

Case Attraction Phenomena in German

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Abstract

In this paper we investigate how case features are represented and processed during language comprehension. To this end, we explored the phenomena of case attraction in German in a series of four experiments using a speeded grammaticality judgment procedure. Case attraction leads to errors that are akin to subject-verb agreement errors intensively studied in English and other languages (e.g. Bock & Miller, 1991): Under certain circumstances, the case feature of a nominal phrase is erroneously replaced by the case feature of an adjacent relative pronoun with the result that the clause as a whole is perceived to contain a case error. In our experiments, we varied whether the head noun was morphologically case ambiguous or not and whether the case on the relative pronoun was a marked case or an unmarked one. The results revealed the following: (1) Case attraction errors occur independent of whether the head noun is morphologically compatible with the case supplied by the relative pronoun or not. (2) Marked case features can overwrite unmarked case features but not the other way round, where markedness is defined with respect to the syntactic case patterns found in the language. These results, which are similar to what has been found for subject-verb agreement errors, suggest that the syntactic representations computed by the human sentence processing mechanism reflect the syntactic markedness distinctions within the case system but does not encode information about morphological ambiguity.

Keywords

Sentence Comprehension, Parsing, Case, Attraction Errors

Introduction

Current research into the Human Sentence Processing Mechanism (HSPM) has led to numerous insights about the computation of phrase-structure representations during sentence comprehension (cf. Mitchell, 1994, for a recent overview). However, the process of syntactic analysis cannot stop with a pure phrase-structural representation. Such a representation is not complete as long as it does not contain a certain distribution of syntactic features. In English, for example, subject and verb have to agree in their specification of number features. Therefore, the HSPM does not only have to attach subject and verb to their respective positions within the ongoing phrase-structure tree, but also has to check whether subject and verb agree with respect to number.

In this paper, we will be concerned with a further type of syntactic features, namely case features. While these play only a minor role in English (but see Traxler & Pickering, 1996), they are of special importance in languages which have a more elaborate case system than English and which, at the same time, rely on morphological case markings in order to identify syntactic functions like subject or object. In German, the language under investigation in this paper, the position of subject and object is much less constrained than in English. Therefore, the correct analysis of a sentence often depends on case morphology. For example, the fact that in sentence (1a) the first NP is the subject and the second NP the object whereas the reverse holds in sentence (1b) can only be determined by taking case morphology into account.

(1) a. Der Professor hat den Lehrer besucht.

The-NOM professor has the-ACC teacher visited

"The professor visited the teacher."

b. Den Professor hat der Lehrer besucht

The-ACC professor has the-NOM teacher visited

"The teacher visited the professor."

Despite its importance for successful language comprehension, the representation and processing of case has not played an important role in investigations of the HSPM. Most psycholinguistic research on German has considered case only insofar as case-morphology provides a means to create unambiguous control sentences in experiments investigating the processing of ambiguous sentences (cf. Hemforth & Konieczny (in press) for a recent overview of research on parsing German). Only recently has the question as to what role case features might play during language comprehension become a research topic of its own (cf. e.g. Hopf, Bayer, Bader & Meng, 1998; Meng & Bader, in press; Schlesewsky, 1996).

With respect to the representation and processing of number features, so-called attraction errors have provided a main source of evidence (cf. Bock & Cutting, 1992; Bock & Miller, 1991; Eberhard, 1997; Nicol, 1995; cf. Nicol, Forster & Veres (1997) for an application to language comprehension). An example of an attraction error is provided in (2a) (taken from Bock & Cutting, 1992). In this example, verb and subject do not agree in their number specifications. Instead, the verb seems to erroneously agree with the embedded NP the history books. An important finding with respect to number attraction errors has been that there exists an asymmetry between singular and plural. Whereas errors as in (2a) are produced with some frequency, the reverse kind of error, which is shown in (2b), rarely occurs.

(2) a. *The editor of the history books are ...

b. *The editors of the history book is ...

