

Syntactic Function Ambiguities: A Model Of Checking and Diagnosis

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/14. May 2000/

1 Overview

In his 1994 review of the Human Sentence Processing Mechanism (HSPM, for short), Mitchell pointed out that a complete theory of the HSPM cannot stop with the processes that construct some form of phrase-structure representation. In addition to such processes (the ASSEMBLY PROCESSES in Mitchell's terminology), the HSPM must also include procedures for checking the ongoing phrase-structure representation with respect to a range of wellformedness-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) raised three important questions: (i) Do checking operations operate without delay, and are there different kinds of tests applied in a consistent order? (ii) 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? (iii) Can the substructures from a rejected analysis be kept so that they can be built into a new structure?

The second and third question raised by Mitchell (1994) foreshadowed the diagnosis model developed by Fodor and Inoue in a series of recent papers (e.g. Fodor & Inoue, 1994; Fodor & Inoue, 1998). According to Fodor and Inoue, garden-path recovery proceeds by repairing the current partial phrase marker (CPPM) and not by reparsing the falsely analyzed input string. Since this implies that prior structure is not simply discarded, question (iii) of Mitchell (1994) receives a positive answer. Which repair operations have to be taken is determined by a diagnostic reasoning which starts at 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. An important assumption of the diagnosis model is that garden-path strength completely depends on establishing what adjustments to made. Actually making these adjustments, in contrast, is not assumed to be inherently costly. Since finding the necessary adjustments at least partially depends on the information delivered by the checking operations that signaled the garden-path, Mitchell's question (ii) also gets a positive answer.

In this paper, I will propose a model of the checking and diagnosis processes that occur in subject-object ambiguities as they are found in German. This model merges ideas from the research on subject-object ambiguities by my colleagues and me (e.g. Bader, 1994; Bader, Bayer, Hopf & Meng, 1996; Meng & Bader, to appear) and ideas originating with the diagnosis model of Fodor and Inoue. Besides partially answering the three questions raised by Mitchell (1994) with respect to the checking component of the HSPM, the model proposed in this paper will address a fourth question which is specific to garden-path recovery: Can all variation in garden-path strength be reduced to diagnostic reasoning, as claimed by the diagnosis model of Fodor & Inoue, or are constraints on revision operations still necessary in a complete account of garden-path recovery? My tentative conclusion will be that such constraints are indeed not necessary, but only if the scope of diagnosis is extended beyond the narrow range of syntax.

The organization of this paper is as follows. The next section will introduce the basic model of checking and diagnosis in subject-object ambiguities. Section 3 will discuss a range of experimental findings supporting the basic architecture of the model. Sections 4 and 5 will consider certain aspects of the model in more detail. Section 6 will discuss the relation of the model proposed here to some earlier proposals by Meng and Bader (1997). The final section will contain a summary.

2 The Checking and Diagnosis Algorithm

The prevalence of subject-object ambiguities in German is the joint result of two properties of the language: The relative free ordering of subjects and objects, and the lack of unambiguous case-morphology on many NPs. Beginning with the first property, we have to note that a major determinant of the order obtaining between subject and object(s) is the argument structure that is associated with every verb. A verb normally determines a basic order among its arguments which for most verbs is the order subject followed by object(s). A sample argument structure for the verb *unterstützen* (to support), which has a subject and a single object, is shown in (1).

(1) unterstützen: <agent_{NOM}, benefactive_{ACC}>

As indicated in (1), the argument structure of verb will specify at least the following information: (i) How many arguments a verb has, (ii) what thematic roles these arguments bear, (iii) what case each argument is associated with, and (iv) what ordering obtains between the arguments. These different types of information are not necessarily independent of each other. For example, an agent argument will typically bear nominative case and be ordered first on the argument list. For ease of presentation, I will always specify all relevant information within the argument structure, and leave open the question of what information is actually stored with each verb, and what information is computed on the basis of lexical generalizations of the sort just mentioned. Furthermore, I will use familiar notions like agent etc. in order to refer to thematic roles although these are probably only shorthands for more elaborated pieces of lexical conceptual structures (cf. e.g., Grimshaw, 1990; Levin & Rappaport Hovav, 1995).

In a particular sentence, the arguments of a verb are ordered according to their order specified in the verb's argument structure unless there is some reason to deviate from the prespecified basic order. One such reason is the necessity to put wh-phrases or relative pronouns in clause-initial position. Another reason for having the object precede the subject has to do with the information structure of a sentence (for a recent review, cf. Vallduvi & Engdahl, 1996). In particular, when the subject is focused and the object part of the background, the object may be located in front of the subject in order to put the subject in a focus position preceding the clause-final verb. Taking this option gives rise to locally ambiguous sentences as in (2).

- (2) a. (Ich will wissen), ob die Lehrerin die Eltern unterstützt hat.
 I want know whether the teacher the parents supported has
 "I want to know whether the teacher has supported the parents"
- b. (Ich will wissen), ob die Lehrerin die Eltern unterstützt haben.
 I want know whether the teacher the parents supported have
 "I want to know whether the parents have supported the teacher"

The two NPs *die Lehrerin* and *die Eltern* are both morphologically ambiguous between nominative and accusative case. The embedded clauses in (2) are therefore locally ambiguous between a SO- and an OS-word order. This local ambiguity is resolved by the clause final auxiliary. Due to the obligatory agreement between subject and finite verb, disambiguation is towards the SO-word order in (2a) and towards the OS-word order in (2b).

Besides the majority of verbs for which the subject-before-object (OS) word order is basic, there are also certain verb classes with the reverse basic word order. For example, there is a class of psych-verbs where the dative-marked experiencer precedes the nominative marked target-of-emotion (cf. the lexical entry of the verb *gefallen* (to please) in (3)).

(3) /*gefallen*/ <experiencer_{DAT}, target-of-emotion_{NOM}>

The existence of argument structures as in (3) gives rise to subject-object ambiguities of the sort shown in (4).

- (4) a. (Keiner wußte,) daß Britta_{NOM} das_{ACC} Buch gelesen hat.
 Nobody knew that Britta the book read has
 "Nobody knew that Britta read the book."
- b. (Keiner wußte,) daß Britta_{DAT} das_{NOM} Buch gefallen hat.
 Nobody knew that Britta the Buch pleased has
 "Nobody knew that the book pleased Britta"

A proper name like *Britta* is three-way ambiguous between nominative, accusative and dative case. A definite NP like *das Buch* is two-way ambiguous between nominative and accusative case. From this, in conjunction with the semantics of the two verbs *lesen* (to read) and *gefallen* (to please), it follows that the embedded clause in (4a) has to be assigned an SO-word order whereas the embedded clause of (4b) receives an OS-word order.

Although there is a broad consent between syntacticians with respect to the role played by argument structure properties for determining the basic word-order associated with a verb, no agreement has yet been reached when it comes to the question as to how different word-orders might be represented in phrase-structural terms. For purposes of this article, nothing hinges on taking a particular stance on this issue. However, for concreteness sake, I will assume that the word-order corresponding to the order of arguments in a verb's argument structure is base-generated and that all word-orders deviating from the order specified in the argument-structure are derived by movement (cf. Haider & Rosengren, 1998; for a different view, cf. Fanselow, to appear).

This concludes our short review of word-order variation in German. As we have seen, a broad classification of subject-object ambiguities has to distinguish between filler-gap SO-ambiguities (cf. (2)) and base-generated SO-ambiguities (cf. (4)). In the past decade, both types of subject-object ambiguities have been studied intensively in German, and for both types of SO-ambiguities, a rather general subject-object preference has been found (cf. Hemfort & Konieczny, 2000, for an overview of recent results). There are a number of competing proposals as to the source of this preference, e.g. the Active-Filler Strategy (Frazier, 1987), the Minimal-Chain Principle (De Vincenci, 1991), Structural Simplicity (Gorrell, 1995) or the Case Preference Principles (Bader, Bayer, Hopf & Meng, 1996). Furthermore, it has been found that for a NP that has already been identified as an object but is still ambiguous with respect to its case, accusative case is preferred to dative case (cf. Hopf, Bayer, Bader, & Meng, 1998; Meng, 1997). Since the question of first-pass preferences is orthogonal to the question of garden-path recovery, which is the focus of the current paper, I will not try to decide between these competing hypotheses here. With respect to garden-path strength, both intuitions and recent experimental results suggest - as a first generalization - that locally ambiguous OS-sentences containing a filler-gap dependency typically lead to stronger garden-path effects than locally ambiguous base-generated OS-sentences.¹ For example, in two experiments using a selfpaced-reading procedure, Bader (1994) has found that locally ambiguous filler-gap sentences involving pronoun movement lead to a stronger garden-path effect than locally ambiguous base-generated sentences. A similar result has been found by Meng and Bader (to appear) when they compared embedded wh-questions and base-generated OS-sentences using a speeded-grammaticality judgment procedure.

To account for the basic split between filler-gap and base-generated SO-ambiguities, I propose that garden-path recovery in locally ambiguous OS-sentences proceeds according to the four steps given in (5). The algorithm proposed in (5) is meant to apply in verb-final clauses after the verb has been encountered and its argument structure been retrieved from the mental lexicon. How this algorithm applies in other situations (e.g. main clauses with an auxiliary-verb in clause-second position) will be discussed in the next section.

¹ There are some apparent counterexamples to this claim, in particular involving certain kinds of ambiguous wh-questions, which will be discussed in section 3.2.

(5) The Argument-Structure-Based Diagnosis Algorithm (ASBDA)

1. Link each NP within the CPPM to a position within the verb's argument structure.
2. Check the relevant features (case for subject and objects, number and person for subject). If there is a mismatch, go to step 3.
3. Determine whether mismatching features on the offending lexical items can be replaced by correct features.
If so, make the necessary corrections. If not, go to step 4.
4. Search for an alternative assignment of syntactic functions.
If one is found, make the necessary corrections. If not, consider the sentence as ungrammatical.

The first two steps in (5) are checking routines in the sense of Mitchell (1994) and apply to all sentences; the following two steps are responsible for processes of diagnosis and are only invoked if a mismatch has been detected during the prior checking phase. When processing a verb-end sentence, the HSPM has to retrieve the argument structure of the verb and to project the information contained in this argument structure in order to correctly assign the thematic roles associated with the particular verb. As outlined above, the argument structure of a verb contains several pieces of information: The number and semantic types of arguments, the case linked to each argument, and the basic ordering of the arguments. During step 1, each NP contained within the CPPM will be linked to a particular argument slot of the verb. A question arising in connection with step 1 of the ASBDA concerns the information that the HSPM is using in linking NPs with argument slots. As will become clear when we apply the ASBDA to particular examples, not just any information available can be used in effecting this linking. Otherwise, no garden-path effects at all would be expected in subject-object ambiguities. To begin with, I will assume that the arguments of the verb are projected onto the CPPM in the order specified within the argument structure and the NPs linked accordingly (an alternative proposal is discussed in the appendix). Based on the result of the projection of the argument structure, the case features associated with each argument can be checked against the case features contained in the CPPM. Besides its argument structure, the verb also provides certain agreement features (number and person) which will be checked against the respective features of the subject.²

If the features contained within the CPPM match the case features provided by the argument structure and the agreement features found on the finite verb, processing will proceed smoothly. If there is a mismatch, however, processes of diagnosis come into place. According to step 3, the HSPM will first check whether the lexical items giving rise to a feature mismatch allow for an alternative feature assignment. For example, if a NP has been assigned case X on first-pass parsing but should bear case Y according to the verb's argument structure, the parser might determine whether this NP is morphologically also compatible with case Y. If the HSPM can figure out that it is, and this was the only mismatch detected during step 2, then the offending feature can simply be replaced by the correct one, and processing can again proceed smoothly. If such a simple feature correction is not possible, then - as specified in step 4 - the HSPM will have to search for an altogether new syntactic structure. The question as to what kind of information is guiding this search will be addressed in section 5.

