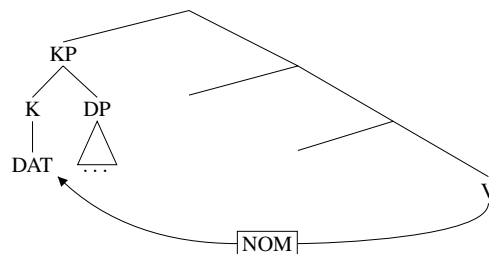
Table 7.1. Case paradigms for feminine and masculine singular DPs

	<i>Nominative</i>	<i>Accusative</i>	<i>Dative</i>	<i>Genitive</i>
Feminine	die Frau		der Frau	
Masculine	der Mann	den Mann	dem Mann	des Mannes

For ungrammatical sentences with an offending feminine DP, Bader et al. (2000) found again a rather low level of correct judgments, namely 61%. For ungrammatical sentences with a masculine DP, in contrast, participants were significantly better at detecting the ungrammaticality, reaching a level of 79%. This finding shows that for the sentences under consideration, participants' speeded grammaticality judgments do not only depend on the syntactic structure per se but also on specific lexical properties of the items causing the Case violation.

To appreciate the full significance of this finding, it is now time to introduce the reverse kind of violation, that is, a violation in which dative Case has been assigned on first-pass parsing but has to be converted to a structural Case—either nominative or accusative—later on. The configuration of such violations is depicted in (11) and exemplified by the sentences in (12).

(11)



- (12) a. *daß der (ok: die) Tante ein Buch geschickt hat.
 that the aunt a book sent has
 b. *daß dem (ok: der) Onkel ein Buch geschickt hat.
 that the uncle a book sent has

For Case violations of the type shown in (11) we propose that the HSPM does not invoke any kind of lexical reaccess. Instead, upon detecting a mismatch configuration of this type, the HSPM will conclude without further reasoning that the input string is ungrammatical. Again, this proposal is closely tied to properties of the German Case system. As already pointed out before, dative Case is in need of a lexical license, which usually is overtly marked by some Case inflection. This means that the HSPM will embed a DP within a KP-shell only if it has some positive evidence to do so. Conversely, the HSPM can assume that a KP which was inserted during the first pass was inserted so because there was no other choice, and can reject a sentence with an offending KP therefore without any further lexical checking procedures.⁴

Like the corresponding ungrammatical passive sentences, ungrammatical active sentences with a feminine first DP have been included in several experiments (e.g. Meng and Bader, 2000b). These experiments have consistently shown that this type of ungrammaticality is reliably detected by participants, with an accuracy of 85% to 90%. Ungrammatical active sentences with a masculine first DP—in addition to those with a feminine first DP—have been part of the same experiment that was cited above in connection with ungrammatical passive sentences (cf. the discussion of (10)). As shown in Table 7.1 above, in terms of morphological ambiguity the same pattern holds for dative marked DPs as for nominative marked DPs: feminine DPs exhibit a morphological ambiguity, masculine DPs do not. Nevertheless, ungrammatical active sentences did not show any difference depending on the first DP's gender, in clear contrast to what was found for passive sentences. For both genders, accuracy was around 90%. Note that this is considerably higher than what has been found for ungrammatical passive sentences with a feminine first DP, and still significantly higher than what has been found for ungrammatical passive sentences with a masculine first DP.

The experimental results on ungrammatical active and passive sentences can therefore be summarized as follows.

⁴As discussed in chapter 5, further evidence for this claim comes from a consideration of ambiguous sentences in which, due to Case attraction, a KP has been erected above a Case-ambiguous DP (cf. Meng and Bader, 2000b). We will come back to this evidence at the end of the next chapter when summarizing our experimental results on Case checking.

- Finding 1:
Ungrammatical passive sentences are more error-prone than ungrammatical active sentences.
- Finding 2:
Ungrammatical passive sentences are susceptible to lexical effects, ungrammatical active sentences are not.

While the first observation rests on a firm empirical basis, the second one is due to a single experiment. This situation will be remedied by the experiments that we will report later in this chapter.

2.2 Reaccessing the Mental Lexicon

How do the two findings presented at the end of the preceding section follow from our hypothesis that lexical reaccess is invoked once dative Case has to be assigned on second-pass parsing to a DP marked for nominative/accusative Case but not when nominative/accusative has to be assigned to a KP? The first finding follows if we assume that lexical reaccess is a somewhat error-prone process. Since judging ungrammatical passive sentences is dependent on lexical reaccess whereas judging ungrammatical active sentences is not, only sentences of the former type will be affected by the error-proneness of lexical reaccess. Furthermore, by its very nature as a process that retrieves information from the mental lexicon, lexical reaccess is liable to specific properties of the words that have to be checked. From this, the second finding follows.

One might wonder why lexical reaccess should be an error-prone process given that the normal process of lexical access—at least under normal circumstances—is not error-prone. For example, when participants have to judge grammatical sentences containing a DP like *die Tante*—i.e., a DP which leads to errors when lexical reaccess becomes necessary—the error rate is usually negligible, indicating that lexical access for the words of this DP is flawless. However, there is a crucial difference between lexical access and lexical reaccess. As a first approximation, lexical reaccess can be decomposed into two steps:

- After the HSPM has determined that some lexical property of a word *w* would have to be changed in order to arrive at a well-formed syntactic structure, the first step consists in recollecting the memory traces which have been set up for *w* in short-term or working memory. In particular, the word form of *w* has to be retrieved since it is the word form which determines which Case(s) it can possibly represent.
- The second step will take the information recollecting at step one as the basis for querying the mental lexicon in order to retrieve the searched-for lexical information associated with *w*.

Lexical reaccess, thus, crucially differs from lexical access in that it depends on retrieving information from working memory. Since representations within working memory in general—and word form representations in particular—are subject to processes of decay and interference (cf. the discussion of working memory in the next chapter), it comes as no surprise that lexical reaccess can be an error-prone process even if lexical access is not.

Considering the process of reading, a further question raised by a process of reaccessing the lexicon concerns the code used to reaccess the lexicon. There are several reasons to assume that this is a phonological code and not a visual or graphemic one.

First of all, there is general agreement within reading research that computing phonological representations forms part of normal, silent reading. For example, in their book summarizing what is known about reading, Rayner and Pollatsek (1989) write: “Although the meanings of individual words can be determined without recoding written language into speech, phonological codes appear to be activated for most words we read, and this phonological information is held in working memory and is used to comprehend text” (Rayner and Pollatsek, 1989: 216).

In addition to the general evidence showing that phonological representations are computed during reading, there is also direct experimental evidence for the more specific assumption that lexical reaccess is mediated by the phonological form of a word. When we introduced the hypothesis that lexical reaccess is invoked in sentences for which dative Case has to be assigned on second-pass parsing, we said that lexical reaccess is not specific to Case-ambiguous words. Instead, lexical reaccess is a much more general process, which also occurs when readers choose one meaning of a lexically ambiguous word like *band* or *ruler* and are later forced to retrieve the second meaning (cf. our discussion of example (9) from the experiment by Duffy, Morris and Rayner (1988)). In a further series of experiments investigating the processing of lexically ambiguous words, Folk and Morris (1995) investigated the role of phonological representations for lexical ambiguity resolution by contrasting HOMOGRAPHIC HOMOPHONES and HOMOGRAPHIC HETEROPHONES.⁵ Homographic homophones are ambiguous words like *band* or *ruler* where the two different meanings share the same orthographic and phonological form. An example sentence from Folk and Morris (1995) with a homographic homophone is given in (13-a). Homographic heterophones are words like *tear*, *sewer*, or *bow* where the two different meanings are associated with the same spelling but different sounds. An example sentence from Folk and Morris including a homographic heterophone is given in (13-b).

⁵A third type of words investigated by Folk and Morris (1995) were heterographic homophones like *brake*—*break*. We will not discuss these words here because they are not pertinent to our purposes.

- (13) a. *Homographic Homophones*
The old ruler was hidden in her castle from the angry mob.
- b. *Homographic Heterophones*
There was a tear in Jim's shirt after he caught his sleeve on a thorn.

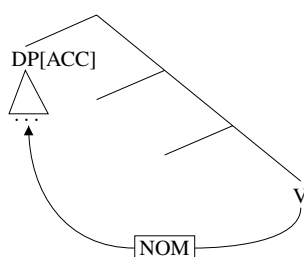
In both (13-a) and (13-b), the non-dominant meaning of the ambiguous word is required for the sentence to make sense. Since readers have been shown to choose the dominant meaning for such lexically ambiguous words unless a preceding context boosts the non-dominant one (cf. Duffy et al., 1988), a lexical garden-path effect is expected to occur when the later part of the sentence forces readers to replace the dominant meaning adopted on the first pass by the non-dominant meaning required by the sentence-context. In three experiments investigating sentences like those in (13), Folk and Morris found a much larger penalty at the point of disambiguation for homographic heterophones than for homographic homophones. In their Experiment 1, for example, they measured eye-movements while participants were reading sentences of the sort shown in (13). The results show an increase in reading times for homographic homophones in comparison to matched control words within the disambiguating region, but no increase in regressive eye-movements back to the ambiguous word. For homographic heterophones, the reverse pattern was found. No increase in the disambiguating region, but a sharp increase in regressions back to the ambiguous word. These findings suggest that for homographic homophones the alternative meaning can be retrieved on the fly (leading to higher reading times in the disambiguating region). For homographic heterophones, in contrast, the ambiguous word had to be reread to activate the correct meaning (as reflected by an increase in regressions to the ambiguous word). Given that in the experiment by Folk and Morris homographic homophones and homographic heterophones only differed in terms of one phonological form versus two phonological forms, their results allow the conclusion that the mental lexicon is reaccessed using a phonological representation.

The results of Folk and Morris (1995) add to the already large body of evidence showing that phonological representations are computed during reading. Furthermore, their results strongly suggest that reaccessing the lexicon—as it might become necessary if the wrong lexical analysis was chosen during the first analysis—is mediated by the phonological representation that becomes available as a result of access to the mental lexicon. Since there is no reason to assume that reaccessing the mental lexicon for reasons of Case checking works in any way different from reaccessing the lexicon for a different meaning, we will make the assumption that lexical reaccess during checking for Case is also mediated by a phonological representation.

2.3 Replacing one of the Structural Cases by the other one

What remains to be discussed is the last of the three Case violations introduced above, namely the violation in which one of the two structural Cases—nominative and accusative—would have to be replaced by the other one in order to arrive at a well-formed syntactic structure. This configuration is depicted in (14) for one of the two directions that are possible in German (nominative instead of accusative and accusative instead of nominative).

(14)



For the time being, we will consider this type of Case violation only insofar as it pertains to the sentences discussed in this chapter, that is, locally ambiguous OS-sentences like (2) (repeated below as (15)).⁶

(15) Ich glaube, daß Maria ein Buch geschickt wurde.

I believe that Maria a book sent was

‘I believe that a book was sent to Maria.’

In (15), the second DP *ein Buch* gets assigned accusative Case on the first pass; when the clause-final auxiliary verb is processed, this decision turns out to be false because this DP has to be a nominative DP according to the correct syntactic analysis. Given the linking-based diagnosis mechanism that we have proposed in the preceding chapter, the need to switch from accusative to nominative is transparently signaled to the HSPM. Furthermore, as discussed above, the HSPM can assume that a DP bearing one of the two structural Cases is also compatible with the complementary one unless specified otherwise. The initial accusative feature on *ein Buch* can therefore be replaced by the correct nominative feature by simply noting that the lexical items *ein* and *Buch* are unspecified for Case. There is thus no need for any kind of lexical rechecking.

Recall from chapter 3 that the assignment of structural Case—be it nominative or accusative—in the absence of any lexical license must be assumed

⁶As with all Case violations, this violation type can also occur in incurable sentences (i.e., ungrammatical sentences). As shown in Meng (1998) (cf. Meng and Bader, 2000b), interesting processing effects are observed in ungrammatical sentences containing Case-violations involving only structural Cases.

anyway because positions to which structural Case is assigned can also be filled by phrases which cannot be inflected. Two examples illustrating this point are shown in (16).

- (16) a. Fritz hat geleugnet, daß er nicht in der Schule war.
 F. has denied that he not in the school was
 ‘Fritz denied that he hadn’t been in school.’
 b. Fritz hat genug verkauft.
 F. has enough sold
 ‘Fritz sold enough’

In (16-a), a *dass*-clause, which arguably has nominal features, represents the accusative object, although clauses cannot be inflected for Case in German. The same is true for adverbials, which, as shown by (16-b) can nevertheless fill the role of an accusative object. Although not shown here, what is true for accusative objects is also true for subjects, that is, the nominative marked argument of a verb. Since neither CPs nor adverbs participate in a Case paradigm, lexical reaccess for reasons of Case checking would be a completely unmotivated operation.

According to this, reanalyzing *ein Buch* in (15) from accusative marked object to nominative marked subject should only contribute minimally to the reanalysis costs for this sentence. The main reanalysis cost induced by sentences of this type should instead come from the need to assign dative Case to the first DP, given our hypothesis that assigning dative Case on the second pass involves lexical reaccess. It does not seem to be possible to directly measure how much each of the two DPs in sentences like (15) contributes to the observed garden-path effect. There is nevertheless empirical evidence for our hypothesis that the assignment of dative Case to a DP which had been assigned structural Case on the first pass is substantially more costly than simply switching between the two structural Cases. This evidence comes from an experiment reported in Bader et al. (2000) which investigated locally ambiguous sentences of the sort shown in (17).

- (17) a. Wessen Mutter besuchte der Lehrer?
 whose mother-ACC visited-ACC the teacher
 ‘Whose mother did the teacher visit?’
 b. Wessen Mutter gratulierte der Lehrer?
 whose mother-DAT congratulated-DAT the teacher
 ‘Whose mother did the teacher congratulate?’

In both (17-a) and (17-b), the initial DP is first assigned nominative Case. This decision turns out to be false when the second DP, which is unambiguously marked for nominative Case, is processed. In (17-a), the initial DP has to be

made the accusative object of the verb *besuchen* (to visit); in (17-b), the verb *gratulieren* (to congratulate) requires the first DP to be reanalyzed as a dative object. In both sentences, the necessary revision steps follow transparently from the fact that the respective verb needs a subject and an object, and the subject slot is filled by the second DP. Nevertheless, the results obtained by Bader et al. (2000) show a substantial garden-path effect for sentences like (17-b) where dative Case has to be assigned to the first DP on second-pass parsing, whereas the assignment of accusative Case in sentences like (17-a) caused a garden-path effect of only the mildest sort. This pattern of garden-path strength is exactly what is to be expected if the assignment of dative Case on reanalysis involves an additional step of lexical reaccess whereas switching between the two structural Cases does not.⁷

2.4 Summary of Case Checking Operations

In this section we have proposed that the three Case violations introduced at the beginning are handled in quite different ways by the HSPM.

- **DAT → DP[NOM/ACC]**
Sentences in which nominative/accusative Case had been assigned during first-pass parsing instead of dative Case trigger a process of lexical reaccess after the HSPM has inspected the CPPM and detected the violation. Lexical reaccess is necessary in order to determine whether or not the lexical material dominated by the offending DP is capable of licensing dative Case. If it is, the DP will be embedded in a KP-shell, and the sentence can be repaired successfully. However, lexical reaccess seems to be somewhat error-prone, signaling sometimes that a DP can license dative Case although in fact it cannot, thereby causing the HSPM to erroneously accept certain ungrammatical sentences as grammatical.
- **NOM/ACC → KP[DAT]**
Sentences where a KP shell was introduced during the first pass instead of a simple DP specified for nominative/accusative Case are classified as ungrammatical by the HSPM immediately after the violation has been detected within the CPPM. This is motivated by the fact that a KP will only be inserted into the CPPM if there is morphological evidence for it.

⁷A further difference between (17-a) and (17-b) is that turning the initial DP into a dative object involves an additional piece of repair, namely the insertion of a KP. In the case of accusative objects, this particular repair operation is not necessary. As already discussed in section 2, we believe that this difference is only of minor importance in comparison to lexical reaccess in explaining the greater processing difficulty of dative-object sentences in comparison to accusative-object sentences. Empirical evidence for this claim will be provided in Experiment 2.

- **NOM/ACC → DP[ACC/NOM]**
Concerning the final type of violation, $\text{NOM} \rightarrow \text{DP}[\text{ACC}]$ or $\text{ACC} \rightarrow \text{DP}[\text{NOM}]$ violations, we have so far only considered the constellation where a DP that has been assigned accusative Case on the first pass has to be assigned nominative Case on the second pass, and where the DP under consideration is unspecified for Case (that is, where it is ambiguous between nominative and accusative Case). In this situation, the HSPM can switch freely between the two structural Cases, without the need to reaccess the lexicon.

3. Testing Case Checking: A Preview of the Following Experiments

This section will give a preview of the three experiments that will be presented in the remainder of this chapter. Three major claims of our model of Case checking and repair will be the focus of these experiments:

- **DAT → DP[NOM/ACC]**
When dative Case has to be assigned to a DP specified for nominative/accusative Case during first-pass parsing, a process of lexical reaccess is triggered.
- **NOM/ACC → KP[DAT]**
When nominative/accusative Case has to be assigned to a DP specified for dative Case (a KP) during first-pass parsing, the sentence is rejected as ungrammatical without any further consideration of the lexical material dominated by the offending KP.
- **NOM → DP[ACC]**
When one structural Case has to be replaced by the other one, and the lexical material dominated by the offending DP is underspecified for structural Case, the mismatch can be repaired without an extra step of rechecking the lexical material.

The major prediction stemming from these claims is that the processing of sentences which contain a temporary or permanent Case violation where the verb requires dative Case on a DP which has been assigned structural Case on first-pass parsing should be liable to factors which can plausibly be assumed to affect lexical reaccess. For sentences containing one of the other two types of Case violation, in contrast, factors manipulating lexical reaccess shouldn't have any effect.

To test these predictions, the upcoming experiments will investigate—in different combinations—(i) locally ambiguous passive sentences (cf. (18)), (ii) ungrammatical passive sentences (cf. (19)), and (iii) ungrammatical active sentences (cf. (20)).

- (18) daß Maria ein Buch geschickt wurde.
 that Maria a book sent was
- (19) *daß die (ok: der) Mutter ein Buch geschickt wurde.
 that the mother a book sent was
- (20) *daß der (ok: die) Mutter ein Buch geschickt hat.
 that our mother a book sent has

After argument linking and determination of Case violations, the HSPM will have arrived at the following representations.

- (21) Ambiguous and ungrammatical passive sentences

CPPM:	*[Maria/ die Tante] _{nom}	*[ein Buch] _{acc}	geschickt wurde <x, y>
Required	DAT	NOM	DAT
Case:			

- (22) Ungrammatical active sentences

CPPM:	*[der Tante] _{dat}	*[ein Buch] _{nom}	geschickt hat <x, y>
Required	NOM	ACC	
Case:			

All three experiments will manipulate factors that should selectively affect the process of lexical reaccess that we have postulated to occur if a post hoc reanalysis in favor of dative Case is required. As (21) and (22) show, the manipulation of lexical properties should have an effect on the first DP in (21) but not on any of the other DPs.

The first experiment will compare performance on ungrammatical passive sentences to performance on ungrammatical active sentences ((19) versus (20)). The factor that will be manipulated in this experiment concerns the phonological similarity between the correct and the incorrect morphological form of the DP involved in the ensuing Case violation. The second and the third experiment will investigate ambiguous sentences to see which effects can plausibly be attributed to the hypothesized process of lexical reaccess. In order to do so, the second and third experiment will manipulate the lexical complexity of the DPs involved in reanalysis. The second experiment will apply this manipulation to the first DP in locally ambiguous passive clauses as in (18). Because the first DP has to be assigned dative Case on the second pass, manipulating the complexity of this DP should have an experimental effect. The third experiment will apply the same manipulation to the second DP in such sentences. In this case, no effect is predicted because switching between the two structural Cases should not trigger any kind of lexical reaccess according to our theory.

4. Experiment 1: Ungrammatical Sentences and Phonological Similarity

The theory of Case checking proposed above claims that there is a fundamental distinction between violations according to which dative Case has to be assigned to a DP which received structural Case on first-pass parsing, and violations of the reverse type: for violations of the former type the HSPM will initiate a process of lexical reaccess before making a decision, whereas sentences containing a violation of the latter type are judged as ungrammatical immediately upon detection of the violation. This predicts that an experimental manipulation of the lexical material dominated by the offending DP should matter in the former but not in the latter case. Furthermore, the strongest kind of argument in favor of the lexical reaccess hypothesis would hold if performance on sentences which are hypothesized to trigger lexical reaccess could be shown to depend on lexical information that is absent in first-pass parsing and that therefore can exert an influence on the processing of these sentences only at a second checking stage.

Experiment 1 is intended to provide such an argument by manipulating the similarity between the correct and the incorrect form of the determiner which gives rise to the Case violation. To see how this works, consider first the ungrammatical passive sentences presented in (23-a) and (23-b).

- (23) a. *daß die (ok: der) Mutter ein Buch geschickt wurde.
 that the mother a book sent was
 b. *daß meine (ok: meiner) Mutter ein Buch geschickt wurde.
 that my mother a book sent was

Syntactically, these two sentences are completely identical. Both are ungrammatical because the form of the determiner used within the initial DP is compatible with structural Case but not with dative Case (*die* in (23-a), *meine* in (23-b)). The crucial difference between these sentences concerns the phonological similarity between the incorrect form of the determiner (*die* and *meine*) and the correct form (*der* and *meiner*). In sentence (23-a), the nominative/accusative form *die* of the definite article is used instead of the correct dative form *der* which is required by the clause-final verb; sentence (23-b), in contrast, contains the nominative/accusative form *meine* of the first-person plural possessive pronoun instead of the correct dative form *meiner*.