According to Nicol (1995) (cf. Eberhard, 1997), attraction errors as in (2) result from the plural feature on history books percolating to the noun editor, thereby turning the subject NP into a plural NP. When this has happened, plural marking on the verb is an automatic consequence. The further finding of an asymmetry between singular and plural number, as witnessed by the more frequent occurrence of errors like (2a) in comparison to errors like (2b) - has been traced back to the fact that plural is the marked category within the English number system whereas singular is the unmarked, default number specification. According to Eberhard (1997), plural as the marked category is represented by a specific plural feature - a plural flag - within the syntactic representation. It is this plural flag which is erroneously attracted in errors like (2). Singular, in contrast, is the default number specification and lacks a featural representation. Therefore it cannot be attracted and errors as in (2b) rarely occur.

In German, a further kind of attraction error exists: errors which occur during language comprehension and which involve case features (cf. Bader, 1994, 1997; Schlewsesky, 1996). As will be described in detail below, under certain circumstances the case feature of a NP seems to be overwritten by the case feature of an adjacent relative pronoun. When this happens, a sentence which is completely grammatical according to the grammar of German will erroneously be perceived as ungrammatical. Since it looks as if the NP has attracted the case feature of the relative pronoun, we have termed this phenomenon CASE ATTRACTION.

In this paper, we will report four experiments that have used the phenomenon of case-attraction in order to further our understanding of the representation and processing of case. These experiments will focus on the following two questions. First, how independent are case features within the ongoing phrase-structure representation computed by the human sentence processing mechanism? In particular, is the phenomenon that we have termed case attraction really due to some kind of erroneous feature migration within the current partial

phrase marker (CPPM), or is it instead a further instance of a syntactic ambiguity resolution strategy which does not necessarily refer to case features? If the former should turn out, then we would have strong evidence that case features are at least to a certain extent independent from the phrase-structural representation they are associated with, because only such an independence will allow case features to percolate within the phrase-marker.

The second question concerns the notion of markedness. As we will describe below, dative case has a marked status within the German case system. Given the fact that the difference in markedness between singular and plural number in English has such a strong effect on subject-verb-agreement attraction errors, one might expect that a similar difference turns up in attraction errors involving case. A main task of the following experiments will therefore be to determine whether case features can be attracted across the board, or whether case attraction is confined to dative case, i.e. to the marked case within the German case system.

In the next two sections, we will first give a short overview of case within the German grammar and then introduce the phenomenon of case attraction and the question raised by this phenomenon. After that, four experiments will be presented that have investigated the representation and processing of case. Our overall conclusion will be that case attraction is a genuine process of erroneous feature migration which only affects marked case features.

Case in German

German has four cases: nominative, accusative, dative, and genitive case. Of these four, only the first three are used productively for arguments of verbs, whereas the main function of genitive case is to mark modifiers and complements of nouns (comparable to English *of*). We will therefore be mainly concerned with nominative, accusative and dative case in the

generalizations of the form "If an argument bears thematic role X, it will be realized as a subject and therefore receive nominative case", generalizations in the reverse direction do not exist. If, for example, an NP bears nominative case, this gives no clue whatsoever as to the thematic role of this NP. Dative case, in contrast, is more restricted with respect to the assignment of thematic roles. Somewhat loosely speaking, one can say that dative case is bound to the thematic roles of recipient and beneficiary (cf. Wegener, 1985, for extensive discussion).

Let us finally turn to the way case is spelled out in the morphology. Morphologically, dative case is special in two ways. First, dative case is unambiguously signaled most of the time, whereas nominative and accusative case often coincide. This is shown for relative pronouns in Table 1. For definite determiners, the inflection paradigm would be identical to that shown in Table 1 with the exception of the genitive forms.

Insert Table 1 about here

A second morphological difference between dative case on the one hand and nominative and accusative case on the other hand shows up when we consider the licensing of different arguments by morphological means. Whereas the assignment of dative case to a verbal NP-argument must be licensed morphologically on the NP, the assignment of accusative does not need such a morphological license (cf. Gallmann, 1996; Vogel & Steinbach, 1995). For example, the quantifier viele (a lot) has both an inflected form and a form without inflection. In a position where structural case is assigned, both the inflected and the uninflected form can be used. This is shown in (4a) for an accusative marked object. The same also holds for nominative marked NPs. As shown in (4b), when used as a dative object, only the inflected form is useable. Without a dative inflection on viel, an

ungrammatical sentence results. This shows that dative case is in need of a morphological spell-out whereas nominative and accusative case are not.