Base-generated and filler-gap OS garden-path sentences crucially differ from each other in that the former can be revised immediately after step 3 whereas revision in the latter is dependent on the successful completion of step 4. To derive this difference, we will now go step-by-step through the

² An open question at the moment is how independent agreement and case checking are from each other. For example, are nominative case and subject-verb agreement checked simultaneously, or is there a fixed order of checking the two?

processing of the garden-path sentences (2b) and (4b). Let us begin with sentence (4b), which is repeated in (6) for convenience.

- (6) (Keiner wußte,) daß Britta das_{NOM} Buch gefallen hat.
 Nobody knew that Britta the book pleased has
 "Nobody knew that the book pleased Britta"

After encountering the clause final verbal complex, the argument structure of the verb *gefallen* becomes available to the HSPM. The argument structure of this verb says that the first argument is an experiencer bearing dative case and the second argument a target-of-emotion bearing nominative case (cf. (3)); the goal is constrained to be realized by an animate NP whereas no particular restriction holds for the target-of-emotion. Given this information, the result of linking the NPs within the CPPM for (6) to positions in the argument structure is shown in (7).

- (7) AS: DAT NOM <experiencer_{DAT}, target-of-emotion_{NOM}>
 | | |
 CPPM: *[Britta]_{nom} *[das Buch]_{acc} gefallen hat

 STEP 3 DAT → Britta? ☺ NOM → [das Buch]? ☺

The upper line in (7) shows the features provided by the argument structure; the middle line shows the relevant part of the CPPM. The middle line of (7) also shows the result of matching the case features provided by the argument structure to the case features given in the CPPM. Within the CPPM, the first NP bears nominative case and the second NP accusative case. This follows from the first-pass parsing preferences alluded to above. As indicated in (7), comparing the case features in the AS to the case features in the CPPM leads to two mismatches. The first NP bears nominative case in the CPPM instead of dative case, as required by the verb; the second NP bears accusative case instead of nominative.

At this point, step 3 of the diagnosis algorithm will come into play. This step is depicted in the lower line in (7). For the two offending NPs, the HSPM has to determine whether these NPs would also be compatible with the case features provided by the argument structure. That is, it has to check whether the name *Britta* can morphologically license dative case and whether the NP *ein Buch* can license nominative case. For both NPs, the answer is positive and easily determined. 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 sum, the ease of processing a locally ambiguous sentence like (6), which ends in a verb with underlying OS-word order, is a function of two factors:

- The verb's argument structure transparently signals to the HSPM what revision operations are necessary to derive the correct OS-structure. The HSPM only has to make sure that the indicated revision operations are indeed legal.
- These latter processes, which involve determining whether the particular lexical items indeed allow for alternative feature assignments, do not pose any particular problems in (6). That is, step 3 of the ASBDA is easy to accomplish in sentences of this type. Note, however, that the claim is not that step 3 is always easy to accomplish. Instead, as will be argued in section 4, the ease of step 3 is a function of the particular features and lexical items involved.

We now turn to the processing of sentence (2b), which is repeated in (8).

- (8) (Ich will wissen), ob die Lehrerin die Eltern unterstützt haben.
 I want know whether the teacher the parents supported have
 "I want to know whether the parents have supported the teacher"

The argument structure provided by the verb *unterstützt haben* specifies again two arguments, in this case an agent argument bearing nominative case followed by a benefactive argument bearing accusative case. When this argument structure is projected onto the CPPM that has been computed for sentence (8) on first-pass parsing, the situation depicted in (9) results. Besides case features, (9) also shows the number features of the verb and the two NPs contained within the CPPM.

- (9) AS: NOM ACC <agent_{NOM}, benefactive_{ACC}>
 | | |
 CPPM: *[die Lehrerin]_{nom/singular} [die Eltern]_{acc/plural} unterstützt haben_{PLURAL}
 STEP 3: Plural → [die Lehrerin]? ☹

As for sentence (6), the CPPM for (8) contains a nominative NP followed by an accusative NP. As can be seen in (9), this distribution of case features matches the distribution required by the argument structure of the clause final verb. However, there is still a feature mismatch, namely with respect to the number features of the subject and the verb. Given that the verb is marked for plural, the NP assigned nominative case should be a plural NP. The NP *die Lehrerin*, however, is not a plural but a singular NP, giving rise to the indicated mismatch.

The next step the HSPM has to take consists in determining whether the offending NP could not also be a plural NP (cf. the lower line in (9)). Since the NP *die Lehrerin* is definitively a singular NP, step 3 of the ASBDA will not already deliver the correct syntactic structure for sentence (8). Instead, step 4 also has to be taken. Based on the information contained within the CPPM, the HSPM has now to search for an alternative syntactic structure. There are several factors that might contribute to the difficulty often found with sentences of type (8). First, the symptom signaling that the CPPM shown in (9) has to be revised is the number mismatch between the presumed subject, the first NP, and the clause-final verb. Fodor & Inoue (1999) have proposed that this is a negative symptom which only says that something has gone wrong without clearly indicating how things might improve. Second, as proposed by Bader & Meng (1999), the HSPM might have difficulties in entertaining the hypothesis that an OS-structure has to be computed because of the marked focus structure associated with the OS-structure of a sentence like (8).

I said above that in the simplest case the arguments provided by the verb will be mapped onto NPs within the CPPM in the order specified in the argument structure. As we have just seen, such a mapping leads to a straightforward account of how locally ambiguous base-generated and filler-gap OS-sentences differ from each other with respect to processes of diagnosis. What remains to be shown with respect to the ASBDA is how OS-sentences with unambiguously case-marked NPs are handled by this algorithm. For unambiguous OS-sentences I will assume that the HSPM has registered that the CPPM contains an object NP followed by the subject. When receiving the clause-final verb, it will therefore be prepared to link the NPs contained within the CPPM to positions in the verb's argument structure in a way deviating from the order specified within the argument structure. Consider for example the unambiguous OS-sentence (10).

- (10) (Ich will wissen), ob den Lehrer der Direktor unterstützt hat.
 I want know whether the teacher the director supported has
 „I want to know whether the director supported the teacher.“

In (10), an unambiguously accusative-marked NP has been moved in front of an NP which is unambiguously marked for nominative case. After the parser has incorporated the two NPs into the CPPM, it will know that the subject follows the object. When it then encounters the clause-final verb *unterstützt hat*, it can immediately conclude that the argument positions provided by this verb cannot be linked in the order specified within the argument structure - namely subject-before-object - but that instead the first NP has to be linked to the object-slot whereas the second NP has to be linked to the subject slot. In order to accomplish this linking pattern, the HSPM will insert a trace between the second NP and the verb, coindex this trace with the first NP and project the verb's argument structure on the resulting CPPM. Base-generated OS-sentences will be processed in

almost the same way, the exception being that the NPs contained within the CPPM can be linked to positions within the verb's argument structure without the extraneous step of trace-insertion.

This concludes our overview of how checking and diagnosis proceed in subject-object ambiguities. As the preceding discussion will have made clear, the ASBDA is not yet a fully determinate system. Some of the missing details will be filled in in the following sections. The next section will discuss a range of contrasts that provide further evidence for the basic organization of the ASBDA. Section 4 will then discuss findings pertaining to step 3. The basic claim of this section will be that even in situations where the necessary revisions are transparently signaled garden-path strength can vary substantially, if, for example, finding alternative lexical features turns out to be difficult. In section 5, we will turn to step 4 and discuss in more detail how garden-path recovery might proceed in filler-gap sentences.

3 Contrasts Deriving from the Basic Organization of the Diagnosis Algorithm

In this section further evidence for the basic architecture of the ASDBA will be presented. Section 3.1 will provide evidence against an alternative explanation of the facts on which the ASDBA has been grounded. Section 3.2 will then show that even within the class of filler-gap ambiguities, the distinction between step 3 and step 4 of the ASBDA is necessary to account for the whole range of garden-path effects.

3.1 The Role of the Verb's Argument Structure

The hypothesis that garden-path strength in subject-object ambiguities is heavily dependent on argument-structure properties goes back to ideas originally presented in Bader (1994). According to the first step of the ASBDA, on receiving the clause final verb the parser links each NP to a slot in the verb's argument structure. For base-generated OS-sentences, this linking transparently signals what should be done in order to arrive at the correct OS-structure. For filler-gap OS-sentences, in contrast, the initial linking does not already deliver the information necessary for computing the OS-structure. The major evidence for these assumptions comes from the finding that filler-gap sentences as in (8) cause a stronger garden-path effect than base-generated sentences as in (6). However, there might be a different explanation of the processing difference between sentences like (6) and sentences like (8), an explanation which obviates recourse to the notion of argument-structure transparency. Such an alternative explanation could make use of the fact that sentences like (6) differ from sentences like (8) not only with respect to argument structure properties but also with respect to semantic properties which arise from the different semantic constraints on the arguments in sentences like (6) and (8). In particular, the lexical entry for an OS-verb like *gefallen* does not only specify that the experiencer precedes the target-of-emotion but also that the experiencer must be linked to an animate NP whereas the target-of-emotion is semantically unconstrained. A verb like *unterstützen*, in contrast, has an agent argument preceding a benefactive argument where both arguments are confined to animate NPs.

When it comes to garden-path recovery, semantic constraints on the realization of particular argument roles might either strengthen the association of NPs with argument slots during step 1 of the ASBDA, or they might make some of the operations of the ASBDA superfluous:

(i) The fact that for a verb like *gefallen* the first argument has to be animate might simply strengthen the particular linking pattern shown in (7). That is, when linking NPs within the CPPM to argument slots within the argument structure during step 1 of the ASBDA, the HSPM can rely both on the order of arguments and on the semantic constraints on these arguments in order to effect the correct linking. For a verb like *unterstützen*, in contrast, the HSPM has to rely on order information alone in its initial argument linking.

(ii) The semantic differences between the two types of verbs might obviate any recourse to the notion of argument structure in explaining differences in garden-path strength. Given that a filler-

gap sentence like (8) contains two animate NPs, the SO-structure and the OS-structure are on a par with respect to semantic plausibility. Both structures would lead to a coherent reading. Therefore, the HSPM completely has to rely on syntactic information in order to resolve the ambiguity. A base-generated sentence like (7), in contrast, contains an inanimate NP followed by an animate NP. Together with the fact that the experiencer role must be realized by an animate NP, the parser might find the correct OS-structure by simply noting that only the OS-structure will lead to a plausible reading. In sum, the difference in garden-path strength between sentences like (7) and sentences like (8) might be a consequence of the fact that the HSPM can rely on semantic guidance in the former but not in the latter. Under this interpretation, recourse to argument-structure properties would be superfluous.