While the pairs *die/der* and *mein/meiner* do not differ in any relevant morpho-syntactic properties—in particular, they are on a par with respect to Case ambiguity—they differ in terms of how similar the correct form is to the incorrect one. This is true no matter if similarity is measured in orthographic or phonological terms. Therefore, the question arises whether lexical reaccess is affected by orthographic or phonological similarity (or both). Like all the other experiments reported in this book, the current one will present sentences

visually. Given the evidence presented in Folk and Morris (1995) that has been discussed above (cf. (13)), we will assume that independent of the input modality, lexical reaccess is mediated by the phonological form of a word, and that therefore phonological similarity is the crucial variable at this point.

Our task therefore is to specify the phonological similarity between the correct and the incorrect forms of the determiners used in the current experiment. These determiners are shown in Table 7.2. The row labeled Nom/Acc shows the incorrect determiners, that is, the determiners which will actually appear in the ungrammatical sentences under consideration. The determiners which would make the sentence correct if they would be substituted for the incorrect ones, are shown in the row labeled Dative.

Table 7.2. Phonological similarity and Case of the definite determiner and selected possessive pronouns

	<i>Low Phonological Similarity</i> (<i>Definite Article</i>)	<i>High Phonological Similarity</i> (<i>Possessive Pronouns</i>)			
Nom/Acc	die	meine	unsere	ihre	seine
Dative	der	meiner	unserer	ihrer	seiner
	'the'	'my'	'our'	'her'	'his'

In the condition of low phonological similarity, the feminine form of the definite article will be used. The condition of high phonological similarity will make use of several forms of the feminine possessive pronoun, as shown in Table 7.2. The notion of low and high similarity which is given in Table 7.2 can be based on several measures of phonological similarity. For example, *die/der* map onto monosyllables which differ by nucleus and coda: [di:] vs. [de:ɐ]. In all the other cases either two or three syllables are involved of which all but the last remain fully identical, e.g. [maɪ.nə] vs. [maɪ.nɐ] or [ʊn.zə.rə] vs. [ʊn.zə.rɐ]. In addition, the last syllables differ only by the quality of the syllable's nucleus and it is always the identical first syllable which receives the word accent.

In contrast to this, it is predicted that the lexical material dominated by an offending dative phrase should have no effect whatsoever. This prediction follows from the assumption that a sentence with a DP bearing dative Case instead of nominative Case can be judged as ungrammatical by simply inspecting the phrase marker. To test this additional prediction, Experiment 1 will contain ungrammatical active sentences like those in (24).

- (24) a. *daß der (ok: die) Mutter ein Buch geschickt hat.
 that the mother a book sent has

- b. *daß unserer (ok: unsere) Mutter ein Buch geschickt hat.
 that our mother a book sent has

Note that exactly the same determiners are involved in the ungrammatical active sentences as in the ungrammatical passive sentences—the only difference is that their role has been reversed, that is, the form that is correct in a passive sentence is incorrect in an active sentence and vice versa. Therefore, the argument concerning phonological similarity is equally valid for the sentences in (24). Nevertheless, if our account of Case checking is on the right track, no difference should be found between (24-a) and (24-b) in terms of how accurately these sentences are rejected by the HSPM.

4.1 Method

Participants and Procedure. 40 students of the University of Jena participated in this experiment which used our standard method of speeded grammaticality judgments.

Materials. 40 sentences were constructed, with each sentence appearing in eight versions. The eight versions resulted from crossing the three factors STATUS (grammatical vs. ungrammatical), STRUCTURE (active vs. passive), and PHONOLOGICAL SIMILARITY BETWEEN CORRECT AND INCORRECT FORM (low vs. high). A complete stimulus set from Experiment 1 is shown in Table 7.3.

All sentences consisted of a main clause followed by an embedded clause. All experimental manipulations were confined to the embedded clause of the experimental sentences.

The four types of ungrammatical sentences were already described in the introduction to this experiment (ungrammatical passive sentences: (23); ungrammatical active sentences: (24)). The corresponding grammatical sentences were identical to the ungrammatical sentences with the exception that the incorrect form of the determiner was replaced by the correct one. For sentences in the condition with low similarity between correct and incorrect determiner, only the definite feminine singular article was used. For sentences in the condition with high similarity between correct and incorrect determiner, the following four possessive pronouns were used: *ihre* (her), *seine* (his), *meine* (my), *unsere* (our). Each possessive pronoun appeared in exactly ten sentences.

4.2 Results

Judgments. The percentages of correct judgments for Experiment 1 are presented in Table 7.4. The results were statistically analyzed in two steps. First, three-way ANOVAs were conducted taking all three factors (grammaticality, syntactic structure, and phonological similarity) into account. On the basis of significant three-way interactions between all three factors, grammatical and

Table 7.3. A complete stimulus set for Experiment 1. Note: All clauses in this table were introduced by the main clause *Ich habe erfahren* ('I have heard')

Grammatical	
Active	
Low Similarity	daß die Chefin letzte Woche eine Postkarte geschickt hat. that the boss last week a postcard sent has '... that the boss sent a postcard last week.'
High Similarity	daß meine Chefin letzte Woche eine Postkarte geschickt hat. that my boss last week a postcard sent has '... that my boss sent a postcard last week.'
Passive	
Low Similarity	daß der Chefin letzte Woche eine Postkarte geschickt wurde. that the boss last week a postcard sent was '... that a postcard was sent to the boss last week.'
High Similarity	daß meiner Chefin letzte Woche eine Postkarte geschickt hat. that my boss last week a postcard sent has '... that a postcard was sent to my boss last week.'
Ungrammatical	
Active	
Low Similarity	daß der Chefin letzte Woche eine Postkarte geschickt hat. that the boss last week a postcard sent has
High Similarity	daß meiner Chefin letzte Woche eine Postkarte geschickt hat. that my boss last week a postcard sent has
Passive	
Low Similarity	daß die Chefin letzte Woche eine Postkarte geschickt wurde. that the boss last week a postcard sent was
High Similarity	daß meine Chefin letzte Woche eine Postkarte geschickt hat. that my boss last week a postcard sent has

ungrammatical sentences were then analyzed by separate two-way ANOVAs with the factors syntactic structure and phonological similarity. For reasons of space, we will only report the results of the separate two-way ANOVAs here. The results of the three-way ANOVAs can be found in an appendix to this chapter.

For grammatical sentences, separate two-way ANOVAs (2 structure \times 2 phonological similarity) showed a significant main effect of structure ($F(1,39) = 10.52, p < .01$; $F(1,39) = 8.10, p < .01$), no significant effect of similarity ($F(1,39) = 2.32, p = .14$; $F(1,39) = 1.84, p = .18$), and an interaction between structure and similarity which was significant in the subject analysis and marginally significant in the item analysis ($F(1,39) = 5.27, p < .05$; $F(1,39) = 3.29, p = .08$). As shown by planned comparisons, this interaction was due to a significant effect of similarity on grammatical active sentences (87% vs. 80%:

Table 7.4. Percentage of Correct Judgments for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Grammatical</i>		<i>Ungrammatical</i>	
	<i>Active</i>	<i>Passive</i>	<i>Active</i>	<i>Passive</i>
<i>Low Similarity</i> (<i>Definite Article</i>)	87 (2.5)	91 (2.0)	85 (3.5)	70 (4.5)
<i>High Similarity</i> (<i>Possessive Pronoun</i>)	80 (2.5)	93 (1.9)	85 (2.9)	49 (4.2)

$t_1 = 2.71, p < .01; t_2 = 2.14, p < .05$) but not on grammatical passive sentences (91% vs. 93%, both t -values < 1).

For ungrammatical sentences, there was a significant effect of structure ($F(1,39) = 52.30, p < .001; F(1,39) = 50.76, p < .001$), a significant effect of similarity ($F(1,39) = 9.93, p < .01; F(1,39) = 10.58, p < .01$), and a significant interaction between structure and similarity ($F(1,39) = 14.45, p < .001; F(1,39) = 13.79, p < .001$). Subsequent planned comparisons showed first of all that ungrammatical passive sentences were judged less reliably than ungrammatical active sentences, in both the low similarity condition (70% vs. 85%: $t_1 = 4.26, p < .001; t_2 = 3.35, p < .01$) and the high similarity condition (49% vs. 85%: $t_1 = 8.37, p < .001; t_2 = 7.5, p < .001$). Further planned comparisons showed that for ungrammatical active sentences similarity had no effect (85% vs. 85%, both t -values < 1) whereas it had a significant effect on ungrammatical passive sentences (70% vs. 49%: $t_1 = 3.96, p < .001; t_2 = 4.02, p < .001$).

Table 7.5. Mean Reaction Times (ms) to Make Correct Judgments for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Grammatical</i>		<i>Ungrammatical</i>	
	<i>Active</i>	<i>Passive</i>	<i>Active</i>	<i>Passive</i>
<i>Low Similarity</i> (<i>Definite Article</i>)	549 (37.4)	582 (39.3)	738 (49.6)	897 (46.9)
<i>High Similarity</i> (<i>Possessive Pronoun</i>)	549 (36.6)	552 (40.5)	756 (36.7)	916 (55.1)

Judgment times. Table 7.5 shows the response times for correct judgments in Experiment 1. As with the percentages of correct judgments, response times were first subjected to three-way ANOVAs and then to separate two-way ANOVAs for grammatical and ungrammatical sentences. ANOVAs for the grammatical sentences revealed no significant effect (all p 's $> .15$).

For ungrammatical sentences, the effect of structure was significant, reflecting the fact that ungrammatical passive sentences received longer reaction times than ungrammatical active sentences ($F(1,35) = 34.46$, $p < .001$; $F(1,35) = 25.06$, $p < .001$). The factor similarity was not significant in the subject and marginally significant in the item analysis ($F(1,35) = .78$, $p = .38$; $F(1,35) = 3.72$, $p = .06$). The interaction between structure and similarity was not significant (both F -values < 1).

4.3 Discussion

Experiment 1 has two major outcomes. First, ungrammatical active sentences were generally rejected as ungrammatical more reliably and faster than ungrammatical passive sentences. Second, the phonological similarity between the correct and the incorrect form of the determiner within the crucial initial DP had a strong effect on ungrammatical passive sentences but no effect on ungrammatical active sentences. These two outcomes are exactly as predicted by the model of Case checking developed in this chapter.

Note in particular that the finding of an effect of phonological similarity between correct and incorrect determiner form for ungrammatical passive sentences provides a particularly strong argument that the lexicon is reaccessed during Case checking/repair. If the lexicon were not reaccessed, such an effect could not arise. Without lexical reaccess, the word form of the correct determiner would not be available—there was no reason to retrieve it during the first-pass through the sentence—, and consequently no interference between the incorrect form of the determiner (the form that was actually read) and the correct form would have been possible.

In addition to the substantial effects found for ungrammatical sentences, we also found some effects for grammatical sentences in Experiment 1. In particular, grammatical active sentences were judged worse than grammatical passive sentences. This effect, which has also been found in Experiment 5 of chapter 6, is probably due to the fact that all sentences involved a ditransitive verb with one argument missing. For active sentences, the dative argument was simply dropped. While this was grammatically licit for all the verbs we used, there might nevertheless be certain acceptability differences depending on the particular verb. Such a problem does not arise with passive sentences because passivization is a grammaticalized way of suppressing the underlying subject, without any differences in acceptability depending on a particular verb.

5. Experiment 2: Locally Ambiguous Sentences and DP Complexity

The preceding experiment has provided strong evidence for the claim that a process of lexical reaccess is invoked when a DP that has been assigned structural Case on first-pass parsing actually has to be assigned dative Case on second-pass parsing in order to arrive at a grammatically correct analysis. However, the preceding experiment as well as the experiments cited earlier have investigated ungrammatical sentences. While we have argued in section 2 that the same processes occur in ungrammatical and locally ambiguous sentences containing a nominative DP instead of a dative KP, we have not yet provided an experimental demonstration that locally ambiguous sentences are susceptible to factors that should directly affect the process of lexical reaccess. The aim of Experiment 2 is to fill this gap.

A certain difficulty one faces when trying to come up with such an experimental demonstration is that DPs suitable for such a test—that is, DPs which are three-way ambiguous between nominative, accusative, or dative Case—are restricted to a small choice of possibilities in German.⁸ This difficulty is, of course, not unexpected. It simply echoes the generalization that dative Case in German is usually morphologically marked in an unambiguous way. As already pointed out in chapter 3, there are a few exceptions to this generalization: proper names, DPs with a possessive phrase in their specifier (*Peters Mutter* ('Peter's mother'), *wessen Mutter* ('whose mother')), bare NPs, and DPs with a small set of determiners or quasi-determiners like *ein paar*.⁹

Given that all prior experiments on ungrammatical passive sentences used DPs of the form "determiner + noun", Experiment 2 will make use of the ambiguity of the quasi-determiner *ein paar* and compare locally ambiguous passive sentences beginning with a proper name to corresponding sentences beginning with a DP of the form "*ein paar N*". Two sample sentences illustrating the resulting experimental manipulation are shown in (25).

⁸For the experimental sentences under consideration, it would of course be enough to have a DP which is two-way ambiguous between nominative and dative Case. However, as far as we know, all DPs which are two-way ambiguous in this way are also compatible with accusative Case.

There are two lexical items which are two-way ambiguous between accusative and dative Case, namely the first- and second person plural forms of the personal pronoun: *uns* ('us') and *euch* ('you'). While these items are not useable in the experiments reported here, an interesting question is how they might be processed given their exceptional status within the German Case system.

⁹While proper names are always three-way ambiguous, the other types of DPs listed here are three-way ambiguous only with nouns which do not have a separate form for dative Case (cf. *Peters Professoren* (nominative, accusative, dative) but *Peters Lehrer* (nominative, accusative)—*Peters Lehrern* (dative))

- (25) a. (Keiner wußte,) daß Maria die Zeitung gebracht
 Nobody knew that Maria-DAT the newspaper-NOM brought
 wurde.
 was
 ‘Nobody knew that the newspaper was brought to Maria’
- b. (Keiner wußte,) daß ein paar Professoren die Zeitungen
 Nobody knew that a pair professors the newspaper-NOM
 gebracht wurden.
 brought were
 ‘Nobody knew that the newspapers were brought to some professors.’

In sentence (25-a), which is repeated from above, the first DP consists of the simple proper name *Maria*. In (25-b), in contrast, the first DP is made up of the indefinite determiner *ein paar* (lit. *a pair*, corresponding to English *a couple of*) followed by the noun *Professoren*. Due to the morphological ambiguity of the DPs involved, the two sentences in (25) are completely ambiguous with respect to their word order until the clause-final verb is received. Note that sentence (25-b) differs from sentence (25-a) also by the fact that the second DP and the clause-final verb have been pluralized. These additional changes guarantee that neither of the two sentences contains any word-order cue based on the obligatory agreement between subject and verb.

Given our hypothesis that a phrase to which dative Case has to be assigned on reanalysis has to be lexically reaccessed in order to determine whether the lexical items making up the phrase are capable of licensing dative Case, it is a natural expectation that the more complex the phrase is for which reaccess has to be invoked, the more difficult reaccess will be. For the sentences that will be tested in the current experiment, the prediction therefore is that sentences like (25-a) (dative Case assigned to a proper name) should cause a less severe garden-path effect than sentences like (25-b) (dative Case assigned to a DP made up of a complex determiner and a noun).

A certain concern one might have with regard to comparing sentences like (25-a) to sentences like (25-b) is raised by the fact that a proper name is a definite DP whereas a DP with the determiner *ein paar* is an indefinite DP. Since a sentence with the first DP definite, as in (25-a), might be pragmatically less complex than a sentence with the first DP indefinite (as in (25-b)), sentences like (25-b) might be at a disadvantage in comparison to sentences like (25-a) (note that this holds irrespective of whether the second NP in these sentences is definite or indefinite).

To control for such definiteness-related effects, the current experiment will make use of unambiguous control sentences which are matched in terms of definiteness to their corresponding ambiguous counterparts. For ambiguous sentences with a proper name, unambiguous sentences will have a definite

DP in place of the proper name. For ambiguous sentences with a DP of the form *ein paar N*, unambiguous sentences will contain the indefinite determiner *einige-NOM/einigen-DAT* (some). Since in the unambiguous case there is no difference in terms of complexity between definite DPs and indefinite DPs, in the following we will speak of the factor definiteness instead of the factor DP-complexity, bearing in mind that for ambiguous sentences definite DPs are simple (proper name) and indefinite DPs complex (*ein paar N*)

5.1 Method

Participants and Procedure. 24 students of the University of Jena participated in this experiment which used our standard method of speeded grammaticality judgments.

Materials. For Experiment 2 we constructed 40 sentences, with each sentence appearing in eight versions according to the factors STATUS (ambiguous vs. unambiguous), STRUCTURE (active vs. passive), and DEFINITENESS OF THE FIRST DP (definite vs. indefinite). All sentences consisted of a main clause and an embedded clause, with the experimental manipulation confined to the embedded clause. A complete stimulus set is provided in Table 7.6.

As already discussed above (cf. (25)), the second DP and the clause-final auxiliary were always matched in terms of number to the first DP: In sentences with a definite first DP, both first and second DP as well as the auxiliary were marked for singular; in sentences with an indefinite first DP, these elements were marked for plural.

To make ambiguous sentences unambiguous, the ambiguous initial DP was replaced by a corresponding unambiguous DP: a definite DP (definite determiner + noun) for proper names, and an indefinite DP with the Case-inflected determiner *einige* (some) for indefinite ambiguous DPs with the determiner *ein paar* ('a couple of').

5.2 Results

Judgments. Table 7.7 on page 226 presents the percentages of correct responses for Experiment 2. Three-way ANOVAs taking all three factors into account again resulted in a significant three-way interaction (cf. the Appendix to this chapter for details). Separate two-way ANOVAs (2 structure \times 2 definiteness of the first DP) were then conducted for the unambiguous and the ambiguous sentences. For unambiguous sentences, there was neither a significant main effect nor a significant interaction (all p 's $>$.05). For ambiguous sentences, both main factors as well as the interaction between them were significant (Factor Structure: $F(1,23) = 46.22$, $p < .001$; $F(1,39) = 75.78$, $p < .001$. Factor First DP: $F(1,23) = 11.52$, $p < .01$; $F(1,39) = 8.19$, $p < .01$. Interaction between Structure and First DP: $F(1,23) = 5.71$, $p < .05$; $F(1,39) = 11.42$, $p < .01$).

Table 7.6. A complete stimulus set for Experiment 2. Note: All clauses in this table were introduced by the main clause *Man munkelte* ('Rumor had it')

Unambiguous	
Active	
definite DP	daß das Mädchen ein teures Schmuckstück gekauft hat. that the girl a expensive jewelry-piece bought has '... that the girl bought an expensive piece of jewelry.'
indefinite DP	daß einige Mädchen teure Schmuckstücke gekauft haben. that some girls expensive jewelry-pieces bought have '... that some girls bought expensive pieces of jewelry.'
Passive	
definite DP	daß dem Mädchen ein teures Schmuckstück gekauft wurde. that the girl a expensive jewelry-piece bought was '... that an expensive piece of jewelry was bought for the girl.'
indefinite DP	daß einigen Mädchen teure Schmuckstücke gekauft wurden. that some girls expensive jewelry-pieces bought were '... that expensive pieces of jewelry were bought for some girls.'
Ambiguous	
Active	
definite DP	daß Vera ein teures Schmuckstück gekauft hat. that V. a expensive jewelry-piece bought has '... that Vera bought an expensive piece of jewelry.'
indefinite DP	daß ein paar Mädchen teure Schmuckstücke gekauft haben. that a pair girls expensive jewelry-pieces bought have '... that a couple of girls bought expensive pieces of jewelry.'
Passive	
definite DP	daß Vera ein teures Schmuckstück gekauft wurde. that V. a expensive jewelry-piece bought was '... that an expensive piece of jewelry was bought for Vera.'
indefinite DP	daß ein paar Mädchen teure Schmuckstücke gekauft wurden. that a pair girls expensive jewelry-pieces bought were '... that expensive pieces of jewelry were bought for some girls.'

Subsequent planned comparisons showed that for ambiguous active sentences the factor definiteness had no significant effect (92% vs. 91%: both t -values < 1) whereas it was highly significant for ambiguous passive sentences (71% vs. 49%: $t_1 = 3.51$, $p < .001$; $t_2 = 4.96$, $p < .001$).

Judgment times. Table 7.8 shows the response times for correct judgments in Experiment 2. For unambiguous sentences, ANOVAS revealed no significant effect (all F -values < 1). For ambiguous sentences, the factor structure was significant, reflecting the finding that ambiguous passive sentences were associated with longer reaction times than ambiguous active sentences ($F(1,19) = 31.44$,

Table 7.7. Percentage of Correct Judgments for Experiment 2 (Standard Errors by Subjects in Parentheses)

	<i>Unambiguous</i>		<i>Ambiguous</i>	
	<i>Active</i>	<i>Passive</i>	<i>Active</i>	<i>Passive</i>
Definite	93 (2.3)	94 (2.2)	92 (2.7)	71 (5.2)
Indefinite	88 (3.2)	94 (2.5)	91 (2.7)	49 (5.5)

Table 7.8. Mean Reaction Times (ms) to Make Correct Judgments for Experiment 2 (Standard Errors by Subjects in Parentheses)

	<i>Unambiguous</i>		<i>Ambiguous</i>	
	<i>Active</i>	<i>Passive</i>	<i>Active</i>	<i>Passive</i>
Definite	389 (29.0)	411 (29.3)	405 (32.2)	662 (50.4)
Indefinite	427 (34.1)	432 (44.7)	436 (29.7)	726 (54.2)

$p < .001$; $F2(1,32) = 25.67$, $p < .001$). The factor first DP was significant in the subject but not in the item analysis ($F1(1,19) = 7.34$, $p < .05$; $F2(1,32) = 2.06$, $p = .16$), and the interaction was not significant ($F1(1,19) = .01$, $p = .93$; $F2(1,32) = 1.84$, $p = .18$).

5.3 Discussion

The results of Experiment 2 show that garden-path strength in the OS-sentences under consideration here is not simply a function of the syntactic revisions that become necessary at the end of the clause. Otherwise, no differences in garden-path strength should have shown up. Instead, garden-path strength is a function of the lexical material to which dative Case has to be assigned on second-pass parsing. Experiment 2 thereby fills the gap noted at the beginning: It shows that lexical effects are not confined to ungrammatical passive sentences but also occur in locally ambiguous ones.