(4) a. Peter unterstützt vie**les** / viel

Peter supports a lot (of institutions, campaigns, ...)

b. Peter widerspricht vie**lem** / *viel

Peter objects-to a lot (of institutions, campaigns, ...)

Our short survey of the case system of German can be summarized by the following statement. Morphologically, syntactically and semantically, dative case is the marked option whereas the two structural cases nominative and accusative are unmarked, default options. Based both on these grammatical generalizations and on an experimental investigation of an ambiguity between accusative and dative objects, Bader et al. (1996) have proposed a syntactic representation of case that gives the marked status of dative case an explicit representation. According to Bader et al. (1996), dative case - but not nominative or accusative case - is associated with a lexical case flag. This proposal can be graphically represented as in Figure 1. The left side of Figure 1 shows the phrase-structure tree of a NP with structural case, here with accusative case; the right side of Figure 1 is the analogous tree for a NP bearing dative case.

Insert Figure 1 about here

The dative case flag shown in Figure 1 is to be understood in analogy to the number flag proposed by Eberhard (1997) in order to account for number attraction errors in English. It captures the generalization that arguments bearing dative case have to obey stricter morphological licensing condition in comparison to arguments bearing one of the structural cases nominative or accusative (cf. Vogel & Steinbach (1995) and Bayer, Bader

& Meng (1999) for a more thorough linguistic discussion of morpho-syntactic differences between structural and lexical case in German). The main difference to the representation of number features proposed by Eberhard (1997) lies in the fact that the case flag in Figure 1 is provided not by the noun but by the determiner. This property stems from the fact that case in German is morphologically realized mainly on determiners but only rarely on nouns. A further difference pertains to the fact that there are two unmarked cases – nominative for subjects and accusative for objects – whereas there is only one unmarked number feature, namely singular. We assume that this further distinction is reflected in the fact that subject and objects are differentiated by virtue of their phrase-structural position as determined by the argument structure of the verb.

Case Attraction: The Basic Phenomenon

Case-attraction was first reported and experimentally investigated in sentences exhibiting an ambiguity between accusative and dative object (cf. Bader, 1994; Schlesewsky, 1996). In the experiments to follow, we will investigate case attraction using the particular kind of subject-object ambiguity seen in embedded clauses like (5a) and (5b).

(5) a. (Ich glaube,) daß Fritz das Buch geschickt **hat**.

I believe that Fritz a book sent has

"I believe that Fritz sent the book"

b. (Ich glaube,) daß Fritz das Buch geschickt **wurde**.

I believe that Fritz a book sent was

"I believe that the book was sent to Fritz"

In the active clause (5a), the proper name Fritz is the subject and the following NP das Buch the accusative object of the clause final verb geschickt hat. In the passive clause (5b),

in contrast, Fritz is the dative object and das Buch the subject of the verb geschickt wurde. Since a proper name is ambiguous between nominative, accusative, and dative case and a neuter NP like das Buch is ambiguous between nominative and accusative case, the sentences in (5) are locally ambiguous with respect to the syntactic functions that the two NPs play. Before the clause final auxiliary is encountered, the sentences are compatible both with a subject-before-object (SO) analysis and an object-before-subject (OS) analysis. The local ambiguity seen in (5) disappears if the proper names are replaced by NPs that morphologically distinguish between nominative and dative case. For example, a masculine definite NP like the uncle appears as der Onkel in the nominative and as dem Onkel in the dative.