There are several pieces of evidence supporting the claim that the notion of argument-structure transparency is the crucial one in order to distinguish between garden-path effects in base-generated and filler-gap ambiguities. Consider first the sentences in (11), (12), and (13).

- (11) daß Max_{DAT/i} sogar die Lehrerin_{NOM} t_i geholfen hat.
 that Max even the teacher helped has
 "that even the teacher helped Max."
- (12) daß Max_{DAT} sogar die Lehrerin_{NOM} t_i gefallen hat.
 that Max even the teacher pleased has
 "that even the teacher pleased Max."
- (13) daß Max_{DAT} sogar das Gedicht_{NOM} gefallen hat.
 that Max even the poem pleased has
 "that even a poem pleased to Max"

In all three of these sentences, disambiguation is achieved by the case on the second NP. Whereas the first NP is three-way ambiguous (nominative, accusative, dative), the second NP is only two-way ambiguous (nominative, accusative). On first-pass parsing, all three will therefore be assigned an SO-structure with an accusative object. Since the clause-final verb requires a subject and a dative-object, this SO-structure has to be revised to an OS-structure with the object bearing dative case.

(11) and (13) are again instances of filler-gap and base-generated OS-sentences, respectively. Furthermore, these sentences have the same distribution of animacy features than the sentences considered above. Like (11), sentence (12) contains two animate NPs. Like sentence (13), (12) contains the verb *gefallen*. In terms of semantic constraints on argument linking, (12) is therefore on a par with sentence (11). However, it is not the case that (12) is on a par with sentence (13) in terms of argument structure properties. In the grammar of German, the basic word order of verbs like *gefallen* is strictly OS when the object is inanimate and the subject animate (which of course it is always). When the object is also animate, in contrast, these verbs are indeterminate with respect to their basic word-order: both SO and OS is possible.

If garden-path strength were completely determined by whether semantic considerations lead to the correct syntactic structure, sentences like (11) should not differ from sentences like (12) (no semantic guidance) and both should be more difficult than sentences like (13) (semantic guidance). In contrast, if argument structure transparency is the crucial factor in determining garden-path strength - as claimed by the ASBDA - , the prediction is that (11) should be more difficult than (12) which in turn should be more difficult than (13). Unpublished experiments investigating sentences like (11), (12), and (13) have shown the latter prediction to be correct, thereby supporting the claim that diagnosis is based on argument-structure properties.

However, this evidence is not as strong as one might wish because there is not only a partial correlation between basic-word order and animacy constraints, but also a partial correlation between basic-word order and information or focus structure. In particular, 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 NP 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. This difference might have contributed to the fact that sentences like (11) were the most difficult ones in the experiments just mentioned (cf. Bader & Meng, 1999). To eliminate any differences with respect to focus-structure properties, a further unpublished experiment has compared sentences like (14) to sentences like (15). In these sentences, there is no confounding with focus structure properties because the object is a pronoun and pronouns can be freely put in front of the subject without any consequences on the sentence's information structure.

(14) Maria sagte, daß sie die Lehrerinnen besucht haben.

Maria said that she the teachers visited have
 "Maria said that the teachers visited her."

(15) Maria sagte, daß sie die Lehrerinnen genervt haben.

Maria said that she the teachers annoyed have
 "Maria said that the teachers annoyed her."

Sentence (14) contains the verb *besuchen*, which is underlyingly SO. Sentence (15) contains the verb *nerven* which is again indeterminate between SO and OS. As before, our argument-structure based account predicts that (14) should produce a stronger garden-path effect than (15), and this is what was actually found (for more discussion of psych-verbs and sentence processing, cf. Scheepers, 1996; Scheepers, Hemforth, & Konieczny, 2000).

In summary, we have seen that the contrast between OS- and SO-sentences that was crucial in our development of the ASBDA cannot be reduced to differences in animacy constraints. Instead, argument structure properties are a crucial ingredient if the whole range of garden-path recovery has to be accounted for. What remains open given the correlation between animacy and basic word order seen for certain verb types, is whether animacy, or semantic constraints on argument-linking more generally, also have a role to play besides the fact that they contribute to the basic word order exhibited by a verb (for further discussion cf. the appendix).

3.2 Wh-Sentences and Mode of Disambiguation

So far, base-generated garden-path sentences have been handled by step 3 of the ASBDA whereas filler-gap garden-path sentences were the domain of step 4. It will now be shown that the stage where revision is supposed to occur is not simply a function of the syntactic structure of a sentence. Instead, one and the same syntactic structure might be handled on either step 3 or step 4 as a function of the particular symptom signaling the garden-path.

Consider the two sentences in (16a) and (16b).

(16) a. Welche Tante_i küßten die Lehrer t_i?

Which aunt kissed the teachers
 "Which aunt did the teachers inform?"

b. Welche Tante_i küßte der Lehrer t_i?

Which aunt kissed the teacher
 "Which aunt did the teacher inform?"

Syntactically, (16a) and (16b) are on a par. In both, the object has been moved to sentence initial position. What differs between (16a) and (16b) are the means by which the OS-structure is signaled to the HSPM. In (16a), the verb is marked for plural. Since the only plural-NP in this sentence is the second one, the first NP must be the object and the second one the subject. In (16b),

Critical to our explanation of the processing of sentence (16b) is the assumption that encountering the second, morphologically marked NP leads to an automatic relinking of the agent role from the first to the second NP. Without this assumption, we would end up with (20) instead of (19).

(20) AS:	NOM	<agent _{NOM} , patient _{ACC} >	ACC
CPPM:	[welche Tante] _{nom}	küßte	*[der Lehrer] _{nom}

STEP 3 ACC → [der Lehrer] ⊗

In (20), the error is located on the second NP and not on the first NP as in (19), with the consequence that in (20) the error cannot be remedied by a simple feature correction given that the second NP is unambiguously marked for nominative case.

While the assumption that the HSPM computes (19) instead of (20) does not follow from the ASBDA itself, there is at least some independent evidence for it. This evidence comes from an experiment investigating ungrammatical sentences like (21). In (21), both the first and the second NP are unambiguously marked for nominative case. As with (16b), the HSPM can register the case violation when the second NP is encountered.

- (21) *Welcher Junge küßte der Lehrer?
Which boy kissed the teacher

If there is indeed the kind of „bottom-up priority“ which leads to (19) when processing (16b), then attaching the second NP (21) should also have the effect that this NP is linked to the nominative-marked agent role. In consequence, the first NP will be linked to the accusative-marked patient role, resulting in a case violation on this NP. On the other hand, if no relinking occurs on encountering the second NP, a situation similar to (20) will result and the case violation will be located on the second NP. Meng and Bader (to appear) had subjects read sentences like (21) with the additional task of repeating the sentence in a corrected form. Most of the corrections turned the first NP into an accusative marked NP, suggesting that the error with sentences like (21) is indeed perceived to be located on the first NP, as predicted by the account given for (16b).

The finding that wh-sentences with a case symptom result in less severe garden-path effects than wh-sentences with a number symptom does not only hold for root clauses with the main verb in clause-second position, as in (16), but also for root clauses with the main verb in clause final position and an auxiliary in clause second position (cf. (23)), as well as for embedded wh-questions where all verbs a clause-final (cf. (22)). Because these contrasts involve sentences where disambiguation occurs before the main verb with its argument structure has been processed, the ASBDA has to be generalized somewhat in order to be also applicable in this situation.

- (22) a. Ich will wissen, welche Tante die Lehrer geküßt haben.
I want know which aunt the teachers kissed have
"I want to know which aunt the teachers kissed have"
- b. Ich will wissen, welche Tante der Lehrer geküßt hat.
I want know which aunt the teacher kissed has
"I want to know which aunt the teacher kissed has"
- (23) a. Welche Tante haben die Lehrer geküßt?
Which aunt have the teachers kissed
"Which aunt have the teachers kissed?"
- b. Welche Tante hat der Lehrer geküßt?
Which aunt has the teacher kissed
"Which aunt has the teacher kissed?"

Consider first the sentences in (22). The processing of sentence (22a) is completely analogous to the processing of (8). Sentence (22b), which is already disambiguated by the second NP, can be assimilated to the processing of sentence (16b) if we assume that the HSPM keeps some record about which cases have already been assigned. The *wh*-phrase in (22b) will first be assigned nominative case. When the second NP is encountered, nominative has to be assigned to this NP because of the unambiguous morphological marking, giving two nominative NPs within the clause. To remedy this situation, the nominative feature on the first NP will simply be switched to accusative case, and processing can again proceed smoothly. The two sentences in (23) would be handled in a similar way.

3.3 Summary: Positive and Negative Symptoms

In their discussion of garden-path recovery in subject-object ambiguities, Fodor & Inoue (2000) have distinguished between positive and negative symptoms. Positive symptoms are symptoms which guide the HSPM directly to the initial parsing error and thereby to the necessary revision. Negative symptoms, in contrast, signal that something has gone wrong without providing a direct hint as to the source of the error. As the discussion so far will have made clear, the distinction between positive and negative symptoms allows for an easy reconstruction in terms of the model proposed here. Positive symptoms are symptoms where the argument structure leads the HSPM to the necessary repair operations in a transparent way. Negative symptoms are symptoms without a transparent relation between argument structure and repair. In terms of the ASBDA, garden-path sentences containing a positive symptom can be repaired already on step 3 whereas search processes on step 4 have to be invoked for sentences with a negative symptom.

(24) and (25) summarize the garden-path sentences discussed so far in terms of whether the error is signaled by a case symptom or by a number symptom, with the processing stage at which repair is supposed to occur on the right-hand side (excluded from this summary are sentences which are also disambiguated by semantic constraints on argument linking, i.e. sentences with an animate and an inanimate NP).

(24) Disambiguation by case symptom

- | | |
|--|--------|
| a. ... daß Max sogar die Lehrerin gefallen hat. (= (12)) | Step 3 |
| b. Welche Tante küßte der Lehrer? (= (16b)) | Step 3 |
| c. ...daß Max sogar die Lehrerin geholfen hat. (= (11)) | Step 4 |

(25) Disambiguation by number symptom

- | | |
|---|----------|
| a. Maria sagte, daß sie die Lehrerinnen genervt haben. (= (15)) | Step 3/4 |
| b. Maria sagte, daß sie die Lehrerinnen besucht haben. (= (8)) | Step 4 |
| c. Welche Tante küßten die Lehrer? (= (16a)) | Step 4 |

As shown by the overview in (24) and (25), there is no simple correlation between type of symptom (case vs. number symptom) and the hypothesized stage of repair (and thereby informativeness of the symptom). This is of course as it should be if garden-path recovery is guided by argument-structure properties and not simply by surface properties like whether the garden-path is signaled by means of a case violation or number-agreement violation.