6. Experiment 3: Switching between Structural Cases

The final experiment of this chapter will test the hypothesis that the Case mismatch on the second DP in the sentences under investigation can be remedied without an extra step of lexical reaccess. To this end, Experiment 3 will make

use of the same contrast that had already been used in Experiment 2, namely the contrast between a DP consisting of a single noun and a DP consisting of the compound determiner *ein paar* ('a couple of') followed by a noun. Two sample sentences are given in (26).

- (26) a. Ich glaube, daß Fritz und Maria Postkarten geschickt wurden.
 I believe that Fritz and Maria postcards sent were
 'I believe that postcards were sent to Fritz and Maria.'
- b. Ich glaube, daß Fritz und Maria ein paar Postkarten geschickt wurden.
 I believe that Fritz and Maria a pair postcards sent were
 'I believe that a couple of postcards were sent to Fritz and Maria.'

To exclude any influence of number information on the ambiguity resolution process, the first DP in these sentences contains two coordinated proper names which turns this DP into a plural DP. Given that the sentences in (26) are locally compatible with a subject-before-object reading, we expect a garden-path effect on encountering the clause-final passive auxiliary which signals the need to revise the initial structure in favor of an object-before-subject structure. The strength of the ensuing garden-path effect should not differ between (26-a) and (26-b) if our account of Case checking and repair is on the right track. For the first DP in these sentences, lexical reaccess should occur, but it should be equally costly in the two sentences because they contain the same DP. With respect to the second DP, the two sentences differ from each other, but the repair operation is the same according to our theory: the accusative feature assigned on the first pass simply has to be replaced by the feature nominative. The prediction therefore is that sentences like (26-a) and (26-b) should produce garden-path effects of equal strength, in contrast to what was found when the same lexical manipulation was applied to the first instead of the second DP (Experiment 2).

6.1 Method

Participants and Procedure. 18 students of the University of Jena participated in this experiment which used our standard method of speeded grammaticality judgments.

Materials. The design of Experiment 3 differs from the preceding experiments in that it only investigates passive clauses (that is, OS-clauses). 36 sentences were created, with each sentence appearing in six different versions, according to the two factors STATUS (grammatical vs. ambiguous vs. ungrammatical) and COMPLEXITY OF THE SECOND DP (simple vs. complex). A complete stimulus set is provided in Table 7.9.

Table 7.9. A complete stimulus set for Experiment 3. Note: All clauses shown in this table were introduced by the main clause *Mir ist erzählt worden* ('I was told')

Grammatical	
Simple (bare N)	daß den Dozentinnen Balladen vorgelesen wurden. that the lecturers ballads read were '... that ballads were read to the lecturers.'
complex (<i>ein paar N</i>)	daß den Dozentinnen ein paar Balladen vorgelesen wurden. that the lecturers a pair ballads read were '... that a couple of ballads were read to the lecturers.'
Ambiguous	
Simple (bare N)	daß Maria und Katrin Balladen vorgelesen wurden. that M. and K. ballads read were '... that ballads were read to Maria and Katrin.'
complex (<i>ein paar N</i>)	daß Maria und Katrin ein paar Balladen vorgelesen wurden. that M. and K. a pair ballads read were '... that a couple of ballads were read to the lecturers.'
Ungrammatical	
Simple (bare N)	daß die Dozentinnen Balladen vorgelesen wurden. that the lecturers ballads read were
complex (<i>ein paar N</i>)	daß die Dozentinnen ein paar Balladen vorgelesen wurden. that the lecturers a pair ballads read were

The complexity factor always affected the second DP, that is, the DP which—in the ambiguous condition—is assigned accusative Case on first-pass parsing and nominative Case on second-pass parsing, reflecting the fact that the second DP is the subject in these sentences. In the condition “simple DP”, the second DP was a plural bare noun. In the condition “complex DP”, the same noun as in the simple condition was preceded by the determiner *ein paar* ('a couple of'), the same determiner that caused a rather substantial garden-path effect in the preceding experiment. Both the simple and the complex DPs were always ambiguous between nominative and accusative Case. In the ambiguous condition, the first DP was always a conjunction of two proper names (e.g. *Fritz und Maria*). This means that the first DP in an ambiguous sentence was morphologically compatible with the assignment of nominative, accusative, and dative Case, and that first and second DP were matched in terms of number. In the grammatical and ungrammatical conditions, the first DP was a definite plural DP that in half of the sentences contained the definite article and in the other half of the sentences a possessive pronoun. In the grammatical condition, the first DP was unambiguously marked for dative Case; in the ungrammatical condition, the first DP was incompatible with the assignment of dative Case.

6.2 Results

Table 7.10. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 3 (Standard Errors by Subjects in Parentheses)

	<i>Grammatical</i>		<i>Ambiguous</i>		<i>Ungrammatical</i>	
	<i>Noun</i>	<i>Det+Noun</i>	<i>Noun</i>	<i>Det+Noun</i>	<i>Noun</i>	<i>Det+Noun</i>
Percentage correct	95 (2.6)	96 (1.8)	90 (4.7)	88 (3.5)	74 (5.3)	66 (5.9)
Judgment time	451 (40.2)	465 (54.9)	690 (66.4)	621 (49.8)	860 (64.9)	798 (50.5)

Judgments. Table 7.10 shows the percentages of correct responses for Experiment 3. Two-way ANOVAs (3 status \times 2 complexities) revealed only a significant main effect of status ($F(2,34) = 20.28$, $p < .01$; $F(2,70) = 25.81$, $p < .01$) whereas the factor complexity as well as the interaction between status and complexity were not significant (status: $F(1,17) = 1.73$, n.s.; $F(1,35) = 1.49$, n.s.; status by complexity: $F(2,34) = .72$, n.s.; $F(2,70) = 1.22$, n.s.).

Judgment times. The reaction times for correct responses obtained in Experiment 3 are also shown in Table 7.10. As with the judgment data, two-way ANOVAs (3 status \times 2 complexities) showed a significant main effect of status ($F(2,34) = 55.02$, $p < .01$; $F(2,62) = 55.96$, $p < .01$) but no significant effect for the factor complexity or the interaction between status and complexity (complexity: $F(1,17) = 2.54$, n.s.; $F(1,31) = .24$, n.s.; status by complexity: $F(2,34) = 1.30$, n.s.; $F(2,62) = 1.27$, n.s.).

Further results. As described in the materials section, in half of the sentences the first DP contained the definite article whereas the other half contained a possessive pronoun (except in the ambiguous condition, where the first DP was always a conjunction of two proper names). This variation was introduced to test the generality of the results of Experiment 1 which have shown that phonological similarity between correct and incorrect form affects performance on ungrammatical passive clauses. Percentages of correct responses and response times for correct responses when taking this factor into account are shown in Table 7.11 (grammatical sentences) and Table 7.12 (ungrammatical sentences).

As these tables show, phonological similarity had again a clear effect on ungrammatical sentences but no effect on grammatical sentences, thus replicating the results of Experiment 1.

Table 7.11. Grammatical Sentences: The Effect of High vs. Low Phonological Similarity (definite article vs. possessive pronoun)

	<i>Noun</i>		<i>Det+Noun</i>	
	<i>“die”</i>	<i>“meine”</i>	<i>“die”</i>	<i>“meine”</i>
Percentage correct	91 (4.7)	98 (1.8)	98 (1.8)	94 (3.0)
Judgment time	449 (50.1)	451 (48.6)	478 (57.4)	457 (61.4)

Table 7.12. Ungrammatical Sentences: The Effect of High vs. Low Phonological Similarity (definite article vs. possessive pronoun)

	<i>Noun</i>		<i>Det+Noun</i>	
	<i>“die”</i>	<i>“meine”</i>	<i>“die”</i>	<i>“meine”</i>
Percentage correct	85 (4.0)	63 (8.9)	78 (6.0)	54 (9.0)
Judgment time	806 (80.7)	928 (73.8)	671 (50.6)	997 (70.1)

6.3 Discussion

As predicted by our theory of Case checking, the lexical complexity of a DP which had been assigned accusative Case on first-pass parsing but received nominative Case on second pass-parsing did not have any influence on the resulting garden-path effect. This is in clear contrast to the findings of Experiment 2 which showed that the same manipulation of lexical complexity had a rather substantial effect when applied to a DP assigned nominative Case on the first-pass but dative Case on the second-pass. These findings thus corroborate our claim that different Case violations trigger different actions by the HSPM.

7. Summary

In this chapter we have presented a theory of how the HSPM checks and repairs Case features. A major claim of this theory is that the actions taken by the HSPM after having detected a Case violation vary with the nature of the particular Case violation. Given the German Case system, we have distinguished between three types of Case violations, which are repeated below together with the actions that the HSPM will take for each of them according to the theory put forward in this chapter.

- **DAT → DP[NOM/ACC]**
A Case violation where dative Case has to be assigned on reanalysis to a DP which was originally assigned structural Case triggers a process of lexical reaccess which is mediated by the phonological form of the word for which reaccess is called for.
- **NOM/ACC → KP[DAT]**
A Case violation where structural Case has to be assigned on reanalysis to a dative-marked KP leads to an immediate rejection of the sentence as ungrammatical, without any further consideration of the lexical material dominated by the offending KP.
- **NOM → DP[ACC]**
A Case violation where one structural Case has to be replaced by the other one and where the lexical material dominated by the offending DP is underspecified for Case can be repaired without an extra step of rechecking the lexical material.

The major predictions deriving from our theory of Case checking were confirmed in a series of three experiments. The basic results can be summarized as follows.

- Locally ambiguous passive clauses caused garden-path effects. This replicates earlier findings and is consistent with the fact that these sentences are compatible with the syntactically simpler SO-structure (NOM > ACC) until the clause-final auxiliary reveals that they in fact have an OS-structure (DAT > NOM).
- The accuracy for detecting an ungrammaticality is higher for ungrammatical active sentences than for ungrammatical passive sentences, as expected under the assumption that only ungrammatical passive sentences trigger an additional, error-prone process of lexical reaccess.
- Experimental manipulations that were expected to affect the process of lexical reaccess had a strong effect if a DP was manipulated for which dative Case had to be assigned on second-pass parsing but no effect for the other types of Case violations investigated in the preceding experiments.
- The phonological similarity between the correct and the incorrect form of the determiner modulated accuracy of ungrammaticality detection for ungrammatical passive sentences but not for ungrammatical active sentences.
- Manipulating lexical complexity in locally ambiguous passive sentences had an effect when the first DP was manipulated but not when the same manipulation was applied to the second DP.

Since the next chapter will continue with the topic of Case checking by the HSPM—under the perspective of the memory structure subserving Case checking—we will postpone a more general discussion of these results to the end of the next chapter.

8. Appendix: Summary of Statistical Results

This appendix summarizes the results of the three-way ANOVAS for Experiment 1 and Experiment 2.

Experiment 1: Ungrammatical Sentences and Phonological Similarity

Table 7.13. Three-way ANOVA for percentages of correct judgments for Experiment 1^a

Main Effect/ Interaction	<i>F</i> 1(39,1)	<i>p</i> of <i>F</i> 1	<i>F</i> 2(39,1)	<i>p</i> of <i>F</i> 2
Grammaticality	39.23	**	52.46	**
Structure	24.69	**	27.97	**
Similarity	8.87	**	14.98	**
Grammaticality × Structure	43.39	**	35.21	**
Grammaticality × Similarity	5.78	*	2.93	.095
Structure × Similarity	3.25	<i>p</i> = .079	2.52	n.s.
Grammaticality × Structure × Similarity	19.94	**	17.12	**

^a *: *p* < .05; **: *p* < .01; n.s.: not significant

Table 7.14. Three-way ANOVA for reaction times to make correct judgments for Experiment 1^a

Main Effect/ Interaction	<i>F</i> 1(35,1)	<i>p</i> of <i>F</i> 1	<i>F</i> 2(35,1)	<i>p</i> of <i>F</i> 2
Grammaticality	85.15	**	131.61	**
Structure	18.92	**	9.36	**
Similarity	.96	n.s.	3.99	<i>p</i> = .053
Grammaticality × Structure	19.81	**	12.85	**
Grammaticality × Similarity	.11	n.s.	1.61	n.s.
Structure × Similarity	.28	n.s.	.26	n.s.
Grammaticality × Structure × Similarity	.07	n.s.	1.25	n.s.

^a *: *p* < .05; **: *p* < .01; n.s.: not significant

Experiment 2: Locally Ambiguous Sentences and DP Complexity

Table 7.15. Three-way ANOVA for percentages of correct judgments for Experiment 2^a

Main Effect/ Interaction	<i>F</i> 1(39,1)	<i>p</i> of <i>F</i> 1	<i>F</i> 2(39,1)	<i>p</i> of <i>F</i> 2
Ambiguity	50.05	**	52.02	**
Structure	34.70	**	25.63	**
DP Complexity	9.18	**	7.82	**
Ambiguity × Structure	45.86	**	100.59	**
Ambiguity × DP Complexity	5.52	*	4.30	*
Structure × DP Complexity	1.97	n.s.	4.29	*
Ambiguity × Structure × DP Complexity	8.30	**	10.77	**

^a *: *p* < .05; **: *p* < .01; n.s.: not significant

Table 7.16. Three-way ANOVA for reaction times to make correct judgments for Experiment 2^a

<i>Main Effect/ Interaction</i>	<i>F1(1,19)</i>	<i>p of F1</i>	<i>F2(1,32)</i>	<i>p of F2</i>
Ambiguity	36.92	**	65.40	**
Structure	31.44	**	20.88	**
DP Complexity	7.34	*	2.52	p = .1226
Ambiguity × Structure	19.72	**	16.93	**
Ambiguity × DP Complexity	0.87	n.s.	0.63	n.s.
Structure × DP Complexity	0.01	n.s.	0.89	n.s.
Ambiguity × Structure × DP Complexity	0.14	n.s.	0.88	n.s.

^a *: p < .05; **: p < .01; n.s.: not significant

Chapter 8

CASE CHECKING AND THE HSPM II: THE ROLE OF WORKING MEMORY

1. Introduction

The experimental results of the last chapter have provided strong support for our claim that the grammar of Case is reflected in a direct and transparent way in the HSPM's Case checking routines. In particular, these results have added to the already existing body of evidence showing that structural Case and lexical Case are treated differently by the HSPM, in ways closely mirroring their status within the grammar. At the same time, these results remind us of one of the major lessons learned in psycholinguistic investigations of human sentence processing: The grammar alone is only one part—albeit an important one—within a complete theory of the HSPM.

As the preceding chapter has shown, in addition to the grammar of Case, a model of the HSPM's Case checking routines must make highly specific assumptions about the mental operations that check Case, as well as the operations that are invoked should it turn out that a sentence contains a temporary or permanent Case violation. However, even now that we have specified these operations, our model is not yet complete. As the preceding chapters have made clear, several aspects of sentence memory are crucially involved in how the HSPM checks Case. The question of how sentences are stored during on-line language comprehension is of particular relevance for the current model given that for most of the sentences discussed in this monograph, including the sentences which were experimentally investigated in the last chapter, Case checking by the HSPM is initiated on encountering the clause-final verb. This necessarily implies that the operations responsible for checking and repairing Case features must have access to representations that were built up during the

prior syntactic analysis and then held in some kind of working or short-term memory.¹

In effect, we already took sides on several controversial issues regarding parsing and memory in the preceding chapters. First of all, we assumed that the HSPM is pursuing a single syntactic structure at all points during the ongoing analysis. This assumption—which is nothing else than the hallmark of serial parsing—has come under attack from two sides. On the one side, parallel parsing models have been developed as a major theoretical alternative to serial parsing models. According to parallel models, the HSPM can pursue several structural alternatives at a time. The dispute between serial and parallel processing is therefore intimately connected to questions about working memory: Can the HSPM hold only one syntactic structure in working memory when processing a sentence, or more than one? As already said in the introduction, we will discuss the question of parallelism in detail in the next chapter.

While proponents of parallel parsing would claim that a serial parser computes too few structures, the reverse has also been claimed: That the HSPM does not even compute a single syntactic structure. Such a claim does not necessarily mean that syntactic parsing must be an unimportant or almost non-existent process (although this position can also be found). Instead, theories like those proposed in Kempson, Meyer-Viol and Gabbay (2001) or Steedman (2001) claim that the HSPM uses its knowledge of syntax in order to directly come up with a semantic representation, instead of first computing a syntactic structure which is interpreted only in a second step.

This leads directly to a more general question: What kind of representation(s) does the HSPM compute and store within working memory when processing a sentence? The model we have proposed so far has made use of several distinct memory representations: an ARGUMENT-STRUCTURE REPRESENTATION, a PHRASE-STRUCTURE REPRESENTATION, and a WORD-FORM REPRESENTATION. Based on empirical evidence from McElree and colleagues (McElree, 2000; McElree et al., 2003), the argument-structure representation was introduced in chapter 6 as an indexing device giving direct access to phrases within the phrase-structure representation. In the context of the current model, the phrase-structure representation is needed for the initial steps of the checking processes—determining whether a sentence contains a Case mismatch or not. This holds for all types of grammatical and ungrammatical sentences alike. In contrast to the phrase-structure representation, a store for word-forms—that is, a phonological representation—is implicated in our model only for violations where dative Case has to be assigned on reanalysis since—according to the

¹Within cognitive psychology, several alternative terms have been used for what is now usually called WORKING MEMORY, like PRIMARY MEMORY, SHORT-TERM STORE, or SHORT-TERM MEMORY, often with different theoretical conceptions; for a brief historical overview, cf. Logie (1996).

model—only these violations trigger the process of lexical reaccess mediated by a word's phonological form.

The purpose of this chapter is thus twofold. First, to situate our own model in the wider context of conceptions about working memory and language comprehension, and second to provide further experimental evidence for our assumptions about Case checking by the HSPM. In section 2, we will discuss the general relationship between working memory and the HSPM, and discuss the consequences that emerge for our model of Case-checking. The predictions made by our model will be put to an empirical test in two experiments that will be reported in sections 3 and 4. The conclusions of these experiments with respect to the relation between working memory and the HSPM will be discussed in section 5. Section 6 will provide a general summary of Case checking by the HSPM.

2. Working Memory and the HSPM

How many different types of memory representation does the HSPM compute? In a nutshell, our position will be that when we comprehend a sentence, representations at different levels are computed and held in working memory for at least a short period of time, and each of these representations might be accessed at some later point if necessary. According to this assumption, which we believe to share with a growing number of researchers who have looked at the relation between working memory and the HSPM (e.g., Jackendoff, 1987), the question is not so much whether a particular representation is held in working memory, but instead what use the HSPM makes of these different representations.

It is nevertheless one of the most controversial questions with regard to working memory and sentence comprehension whether a working memory representation of the phonological form of sentences plays any role for on- or off-line sentence comprehension. On the one hand, this means that we still have to show that our claim that syntactic reanalysis may involve a process of lexical reaccess which is mediated by the phonological form of a word is compatible with what is known about the retention of sentences in working memory. On the other hand, this means that our notion of lexical reaccess—if accurate—can shed new light on the relationship between working memory representations and the HSPM.

Within the broader field of cognitive psychology, the notion of a phonology based memory store plays a major part in the working memory model developed by A. Baddeley and colleagues, and the dispute about working memory and sentence comprehension has often revolved around the question whether a phonologically based memory system plays any role in processes of language comprehension in general, or syntactic parsing in particular. In this section, we will first give a short presentation of the working-memory model of A. Badde-

ley and some recent developments this model has taken, and then discuss the relationship between a phonologically based memory system and the HSPM.

2.1 The Phonological-Loop Model

One of the most influential theories of short-term memory within cognitive psychology is the working memory model originally proposed by Baddeley and Hitch (1974) and then developed by Baddeley and colleagues in numerous works (cf. Baddeley, 1986; Baddeley, 1997, for general reviews, and Gathercole and Baddeley, 1993, for work related to language processing). According to this theory, working memory (WM) consists of three major components: a CENTRAL EXECUTIVE responsible for controlling the whole system, and two subsidiary or “slave systems” for temporary storage, one specialized for verbal material (the PHONOLOGICAL LOOP) and a second one specialized for visual-spatial material (the VISUOSPATIAL SKETCHPAD).

For our purposes, only the phonological loop part of Baddeley’s WM model is of immediate concern. This part of the WM model is basically a model of serial or verbatim list recall, that is, the recall of relatively short lists of verbal items in exactly the same order in which the list items were presented (whether the phonological loop is also involved in other cognitive activities, language comprehension in particular, will be discussed below). The most common everyday example of serial list recall is the remembering of a telephone number for a short while. Performance in serial list recall is often measured in terms of MEMORY SPAN which is usually defined as the list length for which participants correctly recall 50% of the lists.

The phonological loop within the WM model of Baddeley consists of two components, a passive phonological store and an active rehearsal process. The phonological store holds material in a phonological code.² The material in the phonological store is assumed to be subject to interference and decay with time. Refreshing decaying material in the phonological store is the task of the second component of the phonological loop, the (subvocal) rehearsal process. The interplay of phonological store and subvocal rehearsal is illustrated in Figure 8.1.

Figure 8.1 also indicates how input is assumed to enter the phonological loop. Speech input is assumed to be transferred directly to the phonological store. Non-speech input, which for our purposes can be equated with written language, first has to be transformed into a phonological format by the subvocal rehearsal process before it can be submitted to the phonological store. The subvocal rehearsal process has therefore double duty: it is responsible

²There has been some discussion as to whether we are indeed dealing with a phonological loop, and not with an acoustic or phonetic loop. Since this question is immaterial for us, we will not discuss it here, and will simply follow recent work like Baddeley and Logie (1999) in assuming a phonological loop.