Both in end-of sentence speeded-grammaticality judgment experiments and experiments using a self-paced reading procedure locally ambiguous sentences as in (5) have been shown to exhibit a preference for the SO-word order, as reflected by a garden-path effect for locally ambiguous OS-sentences (Bader, 1997): Whereas locally ambiguous SO-sentences (5a) did not differ from their unambiguous counterparts, locally ambiguous OS-sentences (5b) are consistently more difficult to process than unambiguous OS-sentences. The finding of an SO-preference in sentence pairs as in (5) is in line with current research on parsing German which has shown an SO-preference in a variety of subject-object ambiguities (cf. Hemforth, Konieczny & Strube, 1993; Friederici, Steinhauer, Mecklinger, & Meyer, 1998; Bader & Meng, 1999). With respect to the source of this preference, we have to note that there is no agreed-upon explanation. In part, this is due to a lack of agreement concerning the correct phrase-structure representation of German sentences. Since this paper is concerned with the nature of case features, nothing of what follows hinges on the particular phrase-structures assigned to sentences as in (5). For the following, we will assume that active and passive sentences of the sort shown in (5) do not differ phrase-structurally from

each other (cf. Haider, 1993; Reuland & Kosmeijer, 1993) and that the preference for the SO-structure in the absence of a relative clause is due to the Case Preference Principles proposed by Bader et al. (1996). When processing a case ambiguous sentence like (5a) or (5b), a parser abiding by the Case Preference Principles will assign nominative to the first NP due to the joint effect of the two clauses of the CPP. The second NP will then be assigned accusative because nominative can only be assigned once. The net effect will be that the sentence receives an SO-word order prior to encountering the clause final verb.

(6) Case Preference Principle

- a. Prefer structural Case to lexical Case.
- b. Prefer nominative Case to accusative Case.

A further experiment reported in Bader (1997) compared the processing of sentences like (5) to the processing of these same sentences but with a relative clause attached to the ambiguous proper name. Two kind of relative clauses were used. The first type of relative clause contained the relative pronoun der which is unambiguously marked for dative case. An example of an SO-sentence containing this type of relative clause is shown in (7).

(7) Ich glaube, daß Maria, **der** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that Maria who I just met am a book sent has/was

"I believe that Maria who I just met sent the book"

In a speeded-grammaticality judgment experiment, SO-sentences containing a relative clause headed by der showed a sharp drop in the percentages of correct answers. Whereas SO-sentences without a relative clause obtained ca. 79% correct answers, SO-sentences containing a dative-relative clause received only 56% correct answers. Given that fact that the SO-word order is usually strongly preferred in all kinds of subject-object ambiguities in

German, the finding of a sharp drop in the percentages of correct answers for such sentences is rather remarkable since it indicates that the usual SO-preference reversed to an OS-preference under the influence of a dative relative pronoun. We will call this phenomenon CASE ATTRACTION because it seems as if the dative case feature of the relative pronoun has been attracted by the head noun, turning the first NP into a dative marked NP and the whole clause into a clause with OS-word order.

What might cause the usual SO-preference to turn into an OS-preference under the influence of a dative relative pronoun? Two hypothesis have been proposed to account for this reversal. According to the Case Attraction Hypothesis (CAH) (Bader, 1997), case attraction is a phenomenon similar to number attraction.

(8) The Case Attraction Hypothesis (CAH)

A marked case feature can erroneously migrate within the CPPM.

Figure 2 shows what is happening in case attraction errors under the CAH. The left side of Figure 2 shows the partial syntactic structure that corresponds to the head NP and the dative relative pronoun of a sentence like (7). Given the representation of case proposed in Bader et al. (1996), the relative pronoun der bears a dative case flag. Furthermore, the NP as a whole bears abstract nominative case due to the Case Preference Principles. According to the CAH, this dative flag sometimes erroneously percolates up to the head noun Maria, in a way similar to what happens in number attraction errors. If this happens, the whole NP will be specified for dative case, as shown on the left side of Figure 2. The second NP will then be assigned nominative case, again by the CPP, and the net result will be that the sentence exhibits an OS-structure prior to disambiguation. If the sentence then ends with an active verb, as it does in (7), the OS-structure that resulted from case-attraction will be contradicted, leading to the erroneous judgment of the sentence as ungrammatical.