4 Factors Modulating Step 3 (Search for Alternative Feature Assignments)

According to the ASBDA, the first action which the HSPM should take after having detected a feature mismatch consists in determining whether the offending lexical items allow for alternative feature assignments (Step 3 of the ASBDA). If the HSPM finds such alternative assignments,

reanalysis is almost finished. However, there are several pieces of experimental evidence which indicate that finding alternative features is not always easy, and sometimes, they are not found at all, even if they exist. Two different situations where this happens have been identified to date:

- Sometimes the parser has to reaccess the lexicon in order to search for alternative feature assignments. Depending on the particular circumstances, lexical reaccess will succeed or not.
- Certain feature violations have the property that the HSPM tends to overlook the fact that a simple feature correction might lead to successful revision.

Evidence for these two points does not only stem from the processing of locally ambiguous sentences but also from the processing of certain sentences which are downright ungrammatical. This section will therefore discuss both temporary ungrammaticalities (garden-path sentences) and permanent ungrammaticalities (ungrammatical sentences).

4.1 Searching for Alternative Features: Lexical Reaccess

There are several instances of garden-path recovery where the HSPM has to make sure that the repair operations which are called for in order to arrive at the correct structure are compatible with the lexical items of the input string. For example, before the necessary revisions can be carried out in (26), the HSPM has to check that „raced“ is also a past participle. Otherwise, the HSPM couldn't distinguish between (26a) (reanalysis lexically allowed) and (26b) (reanalysis lexically prohibited).

- (26) a. The horse raced past the barn fell down.
 b. *The horse rode past the barn fell down.

In their discussion of this topic, Fodor and Inoue (1998) state that "the diagnosis model freely permits re-access of lexical entries, though it requires that, like all other adjustments, lexical reaccess must be specifically prompted by a prior step in the diagnosis process." However, this conclusion might have been premature. In the following, a range of „minimal pairs“ will be presented which are as close as possible with respect to diagnosis but which nevertheless differ with respect to ease of garden-path recovery. As will be argued, these minimal pairs strongly suggest that lexical reaccess might be costly even if it is invoked by a specific step of the diagnosis chain. A first instance where a difference in garden-path strength exists without differential ease of diagnosis is provided by the example pair in (27).

- (27) a. Wessen Mutter_{ACC} besuchte der Lehrer? (besuchen: <agent_{NOM}, goal_{ACC}>)
 whose mother visited the teacher
 "Whose mother did the teacher visit?"
- b. Wessen Mutter_{DAT} gratulierte der Lehrer? (gratulieren: <agent_{NOM}, benefactive_{DAT}>)
 whose mother congratulated the teacher
 "Whose mother did the teacher congratulate?"

Both sentences in (27) start with an NP (*Wessen Mutter*) which is completely case-ambiguous. Due to the subject preference in German, this NP will be assigned nominative case. This is compatible with the immediately following verb but not with the second NP. The second NP in (27) is unambiguously nominative marked and must therefore be attached as the subject of the clause. This will create a case-mismatch on the first NP which can no longer bear nominative case. As also indicated in (27), both the verb *besuchen* and the verb *gratulieren* have a single object, the difference being that *besuchen* assigns accusative case to its object whereas *gratulieren* assigns dative case. We therefore get (28) as the result of argument structure projection and checking of case features.

That lexical reaccess for a phrase like *Wessen Mutter* is particularly difficult, as witnessed by the results of Bader et al. (2000), might be due to the fact that dative case is rather indirectly licensed for such a phrase (cf. Bayer et al., to appear). However, the claim is not that this kind of checking operation is difficult per se. For example, when discussing the base-generated OS-sentence in (4)/(6), we already saw an instance where assigning dative case on second-pass parsing resulted only in a very modest garden-path effect. This was explained by assuming that lexical reaccess is relatively easy for proper names. More generally, the claim is that the ease of garden-path recovery in sentences where an NP has to be re-assigned dative case should be (either mainly or completely) a function of the ease of lexical reaccess.

If this were true, then we should also find that garden-path strength in base-generated OS-sentences of the sort already discussed above (cf. (4)/(6)) can vary depending on the lexical items which have to be reaccessed on second-pass parsing. One piece of evidence for this prediction comes from a comparison of base-generated OS-sentences as in (30).

- (30) a. daß Max_{DAT} ein Päckchen_{NOM} geschickt wurde.
 that Max a package sent was
 "that a package was sent to Max"
- b. daß ein paar Studenten_{DAT} mehrere Päckchen_{NOM} geschickt wurden.
 that a pair students several packages sent were
 "that several packages were sent to a couple of students"

Syntactically, the two sentences in (30) are identical to the base-generated sentences (4)/(6), the difference being that they contain a passivized verb instead of a psych-verb.³ As in the sentences considered above, the first NP in (30a), i.e. the NP which has to be assigned dative case, consists of a proper name. In (30b), in contrast, the first NP is an indefinite NP containing the composite determiner *ein paar* (similar to *a couple of* in English). With nouns without overt case inflection, an NP containing this determiner is as case ambiguous as a proper name. Note that the second NP and the finite auxiliary in (30b) have also been pluralized. This guarantees that neither of the sentences in (30) contains any number cue as to which NP is the subject.

When the clause final verb has been processed in either (30a) or (30b) and its argument structure projected onto the CPPM, the situation depicted in (31) will obtain.

(31) AS:	DAT	NOM	<goal _{DAT} , theme _{NOM} >
CPPM:	*NP1 _{nom}	*NP2 _{acc}	geschickt wurde(n)
STEP 3 DAT → NP1? ☺ NOM → NP2? ☺			

With respect to processes of diagnosis, the scheme shown in (31) is equivalent to the one shown above in (7). Under the assumption that the case-feature on the second NP can be changed without much effort, as suggested by the findings concerning sentences like (27a), the major task now consists in determining whether the first NP is lexically compatible with dative case or not. As an experiment reported in Bader (in prep.) has shown, sentences containing a proper name as first NP (cf. (30a)) cause a much weaker garden-path effect than sentences where the first NP is of the type *ein paar N⁰* (cf. (30b)). Since (30a) and (30b) are syntactically identical and involve the same kind of diagnostic reasoning, this finding strongly indicates that the task of reaccessing the lexicon is accomplished much easier for an NP like *Maria* than for an NP like *ein paar Studenten*.

There are several reasons that might contribute to lexical reaccess being easier for a proper name than for an NP of the form *ein paar N⁰*. For example, lexical reaccess may go astray because the first part of *ein paar* is identical with the nominative form of the singular masculine and neuter

³ For ease of presentation, I will treat the past participle and the passive auxiliary as a unit and simply speak of the (passivized) verb.

indefinite article. This might lead to the erroneous conclusion that *ein paar* is not compatible with dative case, which in fact it is given its frozen nature. For proper names, such a kind of confusion is not possible. Alternatively, or in addition, frequency might also play a role. According to a preliminary frequency count, the absolute frequency of use with dative case seems to be higher for proper names than for *ein paar*.⁴

4.2 Ignoring an easy way of repair

Given the first-pass parsing preferences found in German, a sentence containing a subject-object ambiguity is usually assigned a SO-structure on the first-pass. Consequently, a garden-path effect arises when disambiguation is towards the non-preferred OS-structure. To date, one major exception to this pattern has been identified: a subject-object ambiguity where an OS-structure is assigned on first pass parsing and where a garden-path effect therefore emerges if disambiguation is towards the SO-structure.

Consider the minimal-pair in (32). The sentences in (32) are both SO-sentences with the subject modified by a relative clause. In (32a), the relative pronoun bears accusative case, i.e. one of the structural cases of German. In (32b), the relative pronoun bears dative case.

- (32) a. daß Maria_{DAT}, die_{ACC} ich vorher getroffen habe, das Päckchen_{ACC} geschickt hat.
 that Maria who I before met have the package sent has
 "that Maria, who I met just a moment ago, sent the package"
- b. daß Maria_{NOM}, der_{DAT} ich vorher begegnet bin, das Päckchen_{ACC} geschickt hat.
 that Maria who I before met am the package sent has
 "that Maria, who I met just a moment ago, sent the package"

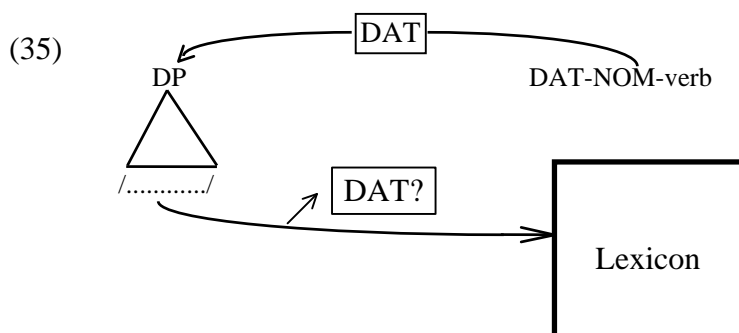
As various experiments have shown (cf. Meng & Bader, to appear; Bader & Meng, 1999), the dative feature on a relative pronoun might get erroneously attracted by its head noun. If this happens, the normally observed SO-preference turns into an OS-preference, with concomitant processing difficulties when an SO-structure is enforced by the clause-final verb. In contrast to dative, structural cases (nominative, accusative) are not attracted. With respect to the two sentences in (32), this means that performance on a sentence like (32a) does not differ from performance on the same sentence but without any relative clause at all. Performance on a sentence like (32b), in contrast, is greatly reduced. In other words, a SO-sentence containing a dative relative clause induces a garden-path effect, a SO-sentence containing an accusative relative clause (or a nominative relative clause, or no relative clause at all) does not.

SO-sentences like (32b) do not only elicit a garden-path effect, but - and this is the crucial observation for the current discussion - this garden-path effect is also much stronger than the one found in comparable OS-sentences. This has been found in experiments reported in Meng & Bader (to appear) who have compared sentences like (32b) to sentences like (33). (33) is again a base-generated OS-sentence (cf. (4b), (30)) which contains a relative clause in order to make it comparable in length to (32b).

- (33) daß Maria_{DAT}, die ich vorher getroffen habe, das Päckchen_{NOM} geschickt wurde.
 that Maria who I before met have the package sent was
 "that the package was sent to Maria, who I met just a moment ago"

How OS-sentences like (33) are processed in our model of checking and diagnosis has already been explained in detail. We can therefore immediately turn to SO-sentences like (32b) and ask

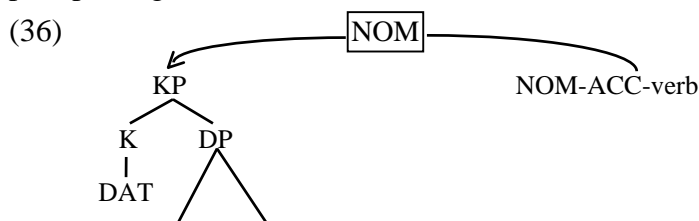
⁴ I consider it an open question as to whether frequency information on how often a lexical item is used with a particular case feature should be invoked to explain ease of lexical reaccess. A more thorough discussion of this topic will be given in Bader (in prep.).



(35) contains the following processing steps:

- Assignment of dative case to an NP bearing nominative case as a result of argument-structure projection (= Step 1 of the ASBDA)
- Registering the resulting case violation (= Step 2 of the ASBDA).
- Reaccessing the mental lexicon in order to make sure that the lexical items can license dative case, and revising the CPPM when lexical reaccess was successful.(= Step 3 of the ASBDA).