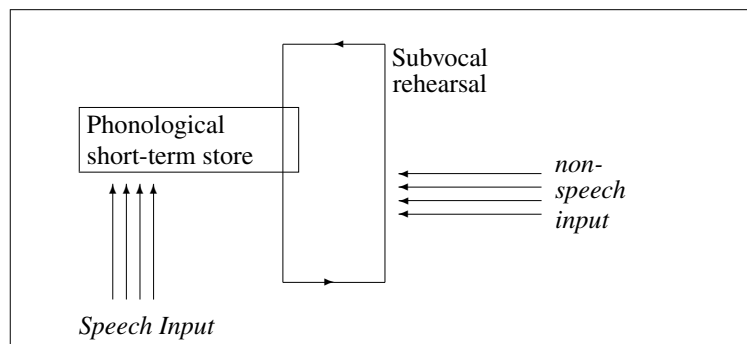


Figure 8.1. Model of the Phonological Loop (from Gathercole and Baddeley (1993))

for refreshing decaying information in the phonological store and for bringing written language into a format suitable for storage in the phonological store.

One piece of evidence showing that the short-term store underlying serial-list recall is of a phonological nature comes from effects of phonological similarity. First, when participants make errors on lists of letters, these errors typically involve similar sounding letters (cf. Conrad, 1964). For example, a *B* is more likely to be recalled as a *D* than as an *R*. A second effect produced by phonological similarity concerns memory span for phonologically similar items versus phonologically dissimilar items. In particular, verbatim recall of a list is much poorer if the list consists of items which are phonologically similar to each other (*B, C, T*, or *cat, rat, mat*) than if they are phonologically distinct (*R, W, H* or *man, egg, boat*). In contrast to phonological similarity, orthographic similarity of the items in the memory list does not seem to have a major effect on memory performance, and semantic similarity can even lead to enhanced memory performance (Wetherick, 1975). Within the phonological loop model, phonological similarity is assumed to have an effect on list recall because discriminating between traces of similar items is more difficult than discriminating between traces of dissimilar items (there are several computational models specifying the details of this process; e.g., Burgess and Hitch, 1992; Houghton et al., 1996). Memory traces are held within the phonological store of the phonological loop, and the phonological loop is therefore the locus of phonological similarity effects.

A second line of evidence in favor of the phonological loop comes from word-length effects on serial list recall. Many experiments have shown that performance in verbatim list recall is largely (although not completely) a function of the spoken length of the items to be remembered. For example, serial recall of lists of short words is superior to recall of lists of long words (e.g. *Chad, Burma, Greece, Cuba, Malta* versus *Czechoslovakia, Somaliland, Nicaragua*,

Afghanistan, Yugoslavia).³ This effect seems not to be due to syllable or segment number per se, but to the articulatory duration of words, as shown by the finding that, even when matched for number of syllables and segments, words with shorter spoken duration are better recalled than words with longer spoken duration (e.g. “short” words like *wicket, bishop* versus “long” words like *harpoon, Friday*). Word-length effects are also at play when comparing digit span for speakers of different languages. The spoken duration of digits in Welsh is greater than the spoken duration of digits in English, which mirrors the finding that digit span for Welsh is less than digit span for English, even when bilingual speakers of Welsh and English are tested (cf. Ellis and Hennelly, 1980).

How does the phonological loop model account for the word-length effect? The basic idea is that when an item (a word, a digit, or a letter) is presented, a trace representing this item is set up in the phonological store. This trace is subject to decay, and successful recall is only possible in the short time span before the trace has degraded into an unusable state. During this time span, it is also possible to refresh the trace by the process of subvocal rehearsal, thereby increasing the trace’s total lifespan. Since shorter words need less time to be rehearsed than longer words, more of the former can be rehearsed in the short time-span before the memory trace has decayed, and therefore memory-span for shorter words is greater than memory-span for longer words.

More precisely, it has been shown that memory span s (measured as items recalled) and articulation rate r (measured as items pronounced per second) stand in a linear relationship to each other. Thus, we get the equation given in (1), where t is time and c is a constant.

$$(1) \quad s = r \times t + c$$

with s = memory span
 r = rate of articulation
 t = time
 c = constant

The time t , which has been found to be approximately 1.6–2 sec under a broad range of circumstances (cf. Baddeley, 1986; Schweickert, 1993) can be taken to reflect the mean duration of memory traces within the phonological store. The constant c in (1) should be zero if memory span were the sole function of the articulatory rate of the items to be recalled. However, this constant is often found to be greater than zero, up to three items (cf. Baddeley, 1986; Hulme et al., 1991). We will come back to this finding shortly.

³All examples concerning serial-list recall are taken from Baddeley (1986).

To summarize, the phonological loop—as one of two slave systems within the overall working memory model of Baddeley—has been attributed the following major properties:

- The PHONOLOGICAL LOOP consists of two parts, a passive PHONOLOGICAL STORE and an active REHEARSAL PROCESS.
- The PHONOLOGICAL STORE contains memory traces which decay within approximately 2 seconds to an unusable state and are subject to interference by phonologically similar traces.
- The REHEARSAL PROCESS serves two functions. It can bring written material into the phonological store and it can refresh decaying memory traces within the phonological store.

2.2 Changing Conceptions of the Phonological Loop

When we introduced equation (1) which relates memory span to articulation rate, we pointed out that the intercept c has often been found to be greater than zero. This indicates that memory span is not only a function of the spoken duration of the items to be remembered, but a function of other factors as well. To a large extent, the finding of a non-zero intercept seems to be related to the growing set of results which have been obtained in comparisons of memory for words and memory for non-words. Several experiments have shown that memory span for lists made up of words is greater than memory span for lists of non-words, even if words and non-words are equated for their spoken duration (cf. Hulme et al., 1991). This finding, which has become known as the LEXICALITY EFFECT, has been one of several factors leading to a rethinking of the place of the phonological loop within a larger model of cognitive architecture.

This rethinking has resulted in the reversal of the direction in which information is assumed to flow through the system (cf. Martin, 1993; Logie, 1996, among others). Information flow is no longer believed to be from the phonological loop to the language comprehension system, but the other way around. That is, the phonological loop is the store for the results of language comprehension processes, not its starting point. This idea is succinctly captured in the following citation from Martin (1993):

“Such an approach to verbal short-term memory that emphasizes the recruitment of language modules suggests that the initial question that was posed about the role of short-term memory in language processing should be reversed. Instead of asking what short-term memory has to do with language processing, we should ask what language processing has to do with short-term memory. That is, rather than seeing short-term memory as a separate system that is drawn upon in language processing, verbal short-term memory should be seen as deriving from the procedures and retentive capacities of language processing modules.” (Martin, 1993: 182)

2.3 Sentence Parsing and the Phonological Loop

What role does a phonologically based memory representation—the phonological loop in the sense discussed above—play in the syntactic processes that are the task of the HSPM? This question must be asked separately with regard to first-pass and second-pass parsing.

Regarding the involvement of the phonological loop in first-pass parsing, a certain consensus has been reached that it does not play any role during the initial syntactic analysis of a sentence. There are basically two reasons for this conclusion. The first reason derives from the now well-established incremental nature of syntactic processing (cf. Engle and Conway, 1998). If each word is integrated as soon as it is encountered into the ongoing syntactic structure, then there is simply no need for the parsing routines to refer back to material stored in the phonological loop. That is, incremental processing obliterates any buffering of words in a phonological format for subsequent syntactic analysis (as has been proposed by, e.g., Clark and Clark, 1977).

A second reason for the claim that the phonological loop is irrelevant for purposes of first-pass parsing comes from findings on brain-damaged patients with severely reduced phonological loop capacity. If the phonological loop were to play an essential role in processes of first-pass parsing, then one would expect that reduced loop capacity due to brain damage will lead to severe language comprehension problems. This, however, has not been found: Several patients have been reported with normal syntactic comprehension capabilities despite reduced phonological store (for an overview, cf. Martin, 1993).

In contrast to the agreement that has been reached concerning phonological-loop involvement in first-pass parsing, opinions differ when it comes to second-pass parsing. Several researchers have proposed that the phonological loop may play some role for what have been called “back-up processes”, processes which come into play if for one reason or the other, the usually effortless flow of comprehension is disrupted. However, there is also some neuropsychological evidence showing that garden-path recovery must be possible without the help of the phonological loop (cf. Martin, 1990). Overall, we do not think that there is already enough evidence for allowing any strong conclusions concerning the role of the phonological loop in processes of second-pass parsing.

Before leaving the topic of the phonological loop’s role for sentence comprehension, we have to make an important qualification with regard to phonological loop involvement in first- and second-pass parsing. In our discussion above, we considered the role of the phonological loop only in terms of a possible buffer for processes of either first- and second-pass parsing. However, besides serving as a buffer, the phonological loop might also have other functions during language comprehension. In particular, it has been proposed that during normal, silent reading, prosodic aspects of the implicit phonological structure that normally accompanies reading (cf. the discussion in section 2.2 of the preceding

chapter) can influence the operations of the HSPM (cf. Bader, 1998; Fodor, 1998; Fodor, 2002; Slowiaczek and Clifton, 1980). This is certainly a function of the phonological loop which we do not want to exclude.

2.4 Summary: Verbal Working Memory and the HSPM

We started our discussion of the relationship between working memory and sentence comprehension with the question as to what types of memory are involved in language comprehension in general, and syntactic parsing in particular. So far, we have considered this question only with regard to the phonological loop, under the assumption that one of the memory types retained during the ongoing syntactic analysis is a memory for the syntactic structure constructed so far.

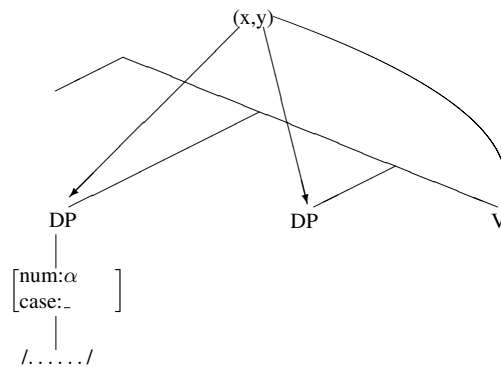
Is this latter memory a unitary one, or do we have to distinguish also between different types of syntactic memory? Investigations of this question have started only recently (cf. McElree, 2000; Frazier, 1999), but they already indicate that syntactic memory is not a unitary phenomenon. Actually, we have already embedded this assumption into our model by postulating a skeletal argument-structure representation as implementing the kind of content-addressable memory proposed by McElree (2000).

Which picture of the relationship between working memory and parsing emerges from the preceding discussion? Abstracting away from possible forms of semantic representations, there are at least four different aspects of a sentence that have to be kept in working memory:

- the argument structure
- the phrase-structure representation (the CPPM)
- the syntactic properties of the different lexical items dominated by the CPPM
- the phonological form of the lexical items

In diagrammatic form, these four aspects are shown in (2).

(2) Representation of a sentence in working memory



On encountering the clause final verb, Case checking will thus proceed as follows. First, the HSPM will use the argument structure associated with the verb to get access to the phrase-marker in order to check for Case features. This step is necessary for all argumental phrases, and for all Cases. If no violation is detected, this is also the only step necessary for the checking of Case. If, however, a Case mismatch is detected, depending on the particular type of violation it might be necessary to retrieve additional information from sentence memory. For violations in which a structural Case has to be assigned to a phrase that has originally been parsed as a KP, in fact, no additional information has to be retrieved. If the HSPM hits on such a violation, it can straightforwardly reject the sentence as ungrammatical. If, on the other hand, dative Case has to be assigned to a phrase that was initially entered into the CPPM as bearing structural Case, it will be necessary to access the phonological form of a lexical item in order to start the process of lexical reaccess. The purpose of lexical reaccess will be to determine whether the lexical items making up the offending DP are capable of licensing dative Case. If lexical reaccess delivers a positive result (as, for example, in the case of proper names), the HSPM will proceed with reanalysis. If lexical reaccess delivers a negative result, in contrast, the sentence will be rejected as ungrammatical.

What predictions follow from the account of Case checking and working memory that we have developed above? The clearest prediction is that we should find substantial length effects when dative Case has to be assigned on reanalysis but not when dative Case has to be withdrawn. We will specify the details of this prediction in the next section in which the first of two experiments will be presented that were designed to test our assumptions concerning working memory and the HSPM.

3. Experiment 1: Ungrammatical Sentences and Length

The preceding chapter has shown that the processing of ungrammatical passive sentences is susceptible to manipulations of the lexical make-up of the first DP, that is, the DP for which we have hypothesized that lexical reaccess will occur. Corresponding ungrammatical active sentences, in contrast, were immune to these manipulations. In the current experiment, the crucial first DP will be held constant across conditions, but the distance between the initial DP and the clause final verb will be varied. Given our model of Case checking by the HSPM, this manipulation should have a strong effect on ungrammatical passive sentences but no or at best a minor effect on ungrammatical active sentences.

To derive this prediction, let us first consider how the length manipulation applies to ungrammatical passive sentences. Relevant examples are provided in (3). These sentences are ungrammatical because *die Mutter* is incompatible with the dative Case required by *schicken*.

- (3) a. *Ich glaube, daß die Mutter ein Buch geschickt wurde.
 I think that the mother a book sent was
 b. *Ich glaube, daß die Mutter **letzte Woche schon wieder** ein Buch
 I think that the mother last week yet again a book
 geschickt wurde.
 sent was

How might the increased distance between the offending DP and the clause final verb affect ungrammaticality detection for these sentences? If successful lexical reaccess of a word *w* is mediated by the phonological form of *w*, we get the prediction that more errors should be made with increasing distance between *w* and the clause-final verb. This prediction derives from the following considerations:

- Word *w*—including its phonological form—has to be held in working memory until the clause final verb is encountered.
- Traces in working memory decay over time (cf. Baddeley and Logie, 1999, and references cited there).
- Increasing the distance between *w* and the clause final verb increases the time for trace decay.
- The more the trace of the phonological form of *w* has decayed, the more likely it is that lexical reaccess goes astray; in particular, the more likely it is that a form like *die* or *meine* (that is, forms that aren't compatible with dative Case) will be confused with the forms *der* or *meiner*, respectively (the forms which are compatible with dative Case).

In summary, we predict that ungrammatical passive sentences should be more error-prone when the distance between *w* and the clause final verb is long than when it is short.

In addition to ungrammatical passive sentences, Experiment 1 will include corresponding ungrammatical active sentences in both a long and a short version. These sentences, which are shown in (4), are ungrammatical because *der Mutter* is incompatible with the nominative Case required by the finite verb *hat*.

- (4) a. *Ich glaube, daß der Mutter ein Buch geschickt hat.
 I think that the mother a book sent has
 b. *Ich glaube, daß der Mutter **letzte Woche schon wieder** ein Buch
 I think that the mother last week yet again a book
 geschickt hat.
 sent has

In contrast to what is predicted for ungrammatical passive sentences, ungrammatical active sentences should not show an effect of length, or a very small one at most (reflecting general effects of sentence length). The reason for this is that for an ungrammatical active sentence, it is only necessary to retrieve phrase-structural information from the CPPM—namely the information that the first DP is embedded in a KP, that is, that it is a dative-marked argument. Under our assumption that the HSPM has direct access to the argumental phrases within the CPPM—via the argument-indexing function of the argument structure—retrieving a KP from the CPPM should be basically unaffected by intervening material (cf. the discussion of the experiments by McElree, 2000, and McElree et al., 2003). Length should therefore not affect accuracy of rejecting an ungrammatical active sentence.

3.1 Method

Participants and Procedure. 40 students of the University of Jena participated in this experiment which used our standard speeded grammaticality judgments method.

Materials. 40 sentences were constructed for Experiment 1. As in the first two experiments of the preceding chapter, each sentence appeared in eight versions according to the three factors STATUS (grammatical vs. ungrammatical), STRUCTURE (active vs. passive), and LENGTH (short vs. long). An experimental sentence with all of its eight versions is shown in Table 8.1.

As before, sentences were made up of a main clause followed by an embedded clause, and the experimental manipulations were confined to the embedded clauses. In the short condition, the embedded clause contained two adjacent DPs immediately followed by the verbal complex. In the long condition, additional material was inserted after the first DP. Most of this additional material

Table 8.1. A complete stimulus set for Experiment 1. Note: All clauses in this table were introduced by the main clause *Peter hat mir berichtet* ('Peter told me')

Grammatical	
Active	
Short	daß die Managerin das Haus verkauft hat. that the executive the house sold has '... that the executive sold the house.'
Long	daß die Managerin nach zähen Verhandlungen that the executive after long negotiations nun endlich das alte Haus verkauft hat. now finally the old house sold has '... that the executive now finally sold the old house after long negotiations.'
Passive	
Short	daß der Managerin das Haus verkauft wurde. that the executive the house sold was '... that the house was sold to the executive.'
Long	daß der Managerin nach zähen Verhandlungen that the executive after long negotiations nun endlich das alte Haus verkauft wurde. now finally the old house sold was '... that the old house was now finally sold to the executive after long negotiations'
Ungrammatical	
Active	
Short	daß der Managerin das Haus verkauft hat. that the executive the house sold has
Long	daß der Managerin nach zähen Verhandlungen that the executive after long negotiations nun endlich das alte Haus verkauft hat. now finally the old house sold has
Passive	
Short	daß die Managerin das Haus verkauft wurde. that the executive the house sold was
Long	daß die Managerin nach zähen Verhandlungen that the executive after long negotiations nun endlich das alte Haus verkauft wurde. now finally the old house sold was

consisted of different types of adverbials, but sometimes the second DP was also lengthened, for example by inserting an adjective. All long sentences contained exactly six additional words between the first and the second DP.

The first DP in the embedded clause was always a feminine DP. In half of the sentences, the first DP started with the definite determiner *die*; in the other half of the sentences, this DP started with one of the possessive pronouns already used in Experiment 1 of the preceding chapter (cf. Table 7.2 on page 217). Besides testing for length effects as such, Experiment 1 will therefore also allow for a test of possible interactions between length and phonological similarity between correct and incorrect form of the determiner.

3.2 Results

Table 8.2. Percentage of Correct Judgments for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Grammatical</i>		<i>Ungrammatical</i>	
	<i>Active</i>	<i>Passive</i>	<i>Active</i>	<i>Passive</i>
<i>Short</i>	85 (2.6)	95 (1.6)	84 (3.4)	73 (4.6)
<i>Long</i>	84 (2.4)	92 (2.4)	82 (3.2)	53 (5.1)

Judgments. Table 8.2 shows the percentages of correct results for Experiment 1. As with the first two experiments of the preceding chapter, we first conducted three-way ANOVAS which are reported in an Appendix to this chapter. Based on a significant three-way interaction, separate two-way ANOVAs (2 structure \times 2 length) were then run for the grammatical and ungrammatical sentences. For grammatical sentences, the main effect of structure was significant ($F(1,39) = 14.70, p < .001$; $F(1,39) = 6.74, p < .05$) whereas the main effect of length as well as the interaction between length and structure were not (all p 's $> .1$).

For ungrammatical sentences, both main factors and the interaction between them were significant (Factor Length: $F(1,39) = 21.37, p < .001$; $F(1,39) = 15.14, p < .001$. Factor Structure: $F(1,39) = 20.05, p < .001$; $F(1,39) = 31.21, p < .001$. Interaction between Length and Structure: $F(1,39) = 9.02, p < .01$; $F(1,39) = 15.24, p < .001$). Subsequent planned comparisons showed that length had no effect on ungrammatical active sentence (84% vs. 82%: both t -values < 1) whereas ungrammatical passive sentences showed a significant effect of length (73% vs. 53%: $t_1 = 4.85, p < .001$; $t_2 = 6.31, p < .001$).

Judgment times. Table 8.3 shows the response times for correct answers for Experiment 1. Separate two-way ANOVAS revealed no significant effects for grammatical sentences (all p 's $> .25$). For ungrammatical sentences, the factor Structure had a significant effect ($F(1,34) = 18.88, p < .001$; $F(1,38) = 19.26, p < .001$), whereas the factor Length had only a somewhat marginal

Table 8.3. Mean Reaction Times (ms) to Make Correct Judgments for Experiment 1 (Standard Errors by Subjects in Parentheses)

	<i>Grammatical</i>		<i>Ungrammatical</i>	
	<i>Active</i>	<i>Passive</i>	<i>Active</i>	<i>Passive</i>
<i>Short</i>	519 (38.7)	515 (35.0)	668 (40.6)	766 (41.4)
<i>Long</i>	574 (46.0)	503 (37.3)	679 (42.2)	867 (59.7)

effect ($F(1,34) = 3.85$, $p = .06$; $F(1,38) = 2.67$, $p = .11$) and the interaction of Structure \times Length did not reach significance ($F(1,34) = 2.52$, $p = .12$; $F(1,38) = .86$, $p = .36$).

Further results. As in Experiment 3 of the preceding chapter, in half of the sentences the first DP contained a form of the definite article whereas the other half contained a possessive pronoun. This variation goes back to the finding of the preceding chapter that for ungrammatical passive sentences, similarity between the correct and the incorrect form of the determiner modulates performance, with definite determiners exhibiting low and possessive pronouns high similarity (cf. Experiment 1 of the preceding chapter). In the context of the present experiment this variation is of particular interest given the assumption that the impact of the length factor on ungrammatical passive sentences results from decaying phonological representations.

The effect of phonological similarity on ungrammatical passive sentences is shown in Table 8.4 (as in preceding experiments with this factor, similarity had no effect on any of the other conditions which are accordingly not shown). As one can see in Table 8.4, similarity had again the expected effect—for both short and long sentences—in that sentences in the condition low similarity (= *die* in Table 8.4) were judged much more reliably than sentences in the condition high similarity (= *meine* in Table 8.4).

3.3 Discussion

Experiment 1 has a clear-cut outcome. First, it replicates the earlier finding that passive sentences are rejected less reliably than active sentences. Second, it shows that length has a substantial effect on ungrammatical passive sentences, whereas all other sentence types (both active and passive grammatical sentences, as well as ungrammatical active sentences) were unaffected by manipulating length. Third, it replicates the finding from the preceding chapter

Table 8.4. The effect of high versus low phonological similarity (definite article versus possessive pronoun) on ungrammatical passive sentences.

	<i>Short</i>		<i>Long</i>	
	<i>“die”</i>	<i>“meine”</i>	<i>“die”</i>	<i>“meine”</i>
Percentage correct	83 (4.4)	60 (5.9)	62 (5.9)	45 (5.6)
Judgment time	716 (46.3)	868 (55.0)	811 (67.0)	951 (69.9)

that phonological similarity between correct and incorrect form affects error rates for ungrammatical passive sentences.