Insert Figure 2 about here

In sum, the CAH claims that case attraction results from a migration of the dative case feature from the relative pronoun to the preceding head noun. This migration of the dative case feature is in no way licensed by the grammar of German, and therefore it represents a kind of malfunctioning on part of the HSPM, in the same sense as number attraction errors as in (2) are due to a malfunctioning of the language production system.

An alternative to the CAH is provided by the Parallel Function Hypothesis (PFA) (cf. (9)) which states that the parser deliberately uses case-information on the relative pronoun in order to resolve the ambiguity of the head noun. If the syntactic function of the head noun is locally ambiguous, and an unambiguous relative pronoun is available, the parser will assume that the head-noun has the same syntactic function as the relative pronoun. Under the PFH, case attraction errors do not result from some malfunctioning of the HSPM but from a particular strategy to resolve a local syntactic ambiguity. Various versions of the PFH have been proposed by e.g. Bader (1994), Schlesewsky (1996) and Sauerland (1996).

(9) The Parallel Function Hypothesis (PFH):

If the syntactic function of the head noun is ambiguous, the parser assumes that the syntactic functions of the head noun and the relative pronoun are identical.

While prior experimental research (Bader, 1997; Schlesewsky, 1996) has shown that dative case sometimes is attracted, it is an open question whether the same can happen with nominative or accusative case. This lack of knowledge is caused by the fact that all prior experimental investigations of case attraction only tested ambiguous sentences where the attraction of structural case features would not be detectable given the general parsing preferences in German. For example, the experiment reported in Bader (1997) also

investigated OS-sentences as in (10). The relative clause in (10) is headed by the relative pronoun die. This relative pronoun, which is compatible with both nominative and accusative case but incompatible with dative case, functioned as a subject in most of the sentences used in Bader (1997).

(10) Ich glaube, daß Maria, die mich bald besuchen wird, das Buch geschickt **wurde**.

I believe that Maria who me soon visit will a book sent has/was

"I believe that the book was sent to Maria who will visit me soon."

Sentences as in (10) induced a garden-path effect, but this garden-path effect does not allow the conclusion that nominative case has been attracted since, due to the general SO-preference in German, a garden-path effect is found in such sentences whether a relative clause is present or not. The same is true for the experiments reported in Schlesewsky (1996). Although he used a different kind of syntactic ambiguity, his sentences containing a relative clause headed by a relative pronoun bearing structural case do cause a garden-path effect even in the absence of such a relative clause and therefore do not allow any conclusions with respect to the attraction of structural case.

To summarize this section, it has been shown that modifying an ambiguous NP with a relative-clause headed by a dative-marked relative pronoun can induce case attraction. In contrast to dative case, it is an open question whether case attraction can also originate from relative pronouns bearing structural case. The experiments that we will report now will investigate what kind of mechanism causes case attraction and whether case attraction is confined to dative case, as the marked case in German, or not.

Experiment 1

The first aim of Experiment 1 was to test between two competing hypothesis about the mechanism(s) responsible for attraction errors, namely the Case Attraction Hypothesis

(CAH) and the Parallel Function Hypothesis (PFA) introduced in the preceding section. As we have shown above, ambiguous SO-sentences containing a dative relative clause (cf. (11a), repeated from above) are predicted to cause processing difficulties both by the CAH and the PFH. However, a crucial difference emerges if we consider sentences like (11b) where the proper name Maria has been replaced by the definite NP die Frau (the woman).

(11) a. Ich glaube, daß **Maria, der** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that Maria who I just met am a book sent has

"I believe that Maria who I just met sent the book"

b. Ich glaube, daß **die Frau, der** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that the woman who I just met am a book sent has

"I believe that the woman who I just met sent the book"

Under the CAH, the sentences in (11a) and (11b) should not differ from each other with respect to the frequency of case attraction. To see why, consider the syntactic representations for the head noun and the following relative pronoun given in Figure 3.