The mirror image, where nominative case has to be assigned to a dative marked NP on second pass parsing, is shown in (36).



In more detail, (36) comprises the following processing steps:

- Assignment of dative case to an NP bearing nominative case as a result of argument-structure projection (= Step 1 of the ASBDA).
- Registering the resulting case violation (= Step 2 of the ASBDA).
- Erroneously concluding that a simple feature correction is not possible (= Step 3 of the ASBDA)
- Possibly search for an altogether new syntactic structure (= Step 4 of the ASBDA)

The most important difference between (35) and (36) concerns the process of lexical reaccess which is postulated to occur in (35) but not in (36). The two kinds of case violations embedded in (35) and (36) can not only be found in garden-path sentences, where they are temporary violations, but also in truly ungrammatical sentences, where they are of a permanent nature. As the next section will show, the purported processing differences find strong support from experiments that have investigated corresponding ungrammatical sentences.

4.4 Corroborating Evidence from the Processing of Ungrammatical Sentences

Two sample ungrammatical sentences illustrating the two kinds of case violations under discussion are given in (37).

- (37) a. *... daß die Chefin das Buch geliefert wurde.
 that the boss the book delivered was
- b. *... daß der Chefin das Buch geliefert hat.
 that the boss the book delivered has

(37a) is an ungrammatical passive sentence, (37b) is an ungrammatical active sentence. The ungrammaticality stems from the fact that the NP *die Chefin* in (37a) is not compatible with dative

passive sentences (cf. (39)). For the definite feminine determiner, nominative and dative form overlap in just the first phoneme (*die* versus *der*); for the feminine possessive pronoun, overlap is much more extensive (*meine* versus *meiner*). In a range of experiments, sentences with possessive pronoun elicited considerable more errors than sentences with definite article.

(39) Definite NP versus Possessive Pronoun

*... daß {die /meine} Chefin das Buch geliefert wurde.
that the /my boss the book delivered was

Furthermore, error rates have also been shown to increase with increasing distance between the NP involved in lexical reaccess and the clause final verb (cf. (40)). This finding makes sense if the word form used in reaccessing the lexicon fades away with time.

(40) Long versus Short Sentence

*... daß die Chefin {am Montag um vier Uhr} das Buch geliefert wurde.
that the boss on Monday at four clock the book delivered was

A final example involves the distinction between morphological ambiguous and unambiguous NPs (cf. (41)). The feminine NP *die Chefin* is two-way ambiguous, the masculine NP *der Chef* is unambiguous. Sentences containing the former kind of NP elicited more errors in an experiment reported in Bader et al. (2000) than sentences containing the latter kind of NP. Bader et al. have attributed this finding to the two-way ambiguity inherent in feminine NPs which might lead to the erroneous conclusion that such an NP is also compatible with dative case if rechecking is not carried out careful enough to note that there is separate dative form (cf. Table 1)..

(41) Feminine NP versus Masculine NP

*... daß die Chefin /der Chef das Buch geliefert wurde.
that the boss (fem)/the boss (masc) the book delivered was

Let us now turn to the processing of ungrammatical active sentences. These sentences are processed according to the scheme shown in (36). According to (36), the HSPM will judge such sentences as ungrammatical without prior reaccess to the mental lexicon. This makes the crucial prediction that the factors that have been shown to affect ungrammaticality detection in ungrammatical passive sentences should have no effect on ungrammatical active sentences. This is indeed what has been found. The experiments which have investigated the sentences in (39), (40) and (41) also contained corresponding ungrammatical active sentences. For these, neither of the manipulations cited lead to a reliable difference: Neither sentence length, nor phonological similarity, nor the distinction between masculine and feminine NPs, had any influence on the accuracy with which ungrammatical active sentences were judged as ungrammatical.

In sum, evidence from the processing of ungrammatical sentences supports the hypothesis that there is a fundamental distinction between the two types of case violations discussed in this section: When dative case would have to be assigned to a nominative marked NP, lexical reaccess becomes necessary. Lexical reaccess is an error-prone process which is modulated by variables like the phonological similarity between correct and incorrect form, or the time passed since a lexical item was first encountered and the point where lexical reaccess starts. When, in contrast, nominative case has to be assigned to an NP already marked for dative case, the HSPM can immediately conclude that the sentence is ungrammatical. In particular, lexical reaccess is skipped over, and the same variables that have been shown to be at work in the reverse situation do not have any influence.

4.5 Step 3 of the ASBDA: Summary and Open Questions

In this section we have seen two related instances where garden-path strength varies despite identical or similar relations between the error and the symptom signaling the error. What do these

instances tell us with respect to the distinction between diagnostic reasoning and repair operations? Consider first those garden-path effects which involve the assignment of dative case to an NP which has been assigned nominative case on first-pass parsing. The experimental results cited above show that there is substantial variation with respect to the ease of garden-path recovery even if it is completely clear that the necessary repair operation consists in assigning dative case. However, ascribing this variation to variations in the cost of repair operations is not possible either. After all, assigning dative case (or inserting a KP) on second-pass parsing cannot be a difficult operation per se given that there are instances where this kind of repair operation leads to very subtle garden-path effects which can only be discovered experimentally.⁶ In sum, neither diagnosis nor repair can account for the observed variation in garden-path strength - as long as one considers these operations only with respect to the CPPM.

What seems to be called for is to broaden the notion of diagnosis. Implicitly, this has already been done by invoking the notion of lexical reaccess in order to explain why assigning dative case on reanalysis is sometimes easy and sometimes hard. Thereby, the discussion above has added further evidence to the claim that garden-path strength does not follow from repair operations being associated with different costs, but from the ease of diagnosing the correct structure, where diagnosis now comprises both reasoning processes operating on the syntactic structure and processes concerned with the retrieval of lexical information.

When turning to the reverse situation, where the HSPM has to assign nominative case to an NP that has - due to case attraction - been analyzed as a dative NP, it becomes more difficult to answer whether the rather strong garden-path effect seen in this situation should be explained in terms of diagnosis or in terms of repair. As already indicated in the discussion at the end of section 4.2, one can stay with the assumption that constraints on repair operations are unnecessary if one is willing to assume that certain feature clashes have the property that the HSPM tends to overlook the possibility of repairing the initial structure by simply replacing the incorrect feature with the correct one.

5 Factors Modulating Step 4 (Search for Alternative Syntactic Structure)

We now turn to instances of garden-path recovery which crucially involve step 4 of the ASBDA. As explained in section 2, these are typically locally ambiguous OS-sentences which contain a verb with an argument structure where the subject precedes the object. In terms of movement, these are OS-sentences where the object has been moved in front of the subject. As the experimental evidence reviewed in this section will show, sentences with an OS-structure derived by movement do differ widely with respect to the ease of garden-path recovery. When these differences are cast in terms of diagnosis versus revision, a kind of double-dissociation is revealed:

- There are contrasts in garden-path strength where the contrasting sentences differ with respect to the revision operations necessary to arrive at the correct structure but where the need to revise is signaled by the same symptom. However, the additional revision operations do not pertain to the syntax proper, but to the information structure component. These contrasts therefore provide further evidence for the claim that ease of garden-path recovery is not entirely dependent on syntactic diagnosis, but also on the consequences a syntactic revision has on non-syntactic representations.

⁶ This is especially clear in sentences like (i) which have shown to elicit a garden-path effect because the preferred accusative assignment to the NP *Peters Mutter* has to be revised on encountering the clause final dative verb. This garden-path effect is only a very minor one and not open to intuition (cf. Bader, 2000).

(i) Wir haben Peters Mutter schon am Sonntag gratuliert.
 we have Peter's mother already on Sunday congratulated
 „We congratulated Peter's mother already on Sunday“

interpretation with narrow focus on the subject. In (42) and (43), in contrast, the focus-structure computed on first-pass parsing needs no change on second-pass parsing. When the first NP is a pronoun, wide-focus is possible for both SO- and OS-sentences because pronoun movement to the position following the complementizer has no effects on a sentence's focus structure. When the first NP is a wh-phrase, one may assume that the wh-phrase is the focus of the sentence (cf. Culicover & Rochemont, 1993) both in SO- and OS-sentences. Given that narrow focus is overtly signaled, the HSPM will compute the correct narrow focus structure from the beginning and again no revision becomes necessary on second-pass parsing.

There are several pieces of corroborating evidence for the claim that a sentence like (44) causes a particular strong garden-path effect due to its marked focus structure. First of all, as reported by Bader, Meng and Bayer (2000), corresponding unambiguous OS-sentences (cf. (46b)) also have a processing disadvantage in comparison to unambiguous SO-sentences if they are presented with either no context at all or in out-of-the-blue contexts (i.e. contexts like „What happened“, „What have you been told“ etc.). This disadvantage disappears if the sentences are preceded by a supporting context (cf. (46a)). For sentences with pronouns, in contrast, unambiguous OS-sentences (cf. (46c)) do not differ from unambiguous SO-sentences in either out-of-the-blue or supporting contexts (cf. (46a)).

- (46) a. Wer hat den Onkel besucht? (Who visited the uncle?)
- b. Man hat mir erzählt, daß den Onkel die Kinder besucht haben.
 One has me told that the uncle the children visited have
 "I was told that the children visited the uncle."
- c. Der Onkel hat mir erzählt, daß ihn die Kinder besucht haben.
 the uncle has me told that him the children visited have
 "The uncle told me that the children visited him."

Furthermore, the strength of the garden-path effect observed in OS-sentences like (44) also depends on whether the sentence already contains some hints as to its marked focus-structure. For example, the OS-structure is easier to get if the second NP, i.e. the subject, is preceded by a focus particle (cf. (47a)) and the processing disadvantage of unambiguous OS-sentences is greatly reduced by this manipulation (cf. (47b)).

- (47) a. Man hat mir erzählt, daß Maria sogar die Kinder besucht haben.
 On has me told that Maria even the children visited have
 I was told that even the children have visited Maria.
- b. Man hat mir erzählt, daß den Onkel sogar die Kinder besucht haben.
 On has me told that the uncle even the children visited have
 I was told that even the children have visited the uncle.

Given that the subject has to be focused in an OS-sentence of the type considered here, a focus particle in front of the subject has the effect that the second NP can be identified as a focus already on the first-pass. Reanalysis then only involves the syntactic structure, but not the focus-structure.

Summing up this section, we have seen that finding the correct syntactic structure on step 4 of the ASBDA does not only depend on the syntactic symptom that signals the garden-path. Even when sentences are matched in terms of symptoms, garden-path strength may vary. In particular, the need to compute a marked focus-structure when this is not signaled within the input sentence seems to place a heavy burden on the process of garden-path recovery. In the discussion of base-generated OS-sentences, we have seen that there are not only constraints on syntactic diagnosis but also constraints with regard to non-syntactic diagnosis, namely with regard to the process of lexical reaccess. Although the latter process does not play a role in the sentences considered in this section, we again have to ask whether the focus-structure effect on reanalysis is best captured in terms of

constraints on diagnosis - albeit not syntactic constraints - or in terms of constraints on revision operations.