In summary, Experiment 1 adds to the already existing evidence that ungrammatical sentences containing a nominative DP instead of a dative KP (passive sentences in our experiments) are processed in a different way than sentences containing the reverse type of violation (active sentences in our experiments). In particular, by finding a length effect for ungrammatical passive sentences but not for ungrammatical active sentences, Experiment 1 supports our hypothesis that the main difference between the two types of violations is whether they trigger the process of lexical reaccess or not. Lexical reaccess is invoked when the HSPM has to assign dative Case on reanalysis, but not when a phrase already marked for dative Case has to be assigned one of the two structural Cases. We now turn to locally ambiguous sentences in order to test whether evidence for lexical reaccess can also be found there.

4. Experiment 2: Locally Ambiguous Sentences and Length

Experiment 1 has shown that the accuracy with which ungrammatical passive sentences are judged as ungrammatical depends on the distance between the offending first DP and the clause final verb. The current experiment will apply the same kind of length manipulation to locally ambiguous sentences and compare short ambiguous sentences (cf. (5-a)) to long ambiguous sentences (cf. (5-b)).

- (5) a. Keiner wußte, daß Maria die Zeitung gebracht
 nobody knew that Maria-DAT the newspaper-NOM brought
 wurde.
 was
 ‘Nobody knew that the newspaper was brought to Maria.’

- b. Keiner wußte, daß Maria **erst ziemlich spät am Nachmittag**
 nobody knew that Maria-DAT only rather late at afternoon
 die Zeitung gebracht wurde.
 the newspaper-NOM brought was
 ‘Nobody knew that the newspaper was brought to Maria rather late in
 the afternoon.’

What effect might this kind of length manipulation have on locally ambiguous sentences? On the basis of intuitive data, Bader et al. (1996) proposed that increasing the distance between point of ambiguity and point of disambiguation increases the strength of the garden-path effect that occurs when dative Case has to be assigned on second-pass parsing. As our discussion of object-object ambiguities in chapter 4 has shown, this proposal could be experimentally corroborated for the situation where dative Case had to be assigned to a DP which was analyzed as an accusative object on the first pass (cf. example (36b) of chapter 4).

Given that in our model of Case checking the assignment of dative Case on second-pass parsing does in no way depend on whether accusative or nominative Case has to be replaced by dative Case (that is, whether we are dealing with an object-object or a subject-object ambiguity), the natural expectation is that a long ambiguous passive sentence as in (5-b) should cause a stronger garden-path effect than a short ambiguous passive sentence as in (5-a).

How does this expectation relate to the notion of lexical reaccess that we have claimed to be triggered by a temporary or permanent violation in which dative Case must be assigned to a DP initially specified for nominative Case in order to get rid of the violation? In Bader et al. (1996), we proposed the following reason for why the difficulty of garden-path recovery should increase with increasing distance between an ambiguous proper name and the disambiguating verb: When a word is encountered on first-pass parsing, its lexical entry will become activated. This activation will decay over time. If lexical reaccess occurs with only a short delay, it will still profit from the initial activation. Reaccess after a long delay, in contrast, will no longer profit because the initial activation has decayed. Experiment 2 was run in order to see whether the prediction of increasing garden-path strength with increasing length is borne out in the kind of sentences investigated in this and the preceding chapter.

4.1 Method

Participants and Procedure. 42 students of the University of Jena participated in this experiment which used our standard speeded grammaticality judgments method.

Materials. For reasons of comparison with Experiment 1 (length effects in ungrammatical sentences), Experiment 2 did not only include ambiguous sen-

tences and their unambiguous grammatical counterparts, but also corresponding ungrammatical sentences. When crossed with the factor length (short vs. long), this already resulted in six different versions of each sentence. It was thus not manageable to also include the factor structure (active vs. passive), as in the preceding experiment. Therefore, Experiment 2 tested only passive sentences.

36 sentences were constructed, with each sentence appearing in six versions according to the factors STATUS (unambiguous vs. ambiguous vs. ungrammatical) and LENGTH (short vs. long). A complete sentence set is shown in Table 8.5.

Table 8.5. A complete stimulus set for Experiment 2. Note: All clauses shown in this table were introduced by the main clause *Mir ist erzählt worden* ('I was told')

Grammatical	
Short	daß der Dozentin eine Ballade vorgelesen wurde. that the lecturer a ballad read was '... that a ballad was read to the lecturer.'
Long	daß der Dozentin letzte Woche während des Seminars that the lecturer last week during the seminar eine Ballade vorgelesen wurde. a ballad read was '... that a ballad was read to the lecturer last week during the seminar.'
Ambiguous	
Short	daß Maria eine Ballade vorgelesen wurde. that M. a ballad read was '... that a ballad was read to Maria.'
Long	daß Maria letzte Woche während des Seminars that M. last week during the seminar eine Ballade vorgelesen wurde. a ballad read was '... that a ballad was read to Maria last week during the seminar.'
Ungrammatical	
Short	daß die Dozentin eine Ballade vorgelesen wurde. that the lecturer a ballad read was
Long	daß die Dozentin letzte Woche während des Seminars that the lecturer last week during the seminar eine Ballade vorgelesen wurde. a ballad read was

4.2 Results

Judgments. The percentages of correct judgments for Experiment 2 are shown in Table 8.6. Two-way ANOVAs (3 status \times 2 lengths) revealed a significant main effect of status ($F(2,82) = 18.72, p < .01$; $F(2,70) = 16.72, p < .01$), a

Table 8.6. Percentages of Correct Judgments and Judgment Times for Correct Judgments (ms) for Experiment 2 (Standard Errors by Subjects in Parentheses)

	<i>Grammatical</i>		<i>Ambiguous</i>		<i>Ungrammatical</i>	
	<i>Short</i>	<i>Long</i>	<i>Short</i>	<i>Long</i>	<i>Short</i>	<i>Long</i>
Percentage correct	91 (2.2)	92 (1.7)	83 (2.7)	73 (4.3)	78 (3.4)	58 (3.9)
judgment time	506 (34.7)	508 (29.9)	731 (42.8)	756 (46.3)	778 (42.3)	818 (39.6)

significant main effect of length ($F(1,41) = 20.94, p < .01$; $F(1,35) = 20.78, p < .01$), as well as a significant interaction between status and length ($F(1,2,82) = 11.57, p < .01$; $F(2,70) = 7.96, p < .01$).

Subsequent planned comparisons revealed first that in both the short and the long condition, ambiguous sentences were judged worse than grammatical (i.e., unambiguous) sentences (Short: 91% vs. 83%: $t_1 = 2.93, p < .01$; $t_2 = 2.42, p < .05$; Long: 92% vs. 73%: $t_1 = 6.40, p < .001$; $t_2 = 5.35, p < .001$). A second set of comparisons showed that length had no effect on grammatical sentences (91% vs. 92%: both t -values < 1) whereas it affected both ambiguous sentences (83% vs. 73%: $t_1 = 3.20, p < .01$; $t_2 = 2.57, p < .05$) and ungrammatical sentences (78% vs. 58%: $t_1 = 6.54, p < .001$; $t_2 = 5.28, p < .001$).

Judgment times. Table 8.6 also shows the mean reaction times for correct responses in Experiment 2. Two-way ANOVAs (3 status \times 2 lengths) revealed a significant main effect of status ($F(1,2,76) = 53.62, p < .01$; $F(2,66) = 42.79, p < .01$) but neither a significant main effect of length ($F(1,38) = 3.27, p = .078$; $F(2,33) = .77, n.s.$) nor a significant interaction between length and status ($F(1,2,76) = .89, n.s.$; $F(2,66) = 1.06, n.s.$). Planned comparisons showed that ambiguous sentences received significantly longer reaction times than grammatical sentences (743ms vs. 507ms: $t_1 = 8.20, p < .001$; $t_2 = 6.4, p < .001$) whereas the further difference between ungrammatical and ambiguous sentences did not reach significance (798ms vs. 743ms: $t_1 = 1.38, p = .17$; $t_2 = 1.83, p = .07$).

Further results. As Table 8.7 shows, varying the determiner of the first DP (definite article vs. possessive pronoun) closely replicates the results of the preceding experiment for ungrammatical passive clauses, confirming the robustness of this effect.

Table 8.7. The effect of high versus low phonological similarity (definite article versus possessive pronoun) on ungrammatical passive sentences.

	<i>Noun</i>		<i>Det+Noun</i>	
	<i>“die”</i>	<i>“meine”</i>	<i>“die”</i>	<i>“meine”</i>
Percentage correct	88 (3.2)	68 (5.0)	68 (4.5)	49 (5.0)
Judgment time	693 (48.9)	903 (47.2)	779 (45.0)	885 (58.8)

4.3 Discussion

For unambiguous grammatical and ungrammatical passive sentences, Experiment 2 has replicated what had already been found in Experiment 1, namely no effect of length on unambiguous passive sentences and more false acceptances for long ungrammatical passive sentences in comparison with short ones. For ambiguous passive sentences, Experiment 1 has shown that garden-path recovery becomes more difficult with increasing length. This is a new finding regarding the processing of ambiguous passive sentences, or subject-object ambiguities in general, but it is in line with the results of earlier experiments in which dative Case had to be assigned during reanalysis in sentences containing an object-object ambiguity. Experiment 2 thus supports our assumption that assigning dative Case during reanalysis to a DP that was originally marked for nominative Case does not differ from assigning dative Case on reanalysis to a DP originally marked for accusative Case.

In summary, the results of Experiment 2 together with other findings on length effects give the following picture: For sentences that involve either a temporary or a permanent violation in which dative Case has to be assigned during reanalysis, increasing the length between the offending DP and the clause final verb leads to increased error rates: Ungrammatical sentences—sentences with a permanent violation—are more often judged as grammatical, and ambiguous sentences—sentences with a temporary violation—are more often judged as ungrammatical.

Note that this straightforward picture looks somewhat different when we make the effect of length contingent on the type of response given instead of the type of sentence. Considered from that perspective, length has opposite effects on ungrammatical and ambiguous sentences: Ungrammatical sentences are more often accepted as grammatical with increasing length, whereas ambiguous sentences are more often rejected with increasing length. Why this should be so will be considered in the next section.

5. General Discussion

The experiments reported in this chapter allow several conclusions concerning the relationship between the HSPM's Case-checking routines and the representation of a sentence in working memory. Considering first processes of first-pass parsing, the two experiments reported in this chapter did not reveal any effect of length on judging unambiguous grammatical sentences as grammatical. This is what was expected given our assumption that the argument-indexing function of the argument structure gives the HSPM direct access to each phrase within the CPPM. This finding also provides further evidence for the assumption that the phonological store (or the phonological loop more generally) is not involved in processes of first-pass parsing.

Turning to ambiguous and ungrammatical sentences, we found no length effect for ungrammatical active sentences, that is, sentences which are ungrammatical because they contain a KP in place of a nominative DP. This was also expected under our theory of the HSPM's Case-checking operations in conjunction with our assumptions about sentence memory. As for unambiguous grammatical sentences, the HSPM has direct access to the offending KP, and finding a KP in place of a DP is reason enough for the HSPM to judge the sentence as ungrammatical.

Ambiguous and ungrammatical passive sentences, in contrast, showed a significant effect of length. This follows if such sentences require an additional step of lexical reaccess which is not necessary in ungrammatical active sentences. Lexical reaccess must rely on the phonological form of the words which have to be reaccessed. Since the phonological form is subject to decay and interference, length affects the accuracy of lexical reaccess, and therefore the accuracy with which unambiguous and ungrammatical passive sentences are judged as grammatical or ungrammatical.

This leaves us with the question pointed out above as to why an increase in length results in more judgments "grammatical" for ungrammatical passive sentences but to less judgments "grammatical" for locally ambiguous passive sentences. To answer this question, let us sketch in more detail how the process of lexical reaccess might work. We first have to specify how the lexicon is queried in order to determine whether it is licit to assign dative Case to the word(s) that were assigned nominative Case on first-pass parsing. For ungrammatical sentences, this means in particular that it has to be determined whether the form of the determiner encountered on first-pass parsing is compatible with dative Case.

Here is one way how lexical reaccess for a word *w* might work. Based on the set of lexical properties of *w*—including the phonological form of *w* as retrieved from the phonological store of working memory—the lexicon is queried in order to determine whether *w* is a dative-licensing item. For the definite determiner, this would amount to the query whether *die* (held in the phonological store)

is the dative form of the definite determiner. For the possessive pronoun, the query would be whether e.g. *unsere* is the dative form of the first person plural possessive pronoun.

The correct outcome of this query should, of course, be “no, w cannot license dative Case” because *die* does not match *der*, the correct dative form, and *unsere* does not match *unserer*. However, given that a quick reaction is required, and that the form within the phonological store will already be degraded to a certain extent, the lexical retrieval process might sometimes go astray. In particular, *die* might erroneously be matched to *der*, or *unsere* to *unserer*, leading to the false conclusion that the word form encountered on first-pass parsing is the one licensing the assignment of dative Case. The probability of such a match should naturally increase with increasing phonological similarity, which explains the repeated finding that participants make more errors in sentences with possessive pronouns than in sentences with the definite determiner. Furthermore, length will have an additional effect because the more the phonological form of w is degraded, the less constraints on the matching process it will provide.

For ambiguous sentences, lexical reaccess will involve the same operations, but there is a crucial difference in the underlying lexical representation. For a proper name like *Maria*, for example, the word form found on first-pass parsing is also the word form compatible with dative Case. Thus, querying the lexicon whether *Maria* licenses dative Case or not cannot lead to the same kind of mismatch that is possible for ungrammatical sentences (that is, erroneously matching *die* to *der* or *unsere* to *unserer*). However, there is another kind of error that might occur during lexical reaccess: The lexical query might not find any matching lexical entry, which would signal that the word has no dative form at all. When this erroneously happens with a proper name, reanalysis will fail, and the sentence will be falsely rejected as ungrammatical. The probability of not finding the relevant information in the lexicon should increase with increasing length. First, the lexical entry of the word was activated during first-pass parsing, but this activation will decay over time. Second, the phonological form of the word is itself an important retrieval cue. Due to degrading of the phonological form with intervening material, this retrieval cue will become less effective with increasing length.

An additional reason for rejecting ambiguous sentences with proper names as ungrammatical derives from the syntax of Case as discussed in chapter 3. As we have pointed out in section 4.2.2 of this chapter, proper names associate with determiners, and determiners provide the Case distinctions which are required by the KP-hypothesis (cf. (55) on page 79). Assume that lexical reaccess is able to invoke the D-paradigm, and the proper name can be raised to D as suggested in chapter 3. Second-pass parsing will in this case determine a structure which is consistent with the KP-hypothesis, but which, of course, involves a number of steps which increase processing load. Given time pressure, the necessary

operations might not be executed completely, resulting in a rejection of the sentence as ungrammatical.

To summarize, the model of the HSPM's Case checking routines leads to a coherent explanation of several striking differences between different types of temporary and permanent case violations when coupled with certain plausible assumptions about the retention of sentences in working memory and the processes that access information from working memory and from the lexicon in case lexical reaccess is called for. A major task would be to transform the informal model that was outlined in this book into a formal, computational model. This is true in particular for the processes subserving lexical reaccess that were outlined above. We must leave this task for future work.

6. Summary: Case Checking and the HSPM

The five experiments that we presented in this and the preceding chapter show that ungrammatical sentences in which a DP bears nominative instead of dative Case and ungrammatical sentences containing a dative KP instead of a nominative DP are handled quite differently by the HSPM. Whether the same is true for locally ambiguous sentences cannot be determined from the experiments presented here because only ambiguous sentences containing a nominative DP instead of a dative KP were investigated. However, recall from the discussion of Case attraction in chapter 5 that a temporary violation of the reverse kind results if the dative feature of a relative pronoun is erroneously attracted by the head noun. An example illustrating the attraction of dative Case is repeated in (6-a), together with a control sentence in (6-b), an ambiguous passive clause of the sort investigated in this chapter, matched in length and syntactic complexity to the sentence in (6-a).

- (6) a. #Ich weiß, daß Maria, **der** ich gerade begegnet bin, ein Päckchen
 I know that M. who I just met am a parcel
 geschickt hat.
 sent has
 'I know that Maria, who I just met, has sent a parcel.'
- b. #Ich weiß, daß Maria, **die** mich gerade besucht hat, ein Päckchen
 I know that M. who me just visited has a parcel
 geschickt wurde.
 sent was.
 'I know that a parcel was sent to Maria, who just visited me.'

In accordance with intuitions, Experiment 1 of chapter 5 has shown that sentences like (6-a) cause much stronger garden-path effects than sentences like (6-b) (cf. Meng and Bader, 2000b, for additional experimental evidence).

The overall relationship between garden-path strength, accuracy of ungrammaticality detection, and type of (temporary or permanent) syntactic violation can thus be summarized as in Table 8.8. The picture that has emerged with respect to factors affecting lexical reaccess is summarized in Table 8.9.

Table 8.8. The Effect of Type of Case Violation on Garden-Path Strength and Accuracy of Ungrammaticality Detection

	NOM/ACC to KP[DAT] during reanalysis	DAT to DP[NOM/ACC] during reanalysis
Garden-path strength	strong	weak
Accuracy of ungrammaticality detection	high	low

Table 8.9. Effects of Lexical Manipulations in Dependency of Type of Case Violation

	Withdrawal of KP[DAT] during reanalysis	Insertion of KP[DAT] during reanalysis
Garden-path strength	(not yet tested)	effects found
Accuracy of ungrammaticality detection	no effects found	effects found

The pattern of results summarized in Table 8.8 and Table 8.9 provides strong evidence for one of the major themes underlying this book: The peculiar role of dative Case as reflected in both grammar and parsing. When combining the findings displayed in Table 8.8 with the HSPM's dispreference for postulating a KP in situations of local syntactic ambiguity (as witnessed by the accusative preference in object-object ambiguities), the generalization in (7) results.

(7) *Dative Case and the HSPM*

Introducing a dative-marked phrase (a KP) into the CPPM is an easy task although the HSPM will not do so unless forced by the input. However, once the HSPM has introduced a KP, it is reluctant to undo it.

One part of this generalization—according to which the HSPM will not introduce a KP unless forced to do so by the input—is a direct consequence of parsing principles according to which the human parser strives for the simplest or most economical structures (cf. Frazier, 1979; Gorrell, 1995; Inoue and

Fodor, 1995). Parsing principles of this kind seem to cover the processing of Case very naturally.

The second part of the generalization in (7)—according to which the HSPM is reluctant to withdraw a formerly introduced KP—has an obvious “monotonicity flavor”. Recall from chapter 2 that according to the MONOTONICITY HYPOTHESIS (cf. Sturt and Crocker, 1998, for a review), monotonically adding information to the CPPM is an easy task for the HSPM—in effect, this is what the HSPM is doing all the time—but as soon as some piece of information has been added, the HSPM cannot remove this information without substantial difficulties. While we are quite sympathetic to this idea, it is clear that reference to the notion of monotonicity is by no way sufficient to account for the whole range of findings reported above. In particular, as shown by Experiment 2, the garden-path strength caused by sentences in which a KP-shell has to be inserted on second-pass parsing varies heavily depending on the lexical material above which the KP-shell has to be erected. In order to make the monotonicity hypothesis work for such sentences, one would have to supplement it with a theory of lexical reaccess of the sort developed in this chapter.

However, this addition would not be the last one. For example, reanalysis of base-generated OS-sentences does not only depend on the lexical material above which a KP has to be erected, but also on semantic constraints imposed by the verb on its arguments, as has been shown in chapter 6. Two relevant examples are repeated in (8).

- (8) a. daß Max das Gedicht gefallen hat.
 that Max-DAT the poem-NOM pleased has
 ‘that a poem pleased to Max.’
 b. daß Max die Lehrerin gefallen hat.
 that Max-DAT the teacher-NOM pleased has
 ‘that the teacher pleased Max.’

In terms of the repair operations necessary to transform the initial SO-structure into the required OS-structure, (8-a) and (8-b) do not differ from each other, and they also do not differ from the locally ambiguous passive clauses investigated in this chapter. For all of them, the first DP has to be embedded in a KP-shell, and the second DP has to be assigned nominative instead of accusative Case. Nevertheless, sentences like (8-b) cause a much stronger garden-path effect than sentences like (8-a). Monotonicity would predict for both sentences that reanalysis should be equally easy because both involve the insertion of additional structure into the CPPM. Again, to make monotonicity work, one would have to supplement it with a theory of linking along the lines proposed in the last chapter.

In summary, the generalization about dative Case and the HSPM in (7) has a clear monotonicity flavor, but the monotonicity hypothesis alone is not suf-

ficient. Neither the linking-based diagnosis theory developed in the preceding chapter nor the theory of lexical reaccess developed in this chapter would become superfluous by adopting the monotonicity hypothesis.

7. Appendix: Summary of Statistical Results

This appendix summarizes the results of the three-way ANOVAS for Experiment 1.

Table 8.10. Three-way ANOVA for percentages of correct judgments for Experiment 1^a

Main Effect/ Interaction	<i>F</i> 1(39,1)	<i>p</i> of <i>F</i> 1	<i>F</i> 2(39,1)	<i>p</i> of <i>F</i> 2
Grammaticality	33.52	**	48.46	**
Structure	6.34	*	7.16	*
Length	18.10	**	14.72	**
Grammaticality × Structure	26.01	**	24.74	**
Grammaticality × Length	7.82	**	6.34	*
Structure × Length	7.11	*	8.37	**
Grammaticality × Structure × Length	5.30	*	7.59	**

^a *: *p* < .05; **: *p* < .01; n.s.: not significant

Table 8.11. Three-way ANOVA for reaction times to make correct judgments for Experiment 1^a

Main Effect/ Interaction	<i>F</i> 1(35,1)	<i>p</i> of <i>F</i> 1	<i>F</i> 2(35,1)	<i>p</i> of <i>F</i> 2
Grammaticality	65,28	**	71,92	**
Structure	13,71	**	8,92	**
Length	2,42	n.s.	3,01	<i>p</i> = .091
Grammaticality × Structure	12,12	**	13,24	**
Grammaticality × Length	2,99	<i>p</i> = .093	,54	n.s.
Structure × Length	,63	n.s.	,01	n.s.
Grammaticality × Structure × Length	2,01	n.s.	1,79	n.s.

^a *: *p* < .05; **: *p* < .01; n.s.: not significant

Chapter 9

IN DEFENSE OF SERIAL PARSING

1. Introduction

With respect to syntactic ambiguity resolution, theories of the HSPM have to explain two related sets of findings: First, for (almost) all ambiguities a preference exists in favor of one of the alternative structures; second, disambiguation towards the non-preferred structure leads to processing difficulties—garden-path effects—of varying strengths. Serial models of the HSPM provide a framework which is perfectly suited to explain these two basic findings: The existence of a preference for one of the possible structures is an immediate consequence of the HSPM pursuing only a single structure at every point of the ongoing analysis. Differences in garden-path strength come about because the initial, erroneous structure has to be replaced by the correct structure, and this can require varying amounts of work. An important task in developing a serial model is to work out the details of this general schema of explanation. The model proposed in this book can be seen as an existence proof that this task is a feasible one.

In contrast to serial models, the hallmark of parallel models is that the HSPM can pursue more than a single analysis after encountering a syntactic ambiguity. Without further assumptions, neither a preference for one of the alternative structures nor a garden-path effect for any of the alternative structures would be expected given a parallel HSPM. Since this is not what is actually observed, further assumptions are necessary to turn parallel parsing into a reasonable account of human syntactic processing. Current parallel models usually make use of two devices in order to account for the way human sentence parsing works: *RANKING* of structures computed in parallel, and *PRUNING* of structures which do not seem promising enough to spend further work on.

The assumption that the structures that are computed in parallel (cf. Figure 9.1) are ranked according to some criteria seems to be shared by all current

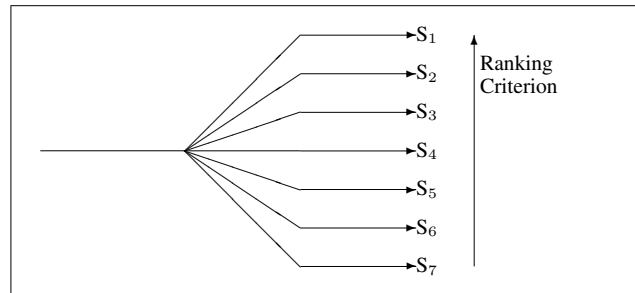


Figure 9.1. Parallel Processing of Syntactically Ambiguous Sentences

parallel models. According to such ranked parallel parsers, processing at the point of disambiguation will be easiest when disambiguation is in favor of the top-ranked structure; if, in contrast, disambiguation is in favor of some lower ranked structure, processing load is assumed to increase.

In addition to ranking structures which have been computed in parallel, a further mechanism employed by some parallel models of the HSPM is the pruning of certain structures from further consideration (cf. Figure 9.2). That is, if a structure fares too bad with respect to the ranking criteria, it will be dropped from further consideration instead of just being low-ranked. One motivation for pruning is that it prevents the HSPM from becoming overloaded with too many structures (cf. Gibson, 1991; Jurafsky, 1996).

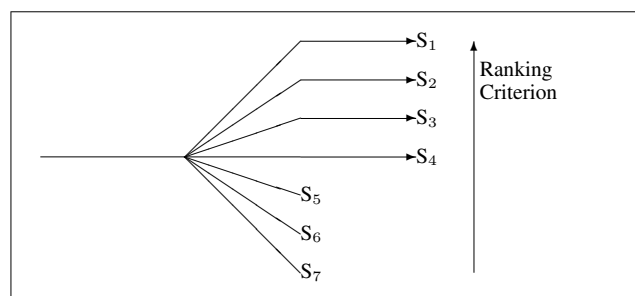


Figure 9.2. Parallel Processing with Pruning of Low Ranked Structures

The parallel models of the HSPM that are currently under debate can be classified along two dimensions. The first one is whether the HSPM is considered a symbol-processing device or a connectionist network. The second dimension concerns the criteria used for ranking alternative syntactic structures. In the

which is of particular interest given the experiments presented in the last two chapters. We will introduce those aspects of the DLT which are relevant to the subject matter of this book in the next section before proceeding to an evaluation of the theory in light of what is known about syntactic-function ambiguities.

2.1 An Outline of the DLT

Following the general conception of working memory resources put forward by Just and Carpenter (1992), the DLT assumes that the HSPM has available a fixed amount of computational resources which it must distribute between two components of sentence processing (Gibson, 2000: 96):

- *Integration cost*
The cost for performing structural integrations, that is, for connecting each word into the structure developed for the input thus far.
- *Memory cost*
The cost for keeping the structure in memory, which includes keeping track of incomplete dependencies.

For the present discussion, we will only need the memory or storage cost component of the DLT. Storage cost within the DLT is measured in terms of MEMORY UNITS. Memory units for each word of a sentence are computed according to the definition in (3).

- (3) *DLT storage cost* (Gibson, 2000: 114)
1 memory unit (MU) is associated with each syntactic head required to complete the current input as a grammatical sentence.

To illustrate the DLT's notion of storage cost, let us consider how subject- and object-extracted relative clauses (cf. (2)) differ from each other in terms of storage cost. The storage-cost profiles for the object-extracted sentence (2-a) and the subject-extracted sentence (2-b) are given in (4) and (5).

- (4)
- | | Input word | | | | | | | | |
|-------------------|------------|----------|-----|-----|---------|----------|----------|-----|---------|
| | The | reporter | who | the | senator | attacked | disliked | the | editor. |
| Storage cost | 2 | 1 | 3 | 4 | 3 | 1 | 1 | 1 | 0 |
| (in memory units) | | | | | | | | | |
- (5)
- | | Input word | | | | | | | | |
|-------------------|------------|----------|-----|----------|-----|---------|----------|-----|---------|
| | The | reporter | who | attacked | the | senator | disliked | the | editor. |
| Storage cost | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 1 | 0 |
| (in memory units) | | | | | | | | | |

The storage-cost profiles in (4) and (5) show the current storage cost measured in memory units at each word during the left-to-right parse of each sentence. As defined in (3), memory units correspond to the number of heads that are

minimally necessary to complete the structure thus far. The particular numbers shown in (4) come about as shown below. In this listing, following each word the heads are given that are minimally required to complete the sentence.

- *The*: noun, main-clause verb
- *reporter*: main-clause verb
- *who*: main-clause verb, relative-clause verb, trace of *who*
- *the*: main-clause verb, relative-clause verb, trace of *who*, noun
- *senator*: main-clause verb, relative-clause verb, trace of *who*
- *attacked*: main-clause verb
- *disliked*: NP object
- *the*: noun
- *editor*: -

Consider next the storage-cost profile for the corresponding sentence with subject-extracted relative clause shown in (5). Storage cost within the main clause is the same as before, so that we only have to consider the embedded relative clause:

- *who*: main-clause verb, relative-clause verb, trace of *who*;
- *attacked*: NP object, main-clause verb;
- *the*: main-clause verb, noun
- *senator*: main-clause verb

A comparison of the memory-cost profiles for the sentence with subject-extracted relative clause and the sentence with object-extracted relative clause shows that within the relative-clause, object-extraction leads to a higher memory-load than subject-extraction. This is in accordance with the finding that relative clauses of the former type are more difficult to understand than relative-clauses of the latter type.

Gibson and Thomas (1999) present an interesting extension of the DLT in order to account for certain errors in ungrammaticality detection. As already pointed out above, a sentence like (1-b) (repeated in (6)) with its two levels of center embedding is hard to comprehend, if it is comprehensible at all.

(6) The patient who the nurse who the clinic had hired admitted met Jack.

Now consider sentence (7) from Gibson and Thomas (1999: 227).

(7) *The patient who the nurse who the clinic had hired met Jack.

Sentence (7) appears to be easier to understand, but in fact, it is ungrammatical and, as a consequence, also uninterpretable.¹ The reason that (7) is aberrant is that it contains three subjects but only two predicates. This is easier to see when looking at (8), which is the structure that people come up when reading such a sentence, as shown by the experimental data presented in Gibson and Thomas (1999).

(8)

The patient

 who the nurse

who the clinic

had hired

met Jack

As indicated in (8), readers match the first predicate (*had hired*) with the third subject (*the clinic*) and the second predicate (*met Jack*) with the first subject (*the patient*). The middle subject (*the nurse*) thus remains without a predicate, but this problem often goes unnoticed. Somehow during the processing of such sentences, the middle subject—together with the preceding relative pronoun—seems to get lost.

To account for this finding, Gibson and Thomas (1999: 231) propose the HIGH MEMORY COST PRUNING HYPOTHESIS which is given in (9).

(9) *The High Memory Cost Pruning Hypothesis*

At points of high memory complexity, forget the syntactic prediction(s) associated with the most memory load.

The HIGH MEMORY COST PRUNING HYPOTHESIS was proposed on the basis of the DLT's predecessor, the SYNTACTIC PREDICTION LOCALITY THEORY (SPLT) of Gibson (1998). The SPLT's definition of storage cost differs from the DLT's definition in that it does not only count predicted heads, but weights each prediction of a head by the amount of work that was necessary since the prediction was made. Under both the DLT and the SPLT, the point of highest processing load in sentences like (6) is on the subject of the most deeply embedded relative clause (*the clinic*). Furthermore, under the SPLT's definition of storage cost, the first part of the higher relative clause (*who the nurse*) contributes most to this storage cost, and will therefore get pruned (cf. Gibson and Thomas, 1999, for details).

In addition to explaining a wide variety of processing load and overload phenomena, the DLT is also a theory of syntactic ambiguity resolution. It is at this point where the assumption of parallel processing enters the stage. According to the DLT, the HSPM computes a preferred structure for an ambiguous input

¹As pointed out in Gibson and Thomas (1999), sentence (7) is a variation on a sentence discussed in Frazier (1985) who attributes the observation of the missing VP-effect to Janet Fodor; for German, this effect could be replicated by Bader, Häussler and Bayer (2003).

string—the top-ranked structure—but alternative, lower-ranked structures can also be pursued. Whether an alternative structure will indeed be considered worth of further elaboration depends on its “heuristic value” in comparison to the top-ranked structure. If a lower-ranked structure has a heuristic value only slightly below the one for the top-ranked structure, it will be elaborated as further input material comes in; otherwise, working on that structure will be stopped. Thus, according to the DLT the HSPM is a ranked parallel device in which parallelism is limited by pruning those structures which have become too low-ranked.

This implies that a syntactic structure which has been computed at some point t_1 can be in one of three states at any later point t_2 during the ongoing parse:

- A structure can be the most highly ranked active one.
- A structure can be ranked below the top-ranked structure but can still be active in the sense that the HSPM pursues this structure in parallel with the top-ranked structure.
- A structure can have become inactive; it will then not be considered for further elaboration.

What determines which structures are active and which are pruned, and how the active structures are ranked? This question is answered by the *AMBIGUITY RESOLUTION HYPOTHESIS* of the DLT which is given in (10).

(10) *Ambiguity Resolution Hypothesis* (Gibson, 2000: 115-116)

In choosing among ambiguous structures, two of the factors that the processor uses to evaluate its choices are DLT storage and structural integration cost (in addition to informational constraints, such as lexical frequencies, plausibility, and context).

To illustrate the Ambiguity Resolution Hypothesis, we will consider the accusative preference found in syntactic-function ambiguities because this is one of the preferences discussed in Gibson (1998). Remember from chapter 4 that Hopf et al. (1998) found an accusative preference when investigating sentences like (11) which contain an ambiguity between accusative and dative object.

- (11) a. Menschen, die in Not sind, sollte man unterstützen.
 persons-ACC who in distress are should one support
 ‘One should support persons who are in distress.’
- b. #Menschen, die in Not sind, sollte man helfen.
 persons-DAT who in distress are should one help
 ‘One should help persons who are in distress.’

In Gibson (1998: 59-60), the preference for accusative Case is explained as follows. First of all, it is noted that there are more ditransitive verbs than verbs with only a single, dative-marked object. From this it is concluded that the HSPM assumes that a dative object is typically the dative object of a ditransitive verb, that is, that a dative object typically cooccurs with an accusative object. The reverse, however, is not true. Since verbs that take only an accusative object outnumber ditransitive verbs, the DLT proposes that for accusative objects the default assumption of the HSPM is that they are the object of a simple transitive verb, that is, they do not cooccur with a second object.

These assumptions about objects and the verb-frames they typically occur in translates into storage cost as follows. First, when a sentence starts with a dative object, the HSPM will predict three heads: the head of the subject, the head of the accusative object, and the verb. The sentence will thus be associated with three memory units after the dative DP has been read. In a sentence starting with an accusative object, the HSPM will only predict the head of the subject and the verb, and the memory load therefore is only two memory units. The sentence with the initial dative object will thus be associated with one memory unit more than the sentence with the accusative object. For ambiguous sentences like those in (11), the HSPM will compute in parallel both the structure with an initial accusative, and the structure with an initial dative object. Given the difference in memory cost just derived, the accusative structure will be ranked above the dative structure, which accounts for why readers prefer the accusative verb to the dative verb in these sentences.

(12) summarizes the relationship between memory load, syntactic ambiguity resolution (preferences and garden-path strength), and the on-line detection of ungrammaticalities.

- (12) Given two syntactic structures A and B, with B incurring more memory load than A:
- a. *Prediction concerning unambiguous sentences*
An unambiguous sentence with structure A should be easier to comprehend than an unambiguous sentence with structure B.
 - b. *Prediction concerning the preferred reading of an ambiguous sentence*
If an input string is compatible with both structure A and structure B, A is higher ranked than B, and therefore A should be preferred on first-pass parsing.
 - c. *Prediction concerning garden-path strength*
Switching from structure A to structure B on reanalysis should be associated with a higher processing load than switching from structure B to structure A.

In summary, the DLT successfully predicts the preferences observed in syntactic function ambiguities, that is, the Case Assignment Generalization (“Nominative Case is preferred to accusative Case which in turn is preferred to dative Case”) that we first introduced in chapter 4. As our discussion thus far has shown, the following ranking can be established on the basis of the storage cost associated with different orders of subject and objects.

- (15) *Ranking of Structures for Predicting Preferences*
 $SO_{ACC} > SO_{DAT} > O_{ACC}S > O_{DAT}S$

According to the predictions summarized in (12), the DLT lets us expect to find the same ranking when looking at unambiguous sentences, garden-path strength, and ungrammaticality detection. We will consider next whether this expectation is borne out. As our main source of evidence we will draw on Experiment 3 of Meng and Bader (2000b) because this experiment contains all relevant conditions (unambiguous, locally ambiguous, and ungrammatical sentences) within a single experiment.

2.3 Unambiguous Sentences

Two unambiguous sentences from Experiment 3 of Meng and Bader (2000b) are shown in (16) and (17).

- (16) *Subject before Object*
 Man hat behauptet, daß meine Mutter das neue Buch
 one has claimed that my mother-NOM the new book-ACC
 sehr schnell geliefert hat.
 very quickly delivered has
 ‘It was claimed that my mother has delivered the new book very quickly.’
- (17) *Object before Subject*
 Man hat behauptet, daß meiner Mutter das neue Buch
 one has claimed that my mother-DAT the new book-NOM
 sehr schnell geliefert wurde.
 very quickly delivered was
 ‘It was claimed that the new book was delivered very quickly to my mother.’

In Meng and Bader’s experiment, unambiguous OS-sentences were judged as grammatical with 86% and SO-sentences with 76%. In those experiments on Case checking presented in chapters 7 and 8 that included both unambiguous SO- and OS-sentences, we obtained similar results in most although not all conditions. As explained in section 4.3 of chapter 7, this might not be an inherent difference between SO- and OS-sentences per se but instead be due to the fact that some of the verbs used in SO-sentences are less than happy when the dative object is omitted, as is necessary for closely matching locally

ambiguous active and passive sentences. This suspicion is supported by the finding of no difference for such sentences when verbs are used that always have just two arguments, as in Experiments 1 and 2 of chapter 6.

For unambiguous SO- and OS-sentences of the type under consideration, we will thus assume the ranking given in (18).²

- (18) *Ranking of Structures for Unambiguous Sentences*
 $SO_{ACC} \approx O_{DATS}$

2.4 Garden-Path Strength

What does the DLT have to say about garden-path strength caused by syntactic-function ambiguities? The first finding that we will consider concerns reanalysis in sentences with base-generated OS-structure. As the experiments reported in this book have amply demonstrated, such sentences usually lead to a garden-path effect in case they are locally ambiguous between an SO- and an OS-structure. Only in the rare situation of Case attraction is the OS-structure computed on first-pass parsing, and reanalysis is toward the SO-structure. Two relevant examples from Meng and Bader (2000b) are given in (19) and (20).

- (19) *Subject before Object*

Ich hoffe, daß Anita, **der** ich letzte Woche begegnet bin,
 I hope that A. who-DAT I last week met am
 das neue Buch sehr schnell geliefert hat.
 the new book very quickly delivered has
 'I hope that Anita, who I met last week, has delivered the new book very quickly.'

- (20) *Object before Subject*

Ich hoffe, daß Anita, **die** ich nächste Woche besuchen werde,
 I hope that A. who-ACC I next week visit will
 das neue Buch sehr schnell geliefert wurde.
 the new book very quickly delivered was
 'I hope that the new book was delivered very quickly to Anita, who I will visit next week.'

With respect to garden-path strength, there is a clear difference between SO-sentences like (19) and OS-sentences like (20). For the OS-sentences, reanalysis is usually rather easy whereas it is difficult for the SO-sentences. In Experiment 3 of Meng and Bader (2000b), for example, locally ambiguous OS-sentences were judged as grammatical with 75% in contrast to unambiguous control sentences which were judged as grammatical with 86%. For SO-sentences, the

²As will become clear when we compare the different rankings in section 2.6 below, assuming a ranking in which SO_{ACC} is ranked below O_{DATS} would be even more problematic for the DLT.

respective numbers are 51% for locally ambiguous sentences and 76% for unambiguous control sentences—clearly a substantially greater difference than the difference found for OS-sentences. This striking difference between SO- and OS-sentences was also found in the experiments reported in this book that included the relevant sentences in their experimental design.

Given the logic of a ranking-based parallel parser, easy reanalysis from an SO-structure to an OS-structure but difficult reanalysis in the reverse direction jointly imply that OS-structures should be ranked above SO-structures. We thus arrive at the ranking shown in (21).

- (21) *Ranking of Structures for Predicting Garden-Path Strength*
 $O_{\text{DATS}} > SO_{\text{ACC}}$

2.5 Accuracy of Ungrammaticality Detection

In addition to the results on ambiguous and unambiguous sentences, the experiment of Meng and Bader (2000b) also revealed a striking difference between ungrammatical SO- and ungrammatical OS-sentences of the type shown in (22) and (23).

- (22) *Subject before Object*
 *... daß meine Mutter das Buch ... geliefert wurde.
 that my mother-NOM the book-ACC ... delivered wurde
- (23) *Object before Subject*
 *... daß meiner Mutter das Buch ... geliefert hat.
 that my mother-DAT the book-ACC ... delivered has

These are ungrammatical sentences of the same sort that were investigated in several of the experiments reported in chapters 7 and 8. Meng and Bader (2000b) found that ungrammatical active (OS) sentences were rejected as ungrammatical with high accuracy, whereas ungrammatical passive (SO) sentences were often erroneously accepted as grammatical. This difference between the two types of ungrammatical sentences was replicated in all experiments of the present book that included this contrast.

If we were to explain the often poor rejection rate for ungrammatical SO-sentences in terms of the HIGH MEMORY COST PRUNING HYPOTHESIS, we might claim that predictions concerning the expected argument structure of the predicted verb get lost due to high memory load, and the HSPM therefore accepts a verb even if it does not match the preceding arguments. Since OS-sentences are basically immune to judgment errors, we also have to assume that when processing these sentences, nothing gets pruned due to high memory load. For ungrammaticality detection, we thus derive the ranking in (24).

- (24) *Ranking of Structures for Ungrammatical Sentences*
 $O_{DATS} > SO_{ACC}$

2.6 The DLT Applied to Syntactic Function Ambiguities: Summary

As stated in (12), the DLT predicts a consistent ranking of alternative syntactic structures for unambiguous sentences, structural preferences, garden-path strength, and ungrammaticality detection. The actual rankings that we have just derived for SO_{ACC} - and O_{DATS} -sentences are summarized in (25).

- (25) a. *Ranking of Structures for Predicting Preferences*
 $SO_{ACC} > O_{DATS}$
 b. *Ranking of Structures for Unambiguous Sentences*
 $O_{DATS} \approx SO_{ACC}$
 c. *Ranking of Structures for Predicting Garden-Path Strength*
 $O_{DATS} > SO_{ACC}$
 d. *Ranking of Structures for Ungrammatical Sentences*
 $O_{DATS} > SO_{ACC}$

The four rankings seen in (25) are not consistent with each other. The DLT predicts that the SO -structure, which is the preferred structure in situations of local syntactic ambiguity, should be at an advantage across the board. This is not born out by our data: Despite being preferred on first-pass parsing, the SO -structure is on a par with the OS -structure in unambiguous sentences, it leads to a stronger garden-path effect in the rare situation where it has to be computed on second-pass parsing (Case-attraction), and it is particularly vulnerable to errors on ungrammaticality detection.

While the pattern that shows up in (25) looks surprising from the perspective of the DLT, from the perspective of the model developed in this book it is not surprising at all. Quite to the contrary, it is exactly what is to be expected given the Case system of German. The pattern in (25) is succinctly captured by the generalization about the role of dative Case for the HSPM that was stated in the last chapter (repeated in (26)).

- (26) *Dative and the HSPM*
 The HSPM will not postulate a dative marked phrase (a KP) unless forced to do so, but once it has introduced such a phrase, it is reluctant to undo it.

As was shown in the preceding chapter, the generalization in (26) is a direct consequence of the markedness of dative Case within the German Case system, and the way we have coded this property in terms of an extra phrase-structural layer KP.