On the one hand, one might say that computing a marked focus structure really is a difficult operation, as witnessed by the fact that even unambiguous OS-sentences are at an disadvantage if the marked focus-structure is not signaled by a preceding context. On the other hand, it might be the case that computing a marked focus structure is not difficult per se but that the parser is more reluctant to make the necessary revisions when these revisions have pragmatic effects that are not supported by the current context. Under this interpretation, the disadvantage of unambiguous OS-sentences might not come about because they involve some kind of inherently difficult operation but because the HSPM is not secure that it has computed the correct structure if that structure is associated with unwarranted pragmatic implications. In favor of this interpretation, one might point out that when simply inserting a focus particle into an unambiguous sentence (cf. (47a)) reduces or even eliminates the problem with unambiguous sentences, than computing a marked focus-structure cannot be such a difficult operation at all. Tentatively, I will assume that the latter interpretation is the correct one, and that again we do not have to assume that particular revision operations are inherently costly.

5.2 Availability of Alternative OS-Structure II: Mode of Disambiguation

Whereas the sentences in the last section were matched with respect to processes of diagnosis, the sentences considered next are matched with respect to the revision operations that are necessary to arrive at the correct structure. Consider first the sentences in (48).

- (48) a. Ich glaube, daß Maria die Lehrerin geholfen hat.
 I believe that Maria the teacher helped has
 "I believe that the teacher has helped Maria"
- b. Ich glaube, daß Maria die Lehrerinnen geholfen haben.
 I believe that Maria the teachers helped have
 "I believe that even the teachers have helped Maria"

These sentences are OS-sentences which differ only in that the first sentence contains two singular NPs and ends in a singular auxiliary whereas the second sentence contains a singular NP followed by a plural NP and ends in plural auxiliary. These differences have the effect that the two sentences differ in terms of the informativeness of the symptom signaling the garden-path effect, as shown in (49).

- (49) a. AS: NOM/SING DAT geholfen hat
 CPPM: nom/sing *acc/sing
- b. AS: NOM/PLURAL DAT geholfen haben
 CPPM: nom/*sing *acc/plural

In (49a), there is only a case symptom: Since the article *die* is compatible with nominative and accusative case but not with dative case, the NP *die Lehrerin* cannot be the object of *geholfen* because this verb requires a dative object. Instead, the NP *Maria* has to be the object. With respect to case, what holds for (49a) does also hold for (49b). However, in addition to a case symptom (49b) does also contain a number symptom given that only the second NP is a plural NP which can agree with the clause-final plural auxiliary.

An unpublished experimental investigation of sentences like those in (49) revealed that (49a) is much more difficult to process than (49b). Given that these sentences do involve exactly the same kind of repair (namely assigning dative case to the first NP and nominative case to the second NP), this finding is a clear experimental demonstration that garden-path recovery is dependent on the symptom signaling the garden-path. However, there are still several possibilities as to why (49a) is

more difficult than (49b). Either a case symptom and an agreement symptom together are more effective than a case symptom alone, or an agreement symptom is simply more effective than a case symptom, or both.⁷

That an agreement symptom might be more effective than a case symptom when the HSPM is searching for an alternative structure on step 4 of the ASBDA could have the following reason. When the incorrectness of the SO-structure is signaled by a number symptom, the CPPM already contains the information that the second NP is a plural NP. This information might help the parser in concluding that the second NP should be assigned the subject role given the necessary number-agreement between subject and verb and the fact that the sentence ends in a verb marked for plural. When the incorrectness of the SO-structure is signaled by a case symptom, in contrast, the CPPM contains no direct hint as to the identity of subject and object. The CPPM contains a verb that is in need of a nominative and a dative NP and it contains a nominative NP which is not the ultimately correct subject-NP, but it does not contain a dative feature which might help in identifying the object. In figuring out how to correctly assign the two syntactic functions provided by the verb, a case symptom does not give the HSPM a cue as direct as the number cue given by a number symptom. Instead, that the first NP has to be assigned dative case only follows from the negative fact that the second NP is not compatible with dative case.

To get more information on this topic, the crucial comparison would have to involve sentences like (50).

- (50) a. Ich glaube, daß Maria eine Lehrerin geholfen hat. case alone
 I believe that Maria a teacher helped has
 "I believe that one of the teacher helped Maria"
- b. Ich glaube, daß Maria ein paar Lehrerinnen geholfen haben. agreement alone
 I believe that Maria a pair teachers helped have
 "I believe that a couple of teachers helped Maria"
- c. Ich glaube, daß Maria einige Lehrerinnen geholfen haben. case &
 agreement
 I believe that Maria some teachers helped have
 "I believe that some teachers helped Maria"

Sentence (50a) differs from sentence (49a) only in that the definite determiner has been replaced by an indefinite one. Since this does not effect the kind of symptom signaling the garden-path, sentence (50a) contains only a case symptom. In sentence (50b), the definite determiner of (49b) has been replaced by the indefinite determiner *ein paar*. As pointed out in the discussion of sentence (30b), this determiner is completely case ambiguous. Sentence (50b) therefore only contains an agreement symptom. Sentence (50c) is again like (49b) but with the indefinite determiner *einige*. In contrast to *ein paar*, *einige* is compatible with nominative and accusative case but not with dative case. Like (49b), (50c) therefore contains both a case and an agreement symptom.

By comparing sentences as in (49) one may inquire whether an agreement symptom is more effective than a case symptom ((49a) versus (49b)) and whether both symptoms together are more effective than a single symptom ((49a)/ (49b) versus (49c)). However, the experiment investigating sentences like (50) is still underway, and so no answers to these question are possible as yet.

⁷ Note that these are symptoms relative to step 4 of the ASBDA, and that the case symptoms considered here are not the same as the case symptoms discussed by Fodor & Inoue (2000) (which are case symptoms pertaining to step 3).

5.3 Step 4 of the ASBDA: Summary

This section has discussed a range of examples that are supposed to involve the search for an alternative syntactic structure on step 4 of the ASBDA. These examples were presented as minimal pairs (or triples) where either the symptom signaling the garden-path or the operations needed to revise the CPPM were held constant. Ease of garden-path recovery has been shown to vary in both cases:

- When the symptom is held constant, garden-path strength varies with focus-structure properties. In particular, garden-path recovery is hampered if a marked focus structure has to be computed on second-pass parsing.
- When repair is held constant, garden-path strength varies with the symptom(s) signaling the garden-path.

6 The Mismatch Effect, or What remains of "No Attempt at Reanalysis" ("Triage")?

In a certain sense, the account of garden-path recovery in subject-object ambiguities developed in this paper is a rephrasing of ideas originally presented in Meng and Bader (1997) in terms of diagnosis. The basic observation of Meng and Bader was that for some constructions there is a correlation between ease of garden-path recovery and the accuracy with which ungrammatical sentences are correctly rejected as ungrammatical. This correlation was captured in terms of the Mismatch Effect which is given in (51).

(51) The Mismatch Effect

Strong garden path sentences correspond to ungrammatical sentences whose (un)grammaticality can be detected reliably. Weak garden path sentences correspond to ungrammatical sentences whose (un)grammaticality is more difficult to detect.

We have already seen an example of the correlation that the Mismatch Effect is intended to capture when discussing the notion of lexical reaccess. The relevant examples are repeated in (52) and (53).

(52) a. daß Maria_{DAT}, die ich vorher getroffen habe, das Päckchen_{NOM} geschickt wurde.
that Maria who I before met have the package sent was
"that the package was sent to Maria, who I met just a moment ago"

b. *... daß die Chefin das Päckchen geschickt wurde.
that the boss the package sent was

(53) a. daß Maria_{NOM}, der_{DAT} ich vorher begegnet bin, das Päckchen_{ACC} geschickt hat.
that Maria who I before met am the package sent has
"that Maria, who I met just a moment ago, sent the package"

b. *... daß der Chefin das Päckchen geschickt hat.
that the boss the package sent has

The sentences in (52) are OS-sentences. (52a) is a locally ambiguous sentences giving rise to a mild garden-path effect. (52b) is an ungrammatical sentences containing the same kind of case violation as sentence (52) albeit in a permanent way; sentences of this kind are often erroneously accepted as grammatical. The sentences in (53) are SO-sentences. (53a) is locally ambiguous and a garden-path-sentence too, due to case-attraction from the relative pronoun to the first-NP. This garden-path effect is considerably stronger than the one elicited by sentence (52b). The ungrammatical sentence corresponding to (53a) is (53b); sentences like (53b) are reliably judged as ungrammatical.

How might the relation between garden-path strength and ungrammaticality detection be captured within a theory of the HSPM? Let us begin with the easy part of the Mismatch Effect, easy both with regard to garden-path recovery and with regard to theoretical analysis. Why do locally ambiguous passive sentences like (52a) give rise to only weak garden-path effects, and why are ungrammatical passive sentences often erroneously accepted as grammatical? According to the theory proposed here, diagnosis (via argument-structure projection) prompts the HSPM to start a process of lexical reaccess in order to determine whether the first NP in these sentences can license dative case. For (52a), it is easily determined that it can. For (52b), lexical reaccess sometimes reports that the first NP is compatible with dative case although in fact it is not, with the consequence that the sentence is then treated in the same way as sentence (52a), that is, the initial SO-structure is transformed into an OS-structure.

How does this account compare to the suggestion of Fodor & Inoue (to appear) that sentences like (52b) are sometimes erroneously accepted because of a hasty response, that is, a response that is based only on the first step of the diagnosis chain? In effect, there is only a small difference, namely with respect to the locus of the „hasty“ part of the explanation. According to the theory proposed here, the hasty part has been moved from the syntactic diagnosis process to the processes responsible for lexical reaccess. Errors with ungrammatical sentences like (52b) occur because the routines determining whether the first NP can license dative case or not are not always executed carefully enough. Given the experimental findings reviewed in section 4, this move seems inevitable.

When we now turn to the other part of the Mismatch Effect, according to which difficult garden path sentences correspond to ungrammatical sentences that are reliably rejected as ungrammatical, there seems to be more of a dispute, at least at first sight. When we first proposed the Mismatch Effect in Meng & Bader (1997), we claimed that for certain garden-path sentences, subjects do not judge sentences as ungrammatical after they have tried to reanalyse them and failed, but at a much earlier point in time, possibly almost immediately after the violation signaling the garden-path had been detected, that is, „without even an attempt at reanalysis“, as we then put it (cf. the notion of „triage“ of Fodor & Inoue, to appear). The related fact that corresponding ungrammatical sentences are judged as ungrammatical with high accuracy was explained in a similar way, by assuming that the parser does not try to reanalyse such sentences, which means in particular that it does not erroneously repair them, as is supposed to occur with sentence like (52b), for example.

A main part of the evidence leading to this description came from a comparison of reaction times for correct responses (i.e. response „grammatical“) and incorrect responses (i.e. response „ungrammatical“) to garden-path sentences. Consider first the reaction time pattern that is typical for weak garden-paths. Figure 1 shows reaction times to unambiguous passive sentences without a relative clause, to ambiguous passive sentences as in (52a), and to ungrammatical passive sentences as in (52b) (the results shown in Figure 1 and Figure 2 are from Meng & Bader, to appear). For ambiguous and ungrammatical sentences, reaction times for both the response „grammatical“ and the response „ungrammatical“ are shown (for unambiguous control sentences, there were too few responses „ungrammatical“ to draw any conclusions).