As a last point before leaving our discussion of the DLT, we would like to stress that the problems posed for the DLT by the results discussed in this book only pertain to the DLT's conception of the HSPM as a parallel device which ranks structures according to factors like memory load. While this assumption is clearly contradicted by the data that we have reviewed above, this in no way diminishes the value of the DLT as a theory of memory-load and overload phenomena. As witnessed by our frequent reference to the notion of integration when discussing the various tasks that the HSPM faces, one of the great virtues of the DLT is in our view that it has drawn attention to the process of integration as the locus of processing complexity.

3. Parallel Parsing and Frequency

The model of the HSPM presented in this book falls into the broad class of structure-based parsing theories. This is true both for the way we have explained preferences during first-pass parsing, as well as for our theory of garden-path recovery. The common feature of structure-based theories is that their explanations make reference to structural notions such as phrase-structure configurations, linking regularities, or linguistic markedness.

Contrasting with structure-based theories of syntactic ambiguity resolution are theories according to which frequency of usage is the most important factor for syntactic ambiguity resolution in general, and the prediction of garden-path strength in particular. Frequency-based accounts of garden-path strength come in different varieties. In the following, we will discuss particular frequency-based models of the HSPM and then evaluate some predictions made by these models with regard to the various garden-path phenomena discussed in this monograph.

There are a range of parallel models that incorporate in one way or the other the idea that garden-path strength is related to frequency properties of linguistic items. For reasons of space, it is impossible to do justice to the complexities of these models. We will instead only point out the main ideas as they pertain to the topic of frequency and garden-path strength.

A frequency-based account of garden-path strength that shares important architectural assumptions with the DLT of Gibson (1998, 2000) is the probabilistic model of access and disambiguation proposed in Jurafsky (1996). Like the DLT, Jurafsky's model assumes that the HSPM is a parallel, symbol-processing device with ranking and pruning of structures computed in parallel. The criteria for ranking and pruning—and this is the difference to the DLT—is based on the probability of the competing structures. In a nutshell, structures are ranked according to their probability of occurrence, and a structure is pruned if its probability is too low in comparison to the highest ranked structure.

Another important class of frequency-based models is the class of constrained-based models (cf. MacDonald, 1994; MacDonald et al., 1994b; MacDonald et al., 1994a; Seidenberg and MacDonald, 1999; Spivey-Knowlton and Tanenhaus, 1994; Tabor et al., 1997; Tabor and Tanenhaus, 1999). The basic idea of these models is that there is a competition between alternative syntactic structures, or alternative properties of lexical items, during the ongoing analysis of an ambiguous sentence. This competition is assumed to depend—to varying degrees—on the frequency of use of the alternative structures that are competing with each other. The strength of a particular garden-path is a function of this competition in the following way: The less frequent an unpreferred structure is in comparison to the preferred one, the stronger the resulting garden-path effect will be.

Note that this short characterization of frequency-based models of garden-path strength has not been specific as to what linguistic units are competing with each other: lexical items, syntactic structures, or both. However, for the ambiguities considered in what follows, such a differentiation does not seem to be necessary because of a heavy confound between construction types and the lexical items crucially involved in these constructions.

3.1 Testing Frequency Based Models of Garden-Path Strength

The next three sections will present the results of several corpus studies that we conducted in order to determine whether garden-path strength in syntactic function ambiguities is reflected in actual frequency counts.³ All corpus studies made use of the COSMAS corpus system that is made available on-line by the *Institut für Deutsche Sprache (IDS)* (Institute for German Language) in Mannheim (for further information, cf. “<http://www.ids-mannheim.de>”). For our own study, we selected the newspaper part of COSMAS. At the time of our studies, this corpus contained several yearly issues of the German newspaper *Mannheimer Morgen* (years included: 1989, 1991, 1994-2000). The corpus size was ca. 81.3 million words making up roughly 3.89 million sentences. Since this is an untagged corpus, all corpus analyses consisted of two steps: Searching and downloading of relevant examples, and then hand-coding for the syntactic features of interest.

³The following corpus studies were first presented in a talk given at the Conference on Architectures and Mechanisms for Language Processing held at the University of Leiden in 2000.

3.2 Case Study I: Base-Generated Subject Object Ambiguities

Embedded declarative clauses with two DP arguments, as illustrated by the sentence fragment in (27), are the subject of our first case-study on frequency and garden-path strength.

- (27) Ich weiß, daß Maria das Päckchen . . .
I know that M. the parcel

Three possible continuations of such a fragment are shown below.

- (28) *Subject before Object*
Ich weiß, daß Maria das Päckchen geschickt hat.
I know, that Maria-NOM the parcel sent has.
'I know that Maria has sent the parcel.'
- (29) *Dative-Object before Subject (Active)*
Ich weiß, daß Maria das Päckchen gefallen hat.
I know, that Maria-DAT the parcel pleased has.
'I know that the parcel pleased Maria.'
- (30) *Dative-Object before Subject (Passive)*
Ich weiß, daß Maria das Päckchen geschickt wurde.
I know, that Maria-DAT the parcel sent was.
'I know that the parcel was sent to Maria.'

Sentences like these were investigated in several of the experiments in the present book. In accordance with prior investigations (e.g., Bader, 1996), these experiments have shown a preference for the SO-structure, and very mild garden-path effects for sentences disambiguated toward the OS-structure.⁴ The experimental finding of only mild garden-path effects comports well with the intuitions one has regarding these sentences. When asked to compare SO-sentences like (28) with OS-sentences like (29) or (30), informants normally judge neither structure as being more difficult than the other.

In order to determine whether this is reflected in corpus frequencies, we conducted a corpus search for sentences containing an embedded declarative clause introduced by the complementizer *daß* and a proper name immediately following the complementizer. Since the search was done on an untagged corpus, we selected 60 surnames from various experiments that had investigated sentences of the appropriate type (like the experiments mentioned in footnote 4), and searched for sentences containing the complementizer *daß* immediately followed by one of the 60 surnames. The search resulted in a set of 398 match-

⁴For active OS-sentences like (29), the relevant experiment is Experiment 3 of chapter 6; for passive OS-sentences like (30), the relevant experiments are Experiments 2 and 3 of chapter 7 and Experiment 2 of chapter 8.

ing sentences which were hand-coded for the syntactic functions of the DP arguments. As might be expected given a newspaper corpus, in most instances the surname was followed by a last name. The results of this corpus study are shown in Table 9.1.

Table 9.1. Frequency counts for “daß + proper name” (n = 398)

	<i>Nominative initial</i>	<i>Dative initial</i>	<i>Genitive initial (Possessive Specifier)</i>
NOM	165	DAT-NOM 4	11
NOM-ACC	177		
NOM-DAT	7		
NOM-GEN	1		
NOM-NOM	25		
NOM-DAT-ACC	5		
Total	380	4	11

Table 9.1 shows a strikingly low number of sentences in which the first DP is not a subject. Only four of the 398 *daß*-clauses that we found started with a dative object. An additional eleven sentences started with a genitive DP, but these were all possessive specifiers of a subject DP (e.g., *daß Michael Jacksons Absage . . .* ‘that Michael Jackson’s cancellation . . .’). In summary, the fact that locally base-generated OS-sentences elicit garden-path effects of the mildest sort is in now way reflected by our corpus data.

A closer look at the four instances of dative-initial sentences revealed that all four of them were of the base-generated type. An original example is shown in (31).

- (31) daß Lothar Matthäus ein Angebot des englischen Zweit-Divisionärs
 that L. M. a offer the English Second-Divisioner
 Crystal Palace als Spieler-Trainer vorliegt
 C. P. as player-manager before-lies
 ‘... that Lothar Matthäus has an offer by Crystal-Palace as player-
 manager.’

This is compatible with the finding of Experiment 3 of chapter 6 that base-generated OS-sentences are easier to process than corresponding OS-sentences derived by movement (cf. (32) versus (33)).

- (32) *Dative-Object before Subject: base-generated*
 Ich weiß, daß Fritz die Lehrerin **gefallen** hat.
 I know, that Fritz the teacher pleased has
 'I know that the teacher pleased Fritz.'
- (33) *Dative-Object before Subject: derived by movement*
 Ich weiß, daß Fritz_i die Lehrerin t_i **geholfen** hat.
 I know, that Fritz the teacher helped has
 'I know that the teacher helped Fritz.'

Note, however, that differences in garden-path strength between base-generated OS-sentences and OS-sentences derived by movement are not generally reflected in corpus frequencies. This is in particular true when comparing base-generated OS-sentences and wh-questions with OS-structure. As stated above, ambiguous base-generated OS-sentences produce rather weak garden-path effects whereas ambiguous OS-wh-questions of the sort shown in (34) cause substantial garden-path effects (cf. Meng and Bader, 2000b).

- (34) Ich weiß, welche Tante die Kinder gestern besucht haben.
 I know which aunt the children yesterday visited have
 'I know which aunt the children have visited yesterday'

This, however, is in direct opposite to what is found in frequency counts. As this section has shown, the rate of base-generated OS-sentences is very low; as the next subsection will show, among other things, the rate of OS-wh-question is substantially higher.

3.3 Case Study II: A Comparison of Different Types of Filler-Gap Ambiguities

The next corpus study will take a closer look at four different types of embedded clauses with derived OS-structure. The experimental results that form the basis for this corpus analysis are taken from Bader and Meng (1999).

3.3.1 Filler-Gap Ambiguities: Experimental Results

Bader and Meng (1999) compared four types of filler-gap OS-sentences in a speeded-grammaticality judgment experiment. Examples of each type are provided in (35) - (38) (the numbers on the right-hand side are percentages of correct judgments from a study by Bader and Meng, 1999).

- (35) *Relative clauses* 53%
 Das ist die Tante, die die Kinder besucht haben.
 This is the aunt, who the children visited have.
 'This is the aunt who the children have visited.'

	<i>Parallel Parsing and Frequency</i>	279
(36)	<i>Wh-questions</i> Ich will wissen, welche Tante die Kinder besucht haben. I want know, which aunt the children visited have. 'I want to know which aunt the children have visited.'	54%
(37)	<i>Pronoun movement</i> Die Tante schrieb, daß sie die Kinder besucht haben. The aunt wrote, that she the children visited have. 'The aunt wrote that the children have visited her.'	55%
(38)	<i>Scrambling</i> Peter schrieb, dass die Tante die Kinder besucht haben. Peter wrote that the aunt the children visited have. 'Peter wrote that the children have visited the aunt.'	34%

The four sentences in (35)–(38) all involve an ambiguous filler-gap dependency, as explained in section 2 of chapter 4. To recapitulate shortly, relative clauses and *wh*-questions contain an active-filler dependency because the initial phrase is located in SpecCP and a phrase in SpecCP is obligatorily coindexed with a trace at some later position in the sentence. In pronoun-movement sentences and scrambling sentences, the initial object is also coindexed with a later trace, but it is not an active filler because in corresponding SO-sentences the initial DP is base-generated there.

The results for the four movement-derived OS-sentences that were obtained by Bader and Meng (1999) are shown on the right side of each sentence in (35)–(38). These numbers are the percentages of correct answers obtained in an experiment using the same method of speeded-grammaticality judgments that was used in the experiments of this book. As shown in (35)–(38), there was no difference in garden-path strength between relative clauses, *wh*-questions, and pronoun-movement sentences. Scrambling sentences, in contrast, were harder to process than all other types of sentences.

Under a structural account of garden-path strength, the equivalence of the first three types of filler-gap sentences follows from the fact that these sentences are syntactically similar insofar as syntactic reanalysis is concerned. The additional finding that scrambling sentences are harder to process follows from the fact that scrambling sentences, but not the other types of filler-gap sentences, have a marked focus structure in the sense of imposing narrow focus on the subject (cf. section 3.3 of chapter 3).

3.3.2 Filler-Gap Ambiguities: Corpus Results

The data for this corpus study were gathered as follows. The first step in finding instances of each structure was to search for identifying substrings: for relative clauses, sentences containing a comma immediately followed by the word *die* were searched; for *wh*-questions, the relevant substring was a comma immediately followed by *welche*; for scrambling and pronoun-movement sentences,

the substring consisted of the complementizer *daß* immediately followed by either *die* or *sie*. In order to hold the amount of data manageable, the search was restricted to a random sample of at most 500 matching sentences. In a second step, the resulting sentence sets were coded by hand for the relevant syntactic features. Note that this step also filtered out instances that did not fit the intended syntactic structure. For example, when searching for strings containing a comma immediately followed by the word *die*, the majority of hits were relative clauses, but other structures—like complement clauses not introduced by a complementizer—also occurred.

Table 9.2. Frequency counts for four different constructions where the OS word-order is derived from an underlying SO word-order

	<i>Relative clauses</i> (<i>n</i> = 347)	<i>Wh-Questions</i> (<i>n</i> = 285)	<i>Pronoun</i> (<i>n</i> = 455)	<i>Scrambling</i> (<i>n</i> = 488)
Subject-initial	315	157	454	488
Object-initial	32	128	2	1
% Object-initial	9.2%	44.9%	.4%	.2%
SO-sentences	144	46	223	188
OS-sentences	32	128	2	1
% OS-sentences	18.2%	74.6%	.9%	.5%
Experimental Results for OS-sentences	53%	54%	55%	34%

The resulting corpus counts for the four types of OS-sentences investigated by Bader and Meng (1999) are shown in Table 9.2. The results reveal two striking mismatches between garden-path strength and corpus counts. First, the corpus data do not match the experimental data when comparing relative clauses, wh-questions, and pronoun sentences. While these three sentence types were on a par in the experimental study, the corpus data show a rather different picture. In particular, wh-sentences show a rather high proportion of object-initial sentences (44.9%) whereas this rate is much reduced for relative clauses (9.2%) and strikingly low for pronoun-movement sentences (.4%). Despite these differences with regard to frequency, all three sentence types caused garden-path effects of about equal strength in the Bader and Meng study.

A second mismatch shows up in Table 9.2 when we compare scrambling and pronoun-movement sentences. For both sentence types, almost no instances were found in our corpus search. Nevertheless, the experimental results reported in Bader and Meng show a clear-cut difference, with scrambling sentences being much harder to understand than pronoun-movement sentences.

In summary, the results of our corpus study do not match the experimental results on garden-path strength in embedded clauses obtained by Bader and Meng. The same conclusion was reached in a broader corpus study by Bader, Häußler and Bayer (2005).

3.4 Case Study III: Wh-Sentences, Mode of Disambiguation, and Animacy

In our third and final case study, we will take a closer look at the particular means by which ambiguous wh-questions can be disambiguated. As in our discussion of the DLT, we will rely on experimental results from Meng and Bader (2000b).

3.4.1 Wh-Questions and Mode of Disambiguation: Experimental Results

As already discussed in section 2 of chapter 4, locally ambiguous wh-questions—both embedded questions and main clause questions—can be disambiguated by subject-verb agreement or by Case morphology. For embedded wh-questions, the possible types of disambiguation are illustrated in (39) and (40) (the numbers on the right-hand side are percentages of correct judgments from a study by Meng and Bader, 2000b).

- (39) *Disambiguation by Agreement* 49%
 Ich will wissen, welche Tante die Kinder besucht **haben**.
 I want know, which aunt the children visited have.
 'I know which aunt the children have visited.'
- (40) *Disambiguation by Case Morphology* 73%
 Ich will wissen, welche Tante **der** Junge besucht hat.
 I want know which aunt the boy visited has.
 'I know which aunt the boy has visited.'

In (39), disambiguation is by number agreement: Only the second DP matches the plural specification on the clause-final finite verb (*haben*). In (40), disambiguation is by Case morphology: Since the second DP is unambiguously marked for nominative Case, this DP must be the subject of the clause.

Main clause wh-questions disambiguated by either agreement or case morphology are shown in (41) and (42), respectively.

- (41) *Disambiguation by Agreement* 72%
 Welche Tante **haben** die Kinder besucht.
 Which aunt have the children visited.
 'Which aunt have the children visited?'

- (42) *Disambiguation by Case Morphology* 91%
 Welche Tante hat **der** Junge besucht.
 Which aunt has the boy visited.
 ‘Which aunt has the boy visited?’

Meng and Bader (2000b) tested both main-clause and embedded-clause wh-questions. As shown by the numbers in (39)–(42), for both types of wh-questions disambiguation by agreement caused a stronger garden-path effect than disambiguation by Case morphology. For corresponding unambiguous sentences, such differences did not show up.

3.4.2 Wh-Questions and Mode of Disambiguation: Results of corpus search

For embedded wh-questions, we used the set of corpus instances that were collected for our comparison of four different types of filler-gap OS-sentences (described in the preceding section). For main-clause wh-questions, a new set of appropriate instances was collected in the same manner as described above. For both types of wh-questions, sentences were hand-coded with regard to the formal means by which disambiguation was achieved. Table 9.3 shows the results of this corpus study according to four categories of disambiguation: Disambiguation by an unambiguous Case-marked second DP, disambiguation by subject-verb agreement (shown separately for number and person features), and sentences without any formal disambiguation. For these latter sentences—as well as for many of the sentences with formal disambiguation—meaning made it usually clear which DP was the subject and which the object.

Table 9.3. Formal means of disambiguation in main and embedded Wh-questions

	<i>Case</i>	<i>Number</i>	<i>Person</i>	<i>Without</i>	<i>Total</i>
Main Clause Questions					
NOM-ACC	3	1	0	23	27
ACC-NOM	13	71	4	73	161
Embedded Questions					
NOM-ACC	14	6	0	12	32
ACC-NOM	30	59	0	30	119

As one can see in Table 9.3, the most frequent type of formal disambiguation is disambiguation by number features on the finite verb. This is true for both main clauses and embedded clauses. Disambiguation by Case is substantially less frequent, although it still occurs with some regularity.

What do the data in Table 9.3 tell us about the relationship of garden-path strength and mode of disambiguation? In order to answer this question, we have to remember that it is the ratio between different competing structures that is crucial for determining garden-path strength according to the parallel models discussed above. Table 9.3 does not show such ratios, but the data contained in this table can be used to compute the relevant numbers. In doing so, we have to take into account that point of disambiguation and means of disambiguation differ depending on clause type in the sentences under consideration. The relevant structures for embedded and main-clause wh-questions are shown in (43-a) and (43-b).

- (43) a. *Embedded clauses:*
 ... , [DP₁ welche X] DP₂ V-finite?
 b. *Main clauses:*
 [DP₁ Welche X] V-finite DP₂?

Due to verb-second, disambiguation by subject-verb agreement occurs in main clauses already after the initial DP, DP₁ in (43-b). This means that for such sentences, an OS-structure will be in competition with all kinds of subject-initial structures. For embedded clauses, in contrast, disambiguation by subject-verb agreement occurs only after processing the second DP, DP₂ in (43-a). Competition at the point of disambiguation will therefore be restricted to subject-initial sentences which also have an object. For sentences that are disambiguated by unambiguous Case morphology on the second DP, similar considerations show that in embedded clauses, the competitor set is not restricted in any way, whereas for main clauses, the competitor set is restricted insofar as certain structures will already have been disambiguated toward an object-initial structure by the finite verb in verb-second position.

Table 9.4. Number of Competing structures at Different Points in Main and Embedded Wh-questions (see text below for explanation)

	<i>Embedded Wh-clauses</i>		<i>Main Wh-clauses</i>	
	<i>After 1. NP</i>	<i>After 2. NP</i>	<i>After 1. NP</i>	<i>After finite verb</i>
NOM-first competitors	32 + 125	18	27 + 95	27 + 95
ACC < NOM sentences	119	89	161	86
% OS	43	83	57	41
Ratio OS to Non-OS	.76	4.9	1.31	.70

The question thus is whether the ratios between the OS-structure and its competitors differ at different points of disambiguation in such a way that the

experimentally observed differences in garden-path strength are predicted. The relevant numbers for answering this question are given in Table 9.4. This table is to be read as follows. The row labeled “NOM-first competitors” shows the number of all sentences compatible with a subject-initial structure up to the point given by the respective column header. For the columns labeled “After 1. NP”, these are simply all sentences with an initial subject DP. In Table 9.4, subject-initial sentences are broken down according to nominative-accusative sentences (the first number, which is the same as the number of nominative-accusative sentences in Table 9.3), and all other kinds of subject-initial sentences. For embedded-clauses, the number of subject-initial competitors is reduced in the column labeled “After 2. NP” because seeing the second NP eliminates all competitors that are not compatible with both a nominative-accusative and an accusative-nominative structure. The row labeled “ACC < NOM sentences” shows the corresponding numbers for accusative-nominative sentences. Initially, these are all sentences of this type (that is, all such sentence from Table 9.3). The numbers are then reduced according to the particular means of disambiguation. For example, 30 embedded OS-clauses were disambiguated by means of Case morphology on the second DP; these 30 clauses have been subtracted in the column “After 2. DP” for embedded clauses.

While the resulting numbers show differences in the ratio of non-OS- to OS-sentences depending on type of disambiguation and clause type, the differences are not in the direction that would be expected given what is known about garden-path strength in *wh*-questions. In main clauses, for example, there are more accusative-nominative sentences than nominative-initial sentences when only the first DP has been encountered whereas the relationship has reversed after the finite verb has been processed. Since garden-path strength should increase with increasing ratio of non-OS-sentences to OS-sentences, garden-path strength and corpus ratios go in opposite directions. The stronger garden-path effect is found when disambiguation is on the finite verb, despite the high ratio of OS-sentences at this point.

For embedded clauses, similar considerations hold. For such sentences, disambiguation by the finite verb also leads to stronger garden-path effects. Disambiguation by the finite verb corresponds to disambiguation after the second NP for embedded clauses. As can be seen in Table 9.4, the proportion of OS-sentences is particularly high after the second NP, which is again just the opposite of what is found with respect to garden-path strength.

3.4.3 Wh-Questions and Animacy

As a final point concerning *wh*-questions, we have to ask for possible influences of animacy properties of the DPs involved in the sentences under consideration. The experimental results of Meng and Bader (2000b) were all based on sentences with two animate NPs. In the corpus analyses of the preceding section,

in contrast, sentences were included irrespective of whether they contained an inanimate or an animate NP. This was actually necessary because there was a strikingly low number of sentences with two animate DPs (three instances were found for main questions, and one instance for embedded questions). It was thus not possible to make any further analyses on sentences exactly like those investigated by Meng and Bader (2000b). For all sentences which contained at least one animate DP, frequencies according to word-order and clause type are shown in Table 9.5.

Table 9.5. Word-order and animate NPs in main-clause and embedded Wh-questions

	<i>Main Clauses</i>		<i>Embedded Clauses</i>	
	<i>NOM < ACC</i>	<i>ACC < NOM</i>	<i>NOM < ACC</i>	<i>ACC < NOM</i>
1. NP animate	9	4	10	1
2. NP animate	5	109	4	78

3.5 Final Reflections on Frequency and Parsing

This section has presented three case studies on the relationship between garden-path strength and corpus frequencies in subject-object ambiguities. Overall, the results of our corpus studies have found no evidence for the claim that garden-path strength reflects corpus frequencies. The main points of divergence between ease of garden-path recovery and corpus counts can be summarized as follows:

- Locally ambiguous base-generated OS-sentences usually lead to garden-path effects of only modest strength, despite being rather rare in comparison to SO-sentences.
- Garden-path strength in different types of locally ambiguous OS-sentences derived by movement of the object does not reflect the rate at which the different sentence types occurred in the corpus.
- The differences in garden-path strength caused by the means by which locally ambiguous wh-sentences are disambiguated (nominal versus verbal disambiguation) were also not reflected by our corpus counts.

One caveat which has to be made regarding these findings concerns the representativeness of the particular corpus on which we relied in our studies. This pertains both to the fact that we only looked at newspaper texts (of only a single newspaper), and that only written language—in contrast to spoken language—was taken into account. At least some of the ambiguities might

be peculiar to written language. For example, proper names are often used with determiners in spoken German, which eliminates the dative ambiguity otherwise found with proper names (cf. chapter 3). We must leave it open for future research to determine whether the results obtained for the corpus of written newspaper language that was examined in the current corpus studies generalize to a larger set of corpora, including more genres as well as spoken in addition to written language.

As a final point on frequency and the HSPM, let us ask what role—if any—frequency might play in a structure-based reanalysis model of the HSPM. Although the results presented in this section are rather negative on this question, we do not think that frequency is completely irrelevant for processes of reanalysis. One obvious point of connection is provided by the process of lexical reaccess that has figured prominently in the two preceding chapters. Given that processes within the mental lexicon are known to be sensitive to various frequency properties of words, lexical reaccess surely is a process which might be expected to be sensitive to lexical frequencies. Given that we do not have found evidence for structural frequency effects in the corpus studies above, we conclude our discussion of the role of frequency for the HSPM with the FREQUENCY-BY-REACCESS HYPOTHESIS which is given in (44).

(44) *The Frequency-By-Reaccess Hypothesis*

Frequency effects on second-pass parsing are confined to frequency properties of lexical items that are involved in lexical reaccess.

According to the FREQUENCY-BY-REACCESS HYPOTHESIS—which can be considered as the second-pass pendant of the MODULAR STATISTICAL HYPOTHESIS proposed by Corley and Crocker (2000)—there would be a neat separation between lexical processes, which would be susceptible to frequency information, and structural processes, which would not. Only further research will be able to show whether such a strong hypothesis can indeed be maintained.

4. Summary

Before we arrived at this chapter, we simply assumed that the HSPM is a serial mechanism. Working under this assumption, the preceding chapters presented a range of experimental evidence compatible with serial parsing in general, and linking and checking operations within the HSPM in particular. After the discussion in this section, we can make a stronger claim: Not only are the results presented here compatible with serial parsing, but they are also difficult to reconcile with the alternative parallel accounts that we considered in this chapter. This does of course not mean that we have ruled out once and for all any conceivable parallel account of the data presented here. However, what we can claim is that the argumentation and the data presented in this chapter

show that the available evidence on processing German syntactic-function ambiguities strongly favors the serial approach to human sentence processing over competing parallel accounts.

Chapter 10

SUMMARY: LINKING, CHECKING, AND BEYOND

1. Introduction

When we reviewed the HSPM in chapter 2, we introduced eight questions a complete theory of the HSPM would have to answer. In the next section, we will give a brief summary of the work presented in this book by indicating how these eight questions are addressed by our theory.

By answering these questions, we do not want to pretend that the theory presented here is a complete theory of the HSPM. While our theory is rather broad in its coverage as far as syntactic functions are concerned, it is not even a complete theory of how the HSPM identifies syntactic functions during the ongoing parse. There are mainly two reasons for this. First, we have not concerned ourselves with the question as to how DPs are assembled and instead simply assumed that they are available for checking and linking. Second, as pointed out at several points, the theory presented here models only those reanalysis processes that are an automatic byproduct of the HSPM's normal linking and checking procedures. Reanalysis beyond these automatic processes could not be taken into account. These two topics will be discussed after the summary of our theory.

2. The Linking and Checking Procedures of the HSPM

The first two of the questions introduced in chapter 2 aimed at general properties of the HSPM, properties that would have to be specified even if syntactic ambiguity was absent from natural languages.

- (Q1) I Is the HSPM, considered as a whole, a module of the human mind?
II Is the HSPM a single, uniform module, or is it composed of multiple modules?

- (Q2) Does the HSPM compute syntactic structures always in an incremental manner, or is incremental parsing restricted to certain types of syntactic structures?

With respect to the modularity of the HSPM considered as a whole, our theory is not committed to any strong position, although some degree of modularity will be necessary given our position on modularity within the HSPM. With regard to the decomposition of the HSPM, the theory we have developed entertains a strong hypothesis: The HSPM is decomposable, and one of its components is restricted to the narrow task of linking and checking. Furthermore, we have hypothesized that these two tasks are strictly ordered. First, arguments are linked, and then checking operations apply to the outcome of the prior linking step. The main evidence for this hypothesis is the very fact that syntactic-function ambiguities can sometimes lead to rather strong garden-path effects. If linking were unconstrained and able to make use of information relevant for checking, this would not be expected. For example, subject-object ambiguities are often disambiguated by subject-verb agreement, namely when a sentence contains two ambiguous DPs that differ in number, and the number specification on the finite verb decides which one is subject and which one object. If the HSPM could use this information from the beginning, arriving at the correct linking should be no problem at all.

Turning next to the question of incremental parsing, the work presented here is clearly compatible with the assumption that the HSPM is a strictly incremental device. However, since we did not investigate the word-by-word assembly of arguments but only their linking and checking, no particular evidence on this point was provided (see section 3 below for further discussion).

The remaining six questions were concerned with first-pass parsing, second-pass parsing, and the relationship between first- and second-pass parsing. We will discuss these topics in turn.

2.1 The HSPM's First-Pass Parsing Routines

The two of the eight questions about the HSPM that were concerned with the HSPM's first-pass parsing routines are repeated below in (Q3) and (Q4).

- (Q3) I Does the HSPM pursue only a single analysis at a time, or does it pursue more than a single analysis in parallel?
 II Does the HSPM compute fully specified syntactic structures, or does it compute structures that are to some extent underspecified?
- (Q4) What information does the HSPM use in establishing an initial syntactic analysis, and how?

Question (Q3) receives a firm answer in our theory: We assume a serial parsing mechanism, that is, a parser that integrates each word of an input string

into a single, fully specified syntactic structure as soon as the word is encountered. That the human parser computes only a single structure for each sentence has been argued at length in the preceding chapter where it was shown that the pattern of garden-path strength that has been found for syntactic-function ambiguities is hardly compatible with a parallel parser. The further assumption that this single structure is a fully specified one is also well motivated by the empirical evidence. As far as is known today, sentences with local syntactic-function ambiguities always lead to garden-path effects—even if only of the slightest sort—under one of their possible disambiguations. This would not be expected if the parser could compute syntactic structures that are left underspecified for Case.

Turning next to question (Q3), we have assumed that the HSPM uses only a very restricted kind of information to establish its initial analysis. In order to establish syntactic functions during first-pass parsing, the HSPM uses mainly two types of information: information about the syntactic category of words and morphological information about Case. In situations where these informations do not suffice to determine a single analysis, we have hypothesized that parsing preferences are the joint product of the Minimal Chain Principle and the Case Preference Principle, as discussed in chapter 4. As Experiment 2 of chapter 6 has demonstrated, this is too simple a picture. This experiment has shown that first-pass preferences change when the main verb is in verb-second position, thereby preceding its arguments. Since first-pass preferences have not been a central theme of this book, we must leave it as a task for future research to determine whether the information sources that we have assumed to guide first-pass parsing are indeed sufficient.

2.2 The HSPM's Second-Pass Parsing Routines

The next three questions about the HSPM, which are repeated in (Q5)-(Q7), concern the processes within the HSPM that are responsible for reanalysis, that is, for arriving at the ultimately correct syntactic analysis of a garden-path sentence.

- (Q5) Is (part of) the original CPPM simply discarded after encountering the disambiguating word, such that new structure has to be built up from scratch, or is it kept as far as possible and only altered where necessary in order to overcome the garden-path?
- (Q6) Do differences in garden-path strength follow from constraints on diagnosis or from constraints on cure?
- (Q7) What are the reasons for the constraints on reanalysis?

With regard to reanalysis, the model we have proposed is in the spirit of the original diagnosis model proposed by Fodor and Inoue (1994), and so our

answer to question (Q5) is clearly that reanalysis does not involve reparsing of the input string. Instead, the CPPM is only altered as far as necessary. In the case of syntactic-function ambiguities, it is often sufficient to simply replace some erroneous Case specification(s) with the correct specification(s), without any alterations of the phrase-structural relations computed on the initial parse. Even in situations where feature corrections alone are not sufficient, most of the CPPM can be left intact. For example, when a DP bearing structural Case has to be assigned dative Case during second-pass parsing, a KP has to be inserted into the CPPM as part of the reanalysis process. This only involves the addition of a further node into the CPPM which otherwise does not have to be altered at all. Similar considerations hold for sentences in which filler-gap dependencies have to be recomputed on reanalysis.

With regard to question (Q6), our theory claims that garden-path strength is to a large extent determined by constraints on diagnosis, not by constraints on cure. The main constraints on diagnosis, as far as syntactic-function ambiguities are concerned, derive from the LINKING-BASED CHECKING ALGORITHM (LBCA) that was introduced in chapter 6, in conjunction with the ARGUMENT LINKING PRINCIPLE that was introduced in the same chapter. The LBCA and the Argument Linking Principle jointly determine whether the revisions necessary to arrive at the correct syntactic structure are easy to deduce or not. As we have discussed in detail, for certain types of syntactic-function ambiguities, diagnosis is an automatic by-product of the normal linking and checking processes of the HSPM. For such ambiguities, garden-path strength is normally rather slight. Syntactic-function ambiguities for which diagnosis is not delivered for free by the LBCA and the Argument Linking Principle, in contrast, are often associated with strong garden-path effects.

The claim that garden-path strength is by and large a function of diagnosis makes our model a variant of Fodor and Inoue's (1994) original diagnosis model. The main difference between our model and the original diagnosis model lies in the way how diagnosis is implemented. To some degree, this difference is a consequence of the different empirical domains covered by the two models: phrase-structure ambiguities are the main focus of Fodor and Inoue's diagnosis model whereas syntactic function ambiguities are the focus of our model (but see Fodor and Inoue (2000a,b) for a discussion of syntactic-function ambiguities within their model). However, there is also a further difference. As discussed throughout the preceding chapters, we assume that diagnosis is a major determinant of garden-path strength, but surely not the only one. In particular, we assume the LEXICAL REACCESS HYPOTHESIS that was presented in chapter 7. According to this hypothesis, successful reanalysis can be hampered when it is difficult to determine that a necessary revision of the CPPM is lexically licensed. This can be the case even if the syntactic revision by itself was easy to diagnose. The Lexical Reaccess Hypothesis is at variance

with Fodor and Inoue's original diagnosis model which assumes that lexical rechecking is always costfree when it is transparently signalled.

As for (Q7), we have again adopted an idea of the original diagnosis model, namely that the HSPM is severely restricted in its diagnostic capabilities because it has only very limited information available for the purpose of diagnosis. In our model, this amounts to a constraint on the information available during the linking of arguments to slots in the argument structure, as specified in the Argument Linking Principle. This principle is constrained in such a way that only a limited amount of information—basically information about Case and animacy—can be used during the initial linking step. We see the ultimate reason for this constraint as deriving from efficiency requirements on the HSPM. The HSPM has to do its work under tight time pressure, and one way to achieve this is by restricting the amount of information that the HSPM has to consider when making decisions (cf. Corley and Crocker, 2000, for further discussion).

2.3 The Relationship between First- and Second-Pass Parsing

The last of the eight questions that we asked about the HSPM is repeated in (Q8).

- (Q8) What is the relationship between the mechanisms responsible for first-pass parsing and the mechanisms responsible for reanalysis?

As discussed in chapter 2, the answer to this question determines what we can learn from investigations of garden-path phenomena for the normal working of the HSPM. If the theory proposed in this book is on the right track, then there is indeed a very close relationship between the mechanisms responsible for first-pass parsing and those responsible for second-pass parsing. The LBCA, which bears a major burden in our account of garden-path strength in syntactic-function ambiguities, is first and foremost an algorithm needed for first-pass parsing. To understand a sentence successfully, it is always necessary to link phrases within the CPPM to their correct slots in the argument-structure of the verb. This is exactly what the LBCA does: it is responsible for computing the correct linking relations. The particular way in which the LBCA has been formulated has the consequence that the LBCA can also come up with the correct diagnosis for a large range of syntactically ambiguous sentences that are initially misanalysed by the HSPM, as summarized above. Thus, the fact notwithstanding that the main focus of our investigations were garden-path sentences of varying types, the model we have developed is not just a model of garden-path recovery. Instead, it is a model of the first-pass parsing routines of the HSPM, but a model that automatically takes care of certain aspects of reanalysis.

2.4 The Major Properties of the HSPM

To conclude this summary of the model of the HSPM that we have presented in this book, (1) repeats the three major claims that we introduced in chapter 1.

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

Given the preceding discussion, claims (1-a) and (1-b) need no further comment. As to claim (1-c), we hope to have made clear in which way this claim is true. In a nutshell, a major distinction within the Case system of German is the one between the two structural Cases nominative and accusative on the one hand and dative Case on the other hand. The repercussions of this distinction for the working of the HSPM are manifold. The special role of dative Case can be observed in Case attraction phenomena, in parsing preferences during first-pass parsing, in the pattern of garden-path strength found for second-pass parsing, and in the detection of ungrammaticalities. In all instances, the special role of dative Case for purposes of sentence understanding could be traced back to the peculiar properties of dative Case within the Case system of German.

3. The Assembly of DPs

Throughout this book we have assumed that the HSPM is able to compute a phrase-structure representation to which it can then apply its linking and checking procedures. While the task of phrase-structure parsing seems in many cases to be easily accomplished for the kind of sentences that were the focus of this monograph, generally this is not true. It is in particular not always easy to correctly identify the boundaries of DPs. With regard to the right boundary of DPs, there is the problem—well-known from English—that PPs sometimes can either form a complex DP with an immediately preceding noun or be attached to the VP. In German, this problem extends to certain DPs because nouns in German cannot only be modified by PPs but also by genitive DPs. This problem arises quite often for feminine DPs because they are generally Case ambiguous between genitive and dative Case. Some of the factors governing parsing decisions in this domain have been identified by Konieczny et al. (1997).

While PP-ambiguities can make it difficult to detect the right boundary of a DP, problems in detecting the left boundary also exist. In German, this problem is more prevalent than in English because determiners can usually also be used as a DP of their own. The definite article, for example, has an additional use as a demonstrative pronoun. In this usage, it does not require an NP complement,

a situation which leads to locally ambiguous sentences of the sort illustrated in (2).

- (2) a. ... dass [DP die Witze] erzählt wurden, die schon bekannt sind.
 that the jokes told were which already known are
 ‘... that the jokes were told which are already known.’
 b. ... dass [DP die] [DP Witze] erzählt haben, die Humor haben.
 that the jokes told have who humour have
 ‘... that those people told jokes who have humour.’

In (2-a), the definite determiner *die* (‘the’) and the following noun *Witze* (‘jokes’) form a single DP together. In (2-b), *die* functions as a demonstrative pronoun, as indicated in the English translation of this sentence. How the HSPM handles this kind of phrase-structure ambiguity is by and large an open question (for preliminary experimental evidence, cf. Häussler and Bader, 2005).

In addition to questions concerning the correct identification of left and right DP-boundaries, questions arise as to the point in time where Case is assigned to a DP. To simplify the discussion of linking and checking, we have treated DPs as complete units, which are morphologically either Case-ambiguous or not. While this is indeed true when considering complete DPs, DPs also raise interesting questions with respect to the point at which their Case properties are fixed during on-line sentence comprehension. The reason for this is that often the Case properties of a DP are a joint function of determiner and noun. This is illustrated by the examples in (3).

- (3) a. ... dass **der** rosa Kater jetzt schläft.
 that the pink tomcat now sleeps
 ‘... that the pink tomcat is now sleeping.’
 b. ... dass **der** rosa Katze niemand geholfen hat.
 that the pink cat nobody helped has
 ‘... that nobody helped the pink cat.’

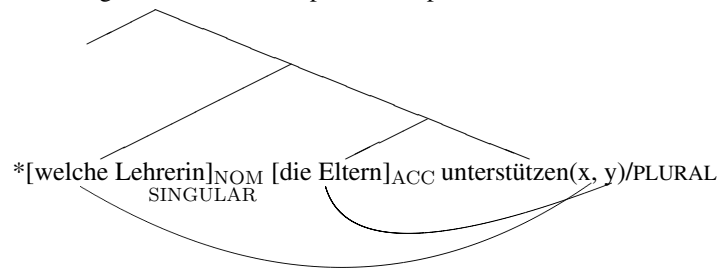
In (3-a), the word form *der* is the nominative, masculine, singular form of the definite article. In (3-b), this word form is the dative, feminine, singular form. The particular features of *der* depend on the gender features of the following noun—the masculine *Kater* (‘tomcat’) in (3-a) and the feminine *Katze* (‘cat’) in (3-b). With respect to on-line sentence comprehension, examples as in (3) raise the question as to when the Case specification of the whole DP is computed. Does the HSPM immediately decide on a particular specification when reading the article *der* and revises its decisions later when necessary, or is the decision only made when the noun (*Katze* or *Kater*) is encountered? Preliminary evidence in favor of the first alternative has been presented by Häussler et al. (2004), but this question can hardly be considered as settled.

4. Beyond Linking and Checking

As discussed in detail in chapter 6, garden-path sentences with derived OS-structure which are disambiguated by requirements imposed by the verb are beyond the scope of automatic reanalysis by the LBCA. Such sentences cannot be reanalysed as a simple by-product of the linking- and checking mechanisms of the HSPM. An example sentence illustrating this point is repeated in (4). The state reached by the HSPM after initial linking and checking appears in (5).

- (4) (Ich will wissen), [welche Lehrerin]_i die Eltern t_i unterstützen.
 I want know which teacher the parents support
 ‘I want to know which teacher the parents support.’

- (5) a. Resulting Structure after Step 1 and Step 2A of the LBCA:



- b. Step 2B of the LBCA:

- PLUR → [welche Lehrerin]? ☹
- SING → [unterstützen]? ☹

Sentence (4) is a typical instance of an OS-sentence derived by moving the object in front of the subject. Because the verb *unterstützen* (‘support’) is associated with an underlying SO word order, the HSPM’s linking procedures will identify the first DP as the subject and the second DP as the object, as depicted in (5-a). When this configuration is checked with regard to subject-verb agreement, a violation will occur because the putative subject *welche Lehrerin* (‘which teacher’) is specified for singular whereas the verb is specified for plural. Since these elements are not ambiguous with respect to number, it is not possible for the HSPM to repair the initial structure by a simple feature correction. The LBCA is thus unable to deliver the correct syntactic structure for this sentence.

What are the exact processing steps that lead to successful reanalysis in these instances? We do not believe that a conclusive answer to this question is possible at the moment. However, several factors have already been identified that affect garden-path strength for sentences of this kind, some of which were already alluded to in earlier parts of this book. One class of factors revolves around the notion of information structure. As discussed in chapter 3, sentences

with derived word-order differ as to whether they are associated with a marked or an unmarked focus structure. The experiment of Bader and Meng (1999) that was discussed in the preceding chapter provides some initial evidence that OS-sentences associated with a marked focus structure (scrambling sentences) are more difficult to reanalyze than sentences with an unmarked focus structure (e.g., wh-questions and sentences with pronoun movement). A more thorough investigation of this topic can be found in Stolterfoht (2004).

In addition to factors derived from the information structure of a sentence, there is also evidence that the reanalysis processes that follow the LBCA proceed in a diagnostic manner, too, at least to a certain degree. Bader (in preparation) investigated derived OS-sentences like those in (6), among others.

- (6) a. ... dass Fritz_i eine Lehrerin t_i geholfen hat
 that Fritz a teacher helped has
 ‘... that a teacher helped Fritz’
 b. ... dass Fritz_i ein paar Lehrerinnen t_i geholfen haben
 that Fritz a pair teachers helped have
 ‘... that a couple of teachers helped Fritz’

Sentence (6-a) contains two singular DPs, and thus the number specification on the finite verb gives no hint whatsoever as to which DP is the subject. Sentence (6-b), in contrast, contains a singular DP and a plural DP, and the number specification on the finite verb is therefore of potential help for the HSPM. Both sentences have been found to elicit substantial garden-path effects, but the strength of the effect was much larger for (6-a) than for (6-b). Finding garden-path effects in both cases strengthens our assumption that number information cannot guide the initial linking decisions of the HSPM. Finding a difference in garden-path strength depending on what number information is available, argues in addition that diagnostic reasoning is involved in the processes that take care of reanalysis in sentences of this kind.

While the empirical evidence cited above imposes clear constraints on the processes within the HSPM that are responsible for reanalysis after initial linking and checking are completed, it does not seem possible at the moment to model them in the same algorithmic way that the LBCA models the HSPM's linking and checking procedures. We must leave this as a task for future research.

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