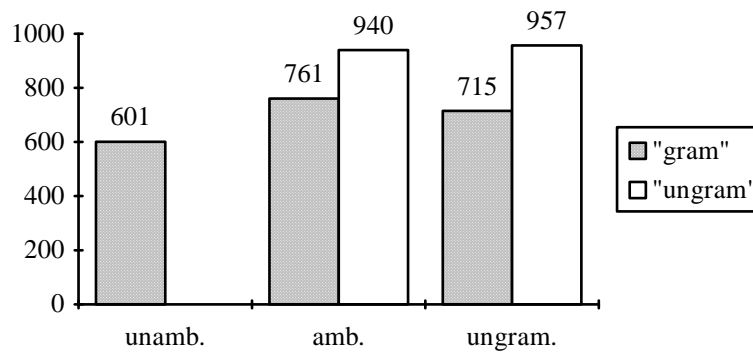


Figure 1

Two points should be noted with regard to Figure 1. First, when an easy garden-path sentence like (52a) is nevertheless judged as ungrammatical, this takes considerably more time than when it is correctly judged as grammatical. In terms of the model proposed here, this is as it should be. A sentence like (52a) will be judged as grammatical when, on step 3 of the ASBDA, lexical reaccess has signaled that the first NP is compatible with dative case. Only in the relatively rare instances where lexical reaccess failed, a more elaborate search process on step 4 will be triggered which will give rise to the prolonged reaction times for the response „ungrammatical“. A second point to note with respect to Figure 1 is that there is a close match between reaction times for ambiguous and unambiguous sentences when considered in terms of response „grammatical“ versus response „ungrammatical“ (instead of correct versus incorrect response). This is also in line with the proposed model given that - for both types of sentences - a response „grammatical“ follows from „successful“ lexical reaccess whereas a response „ungrammatical“ follows when lexical reaccess failed.

Figure 2 shows reaction times for active sentences of the sort given in (52) (unambiguous sentences without a relative clause, ambiguous sentences like (52a) and ungrammatical sentences like (52b); for the latter, only reaction times for the response „ungrammatical are shown“ because there were too few responses „grammatical“).

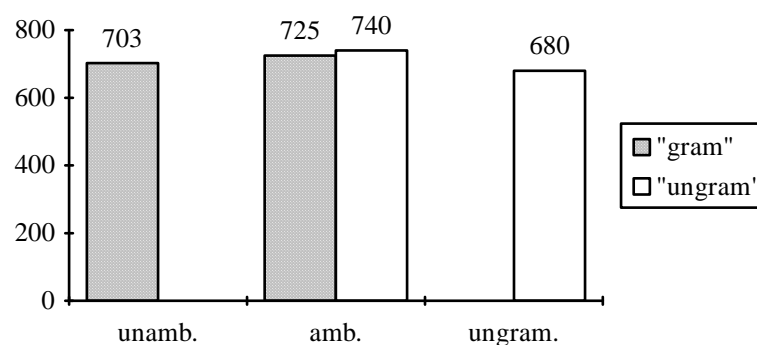


Figure 2

As one can see from Figure 2, reaction times for all responses under consideration are almost equal. When interpreting this finding, one has to take into account that the garden-path effect in (52a) derives from case attraction and not from the normal first-pass preferences found for subject-object ambiguities. Under the assumption that case attraction is a probabilistic process, the data shown in Figure 2 can be described as follows: When dative case is not attracted, the ambiguous sentence (52a) is assigned a simple SO-structure which gives rise to the response „grammatical“ at the end of the sentence. The time for this response does not differ from the time needed for a

control sentence without a relative clause. When dative case is attracted, a case violation arises at the end of the sentence. On encountering this violation, the HSPM judges the sentences as ungrammatical almost as quickly as it does with truly ungrammatical sentences.

Another example of a strong garden-path effect is provided by the examples in (54). The sentences in (54) are ordinary filler-gap OS-sentences. The locally ambiguous sentences (54b) is therefore assigned an SO-structure on the first-pass by the normal parsing preferences at work in German, so no complications of the sort seen for (52a) arise in this case.

- (54) a. Peter hat mir erzählt, daß ihn die Kinder besucht haben.
Peter has me told that him the children visited have
"Peter told me that the children visited him"
- b. Maria hat mir erzählt, daß sie die Kinder besucht haben.
Maria has me told that she/her the children visited have
"Maria told me that the children visited her"
- c. *Peter hat mir erzählt, daß er die Kinder besucht haben.
Peter has me told that he the children visited have
"Peter told me that he have visited the children"

The reaction time pattern for the sentences in (54) is shown in Figure 3 (cf. Bader, 1995). Again, reaction times for both types of responses are only shown for ambiguous sentences.

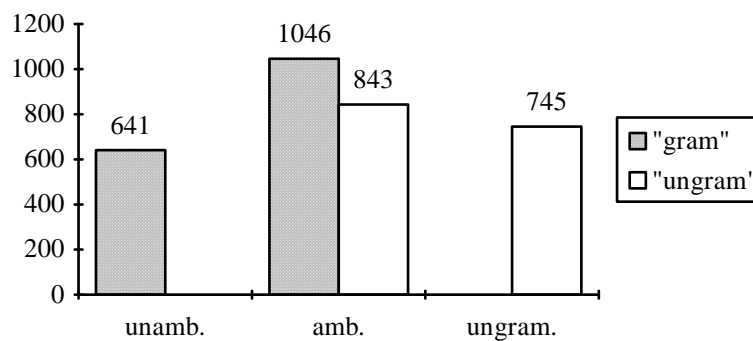


Figure 3

As Figure 3 shows, when an ambiguous sentence is judged as ungrammatical, this takes much less time than when it is judged as grammatical. Given that judging an ambiguous sentence as ungrammatical still takes somewhat more time than judging an ungrammatical sentence as ungrammatical, the data in Figure 3 can be described as follows: When the parser encounters the disambiguating clause-final auxiliary in (54b), it detects a (temporary) violation of subject-verb agreement. Having detected this violation, reanalysis is started. However, often reanalysis is disrupted at a rather early point, leading to relatively fast judgments „ungrammatical“. Only when reanalysis is completed in a time consuming process, as reflected in rather long reaction times, will the response „grammatical“ result.

It were data like those in Figure 2 and Figure 3 that let us to propose that sometimes garden-path sentences are judged as ungrammatical „without an attempt at reanalysis“, although Figure 3 already suggests that a more cautious description should be „without a thorough attempt at reanalysis“. To turn this description into a processing account, we would have to answer at least the following two questions: (i) At what point of time is the processing of a garden-path sentence disrupted, and (ii) what factors determine whether it is disrupted, or whether reanalysis is taken to its end? With respect to the first question, the general answer within the model proposed here would be that when processing a garden-path sentence is prematurely disrupted, this will occur only after

the HSPM has concluded that the sentence cannot be repaired by some kind of feature correction, that is, when the processes thought to occur on step 3 of the ASBDA were not successful and therefore some more elaborate diagnosis process is called for on step 4.

The next question then is what factors determine whether the HSPM will engage in a search for an alternative structure on step 4, or whether it will give up without an attempt at reanalysis, or without a further attempt at reanalysis, as we should say now, given that a first attempt was already undertaken on step 3. As pointed out by Fodor & Inoue (to appear), answering this question is a major challenge to the theory proposed by Meng & Bader (1997). Actually, this was clear from the beginning although it was not discussed properly. In particular, there was the finding that OS-sentences disambiguated by an agreement symptom do differ in garden-path strength depending on information-structure properties (cf. section 5.2 and Bader & Meng, 1999). For example, sentences with pronoun movement as in (54b) cause a relatively strong garden-path effect, but sentences where a definite NP has been moved in front of the subject (cf. (55a), repeated from above) produce an even stronger one.

- (55) a. Man hat mir erzählt, daß die Tante die Kinder besucht haben.
 One has me told that the aunt the children visited have
 "I was told that the children visited the aunt"
- b.*Man hat mir erzählt, daß der Onkel die Kinder besucht haben.
 One has me told that the uncle the children visited have
 "I was told that the uncle have visited the children"

Nevertheless, when comparing performance on corresponding ungrammatical sentences like (54c) and (55b), no significant differences were found. This is of course not too surprising because ungrammatical sentences of this sort are presumably perceived as simple SO-sentences with a violation of subject-verb-agreement, so that focus-structure differences pertaining to corresponding OS-sentences do not come into play at all. Finding no difference between ungrammatical sentences like (54c) and (55b), but finding a difference for corresponding garden-path sentences as in (54b) and (55c), implies that the decision of trying to reanalyse or giving up at an early point cannot be a function of the type of violation alone. Furthermore, as pointed out by Fodor & Inoue (to appear), even for difficult garden-path sentences one finds a difference between garden-path sentences and downright ungrammatical sentences insofar as the former are judged as grammatical more often than the latter. Therefore, subjects cannot reject sentences by taking into account only the violation itself - they also have to somehow be sensitive of whether a sentence allows for a repair or not.

The upshoot of all these considerations is that we need a model which allows for the HSPM to quit from reanalysis way before the search for an alternative structure has been completed, but where the decision to quit depends on properties of the input sentence that go beyond the particular type of feature violation. Stating the problem this way seems to make the theory originally proposed by Meng and Bader (1997) to look rather similar to proposals in Fodor and Inoue (to appear). In their discussion of this topic, they propose that premature „ungrammatical“-responses to garden-path sentences result if the first steps of the diagnosis chain do not lead to successful local revisions. Given the reformulation of the proposals in Meng and Bader (1997) in terms of the ASBDA, we have now reached a position very similar to the position of Fodor and Inoue. Furthermore, both theories seem to be beset with the same problems. For example, why does the HSPM sometimes, but not always, give up if the first steps of the diagnosis chain do not lead to an immediate improvement? Furthermore, what distinguishes sentences like (54b) and (55c) from each other, given that they set the same kind of diagnostic reasoning into motion?⁸

⁸ Note that this problem is not peculiar to tasks like speeded-grammaticality judgements. For rather strong garden-path sentences, participants also make a substantial amount of errors when they have to answer questions in self-paced reading experiments, which suggests that reanalysis sometimes, but not always, did not succeed

the HSPM being more successful at finding an alternative syntactic structure than an alternative semantic structure, or it might simply be a consequence of the fact that (56b) allows both for a semantic and a syntactic revision whereas only a semantic revision is possible in (56c).¹⁰

7 General Summary

In the introduction to this paper I cited three questions that Mitchell (1994) has raised with respect to the checking routines that have to supplement the assembly processes computing phrase-structure representations. How do these questions, which are repeated in (24), get answered within the model proposed in this paper?

- (57) (i) Do checking operations operate without delay, and are there different kinds of tests applied in a consistent order?
- (ii) 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?
- (iii) Can the substructures from a rejected analysis be kept so that they can be built into a new structure?
- (i) The model assumes that checking operations operate without delay. While any particular order of tests in the narrow sense (i.e. case and agreement checking) could not be established, in a wider sense an order has been imposed: First, NPs within the CPPM are linked to positions within the verb's argument structure, and only after this linking has been effect do the particular test operations for case and agreement apply.
- (ii) The answer to this question is clearly yes, in particular for garden-path sentences which can already be revised on step 3 of the ASBDA. For such sentences, the repair operations needed to arrive at the correct structure follow directly from the outcome of the checking operations.
- (iii) This question also gets a positive answer. For the type of garden-path sentences considered in this paper, reanalysis often consists in a simple feature correction so that the phrase-structural skeleton can be completely retained. For those sentences where reanalysis involves more than a feature correction, most of the prior substructure (e.g., parsing into NPs) can also be retained, and only some minor revisions are called for (mostly structure additions like inserting a trace or embedding an NP into a KP).

Having seen how the questions raised by Mitchell (1994) are answered by our model, as a final question we will consider in what relationship the model proposed here stands to the "standard diagnosis model" of Fodor & Inoue. The checking and diagnosis model proposed in this paper is a diagnosis model in the general sense that it attributes variation in garden-path strength to constraints on diagnosis and not to the inherent cost associated with particular repair operations. In this regard, the model is in line with the original diagnosis model of Fodor & Inoue (eg. 1994, 1998). The most important differences that distinguish the model proposed here from the diagnosis model of Fodor & Inoue are instances where diagnosis in a narrow sense, that is, diagnosis operating on the CPPM alone, has to be supplemented by diagnostic processes outside of the parser proper.

¹⁰ These two possibilities might be distinguished by comparing sentences like (56b) to sentences like (i). In (i), *sie* obligatorily has to be coindexed with the topicalized proper name since otherwise an ungrammatical sentence would result (cf. (ii)).

(i) Was Maria betrifft, so wurde erzählt, daß sie die Kinder besucht haben.

what Maria concerning, so was told that she the children visited have

(ii) *Was Maria betrifft, so wurde erzählt, daß mich die Kinder besucht haben.

- Besides a process of syntactic diagnosis, a kind of lexical diagnosis (i.e. lexical reaccess) is needed. This is shown both by results on locally ambiguous sentences and by results on ungrammatical sentences.
- As witnessed by the contrasts involving focus-structure differences, arriving at an OS-structure can also be hampered if this structure has pragmatic consequences that are not warranted by the current context. As discussed above, the reason for this is probably not that certain kind of focus-structures are inherently difficult to compute, but that the HSPM is not secure that it has found the correct structure if that structure is associated with unwarranted pragmatic implications.

Appendix: An alternative formulation of linking NPs within the CPPM to slots within the verb's argument structure

The first step of the ASBDA says: Link each NP within the CPPM to a position within the verb's argument structure. This step is responsible for the fact that (58a) (base-generated OS sentence) is linked as shown in (45a) and (58b) (filler-gap OS sentence) as shown in (45b).

(58) a. daß Britta_{DAT} das_{NOM} Buch gefallen hat.
 that Britta the Buch pleased has
 that the book pleased Britta"

b. daß Max_{DAT/i} sogar die Lehrerin_{NOM} t_i geholfen hat.
 that Max even the teacher helped has
 "that even the teacher helped Max."

(59) a. AS: DAT NOM <θ₁_{DAT}, θ₁_{NOM}>
 | | |
 CPPM: *NP1_{nom} *NP2_{acc} gefallen hat

STEP 3: DAT → NP1? ☺ NOM → NP2? ☺

b. AS: NOM DAT <θ₁_{DAT}, θ₁_{NOM}>
 | | |
 CPPM: NP1_{nom} *NP2_{acc} geholfen hat

STEP 3: DAT → NP2? ☹

According to this linking, (45a) contains two errors, but both are easily repaired by two simple feature corrections. (45b) contains only a single error, but this error does not allow for a simple feature correction. To achieve this linking, I have assumed that NPs within the CPPM are linked to positions within the verb's argument structure in such a way that the first NP within the CPPM is linked to the first argument within the argument structure, and the second NP to the second argument. Together with the assumption that *gefallen* has OS as basic word order, whereas *geholfen* has SO, the linking shown in (45) results.

This way of argument linking has to assume that the HSPM has to treat unambiguous OS-sentences like (60) in a special way. In particular, one has to assume that the HSPM registers that (60) is an OS-sentence so that the arguments of *geholfen* can be immediately linked in a non-canonically way. Otherwise, our theory would predict that such sentences should pose the HSPM some major problems, which they however do not.

- (60) daß dem Schüler_{DAT/i} sogar die Lehrerin_{NOM} t_i geholfen hat.
 that the pupil even the teacher helped has
 "that even the teacher helped the pupil."

An alternative formulation of the initial linking of NPs to argument slots which makes any special provisos for unambiguous OS-structures unnecessary is provided in (61) (for the moment being, (61) only takes into account verbs with two NP-arguments).

(61) Step 1

Link the subject theta-role of the argument-structure to the subject-NP within the CPPM (identified by its nominative case feature and/or its position within SpecIP) if the animacy requirements of the subject theta role match the animacy feature on the subject-NP. Otherwise, assign the object-theta role to the subject-NP.

Step 2

Link the theta-role not yet linked on step 1 to the other NP within the CPPM.

It is not easy to distinguish empirically between (61) and the linking given in the main text. One possibility might be provided by globally ambiguous sentences like (62).

- (62) Werner hat Claudia gefallen.
 Werner has Claudia pleased
 Either "Werner pleased Claudia" or "Claudia pleased Werner"

Given the indeterminacy of the argument-order when both arguments are animate, linking according the order specified within the argument structure leads to the prediction that there should be no clear preference when reading a sentence like (62). The scheme proposed in (61), in contrast, seems to make the prediction that the SO reading should be the preferred one. The question of what structure is preferred for a sentence like (62) is currently under investigation, using sentences like (63a) and (63b), where the final NP disambiguates the globally ambiguous initial clause either towards a SO- or an OS-structure.

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

8 References

- Bader, M. (1994). Sprachverstehen: Syntax und Prosodie beim Lesen. (Language comprehension: syntax and prosody in reading). Doctoral dissertation, University of Stuttgart.
- Bader, M. (1995). Reanalysis and the Modularity of the Human Sentence Processing Mechanism". Poster presented at the Conference on Architectures and Mechanisms for Language Processing, University of Edinburgh.
- Bader, Markus (2000) The Role of Memory Load in Syntactic Ambiguity Resolution: A Reply to Gibson (1998). Unpublished manuscript.
- Bader, Markus (in prep.) Accessing Lexical Information During Reanalysis: An Integrated Model of the Processing of Temporary and Permanent Case Violations.
- Bader, M., & Meng, M. (1999). Subject-object ambiguities in German embedded clauses: an across-the-board comparison. Journal of Psycholinguistic Research, 28, 121-143.

- Bader, M., Bayer, J., Hopf, J.-M., & Meng, M. (1996). Case-Assignment in processing German verb-final clauses. In Proceeding of the NELS 26 Workshop on Sentence Processing, MIT Occasional Papers in Linguistics, Vol 9, pp 1-25.
- Bader, M., Meng, M., & Bayer, J. (2000): Case and reanalysis. Journal of Psycholinguistic Research, 29, 37-52.
- Bayer, J., Bader, M., & Meng, M. (to appear). Morphological underspecification meets oblique case: Syntactic and processing effects. To appear in *Lingua*.
- Culicover, P., & Rochemont, M. (1993). Stress and focus in English. Language, 59, 123-165.
- de Vincenzi, M. (1991). Syntactic parsing strategies in Italian. Dordrecht: Kluwer.
- Fanselow, G. (to appear). Features, theta-roles, and free constituent order. To appear in: *Linguistic Inquiry*.
- Fodor, J.D., & A. Inoue (1994). The diagnosis and cure of garden paths. Journal of Psycholinguistic Research, 23, 407-434.
- Fodor, J.D., & Inoue, A. (1998) Attach Anyway. In: J.D. Fodor & F. Ferreira (Eds.) Reanalysis in sentence processing, pp.101-141. Dordrecht: Kluwer.
- Fodor, J.D., & Inoue, A. (2000) Syntactic features in reanalysis: positive and negative symptoms. Journal of Psycholinguistic Research, 29, 37-52.
- Fodor, J.D., & Inoue, A. (to appear) Garden-path repair: Triage and diagnosis. To appear in *Language and Speech*.
- Frazier, L. (1987b). Syntactic processing: Evidence from Dutch. Natural Language and Linguistic Theory, 5, 519-559.
- Gorrell, P. (1995). Syntax and parsing. Cambridge: Cambridge University Press.
- Grimshaw, J. (1990). Argument structure. Cambridge, MA: MIT Press.
- Haider, H., & Rosengren, I. (1998). Scrambling. *Sprache und Pragmatik, Arbeitsberichte*, Nr. 49.
- Kiparsky, P. (1973). „Elsewhere“ in phonology. In: S. Anderson & P. Kiparsky (eds.) A Festschrift for Morris Halle, pp. 93-106. New York: Holt, Rinehart & Winston.
- Konieczny, L., & Hemforth, B. (Eds.) (2000). German sentence processing. Dordrecht: Kluwer.
- Levin, B., & M. Rappaport Hovav (1995). Unaccusativity. At the syntax-lexical semantics interface. Cambridge, MA: MIT Press.
- Meng, M. (1997). Grammatik und Sprachverarbeitung: Psycholinguistische Untersuchungen zur Berechnung syntaktischer Strukturen. (Grammar and language processing: psycholinguistic investigations of computing syntactic structures). Doctoral dissertation, University of Jena.
- Meng, M., & Bader, M. (1997). Garden-path phenomena and ungrammaticality detection: A new look at German subject-object ambiguities. Manuscript, University of Jena.
- Meng, M., & Bader, M. (in press). Mode of disambiguation and garden path strength: An investigation of subject-object ambiguities in German. To appear in *Language and Speech*.
- Meng, M., & Bader, M. (to appear). Ungrammaticality detection and garden path strength: evidence for serial parsing. To appear in *Language and Cognitive Processes*.
- Mitchell, D.C. (1994). Sentence parsing. In: M.A. Gernsbacher (Eds.), Handbook of Psycholinguistics, pp. 375-409. San Diego, CA: Academic Press.
- Scheepers, C. (1996). Menschliche Satzverarbeitung: Syntaktische und thematische Aspekte der Wortstellung im Deutschen. (Human sentence processing: syntactic and thematic aspects of word order). Doctoral dissertation, University of Freiburg.
- Scheepers, C., Hemforth, B., & Konieczny, L. (2000). Linking syntactic functions with thematic roles: Psych-verbs and the resolution of subject-object ambiguity, pp. 95-135. In: B. Hemforth & L. Konieczny (eds.) *German sentence processing*. Dordrecht: Kluwer.
- Sturt, P., & Crocker, M. (1998). Generalized monotonicity. In: J.D. Fodor & F. Ferreira (Eds.) Reanalysis in sentence processing. Dordrecht: Kluwer.
- Vallduví, E., & Engdahl, E. (1996). The linguistic realization of information packaging. Linguistics, 34, 459-519.

Vogel, R., & Steinbach, M. (1995): On the (absence of a) base position for dative objects in German. In: FAS Papers in Linguistics Vol. 4. S. 99-131.