Insert Figure 3 about here

As a comparison of the two trees in Figure 3 shows, (11a) and (11b) have identical distributions of case features under the syntactic assumptions outlined in the preceding section. In both sentences the head NP bears structural case and is therefore without a case flag. The relative pronoun, in contrast, bears dative case and therefore has a case flag. Under the hypothesis that case attraction errors are caused by an erroneous percolation of the dative feature to the head noun, there should be no difference between (11a) and (11b): In both sentences, the dative feature of the relative pronoun der will percolate to the head noun Frau, thereby turning the whole NP into a dative marked NP. Since the determiner die in

(11b) is as unmarked with respect to case as the nouns Maria and Frau, it should not have any influence on the processing of (11b). (11a) and (11b) are therefore predicted to behave completely identical.

A different prediction emerges from the PFH. According to the PFH, the phenomenon of case attraction results from an ambiguity resolution strategy: The HSPM uses the case information on the relative pronoun in order to resolve the ambiguity of the preceding head noun. The proper name in sentences like (11a) is three-way ambiguous: it can bear nominative, accusative or dative case. When encountering a dative relative pronoun, a parser abiding by the PFH will therefore resolve the ambiguity of the proper name in favor of dative case. This in turn will have the effect that the sentence will be assigned an OS-structure which is not compatible with a clause-final active auxiliary. Sentences (11b), in contrast, contains the definite NP die Frau which is only two-way ambiguous, namely between nominative and accusative case. Dative case is morphologically incompatible with such an NP. The presence of a dative-marked relative pronoun should therefore not matter for sentences of this kind, at least under the natural assumption that the parser applies its syntactic ambiguity resolution strategies only in grammatically licit ways. Under this assumption, the parser can resolve the ambiguity of die Frau either in favor of nominative or in favor of accusative, but not in favor of dative case. Sentences containing die Frau modified by a dative relative clause should therefore not differ from the same sentences but without a relative clause.

Besides deciding between the CAH and the PFH, Experiment 1 had the further aim of testing whether there is an asymmetry between dative case and structural case, as might be expected given that dative is a marked case within the German case system. To this end, the experiment will also include OS-sentences containing a relative clause headed by a pronoun marked for structural case. While ambiguous OS-sentences (cf. (10)) are expected to elicit a

garden-path effect given the pervasive SO-preference found in German, unambiguous OS-sentences allow to test the marked status of dative case. The crucial comparison concerns the two sentence types shown in (12). In (12a), which is repeated from above (cf. (11b)), the NP die Frau, which bears structural case, is modified by a dative relative clause. In (12b), the case distribution has been reversed; the dative marked NP der Frau is followed by a relative pronoun bearing structural case. Figure 4 shows the parts of the syntactic structures for the sentences in (12) which are relevant to the current discussion (the left tree in Figure 4 is again repeated from above).

(12) a. Ich glaube, daß **die Frau**, **der** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that the woman who I just met am a book sent has

"I believe that the woman who I just met sent the book"

b. Ich glaube, daß **der Frau**, **die** ich gerade getroffen habe, das Buch geschickt **wurde**.

I believe that the woman who I just met am a book sent was

"I believe that the book was sent to the woman who I just met."

Insert Figure 4 about here

As already explained, the CAH predicts that case attraction should be observable in sentences like (12a) since the dative feature on der can percolate up to the NP die Frau thereby turning this NP into a dative marked NP. In (12b), in contrast, case attraction should not occur. As shown on the right side of Figure 4, the relative pronoun does not bear any marked case feature and therefore there is nothing that might erroneously percolate up to the NP der Frau.

The differing predictions arising from the CAH and the PFH are summarized in Table 2. Table 2 shows how the CAH and the PFH answer the question "Does a sentence of this

particular type induce a garden-path effect?”, where garden-path effect is to be understood as showing poorer performance than unambiguous control sentences without any intervening relative clause. For differentiating between the CAH and the PFH, sentences with SO-word-order are crucial. For SO-sentences, the CAH predicts that a garden-path effect is induced by a dative relative pronoun independent of whether the head noun is a proper name or a noun preceded by a determiner. The PFH, in contrast, only predicts a garden-path effect for SO-sentences with proper names but not with definite NPs.

Insert Table 2 about here

For sentences with OS-word order and the relative pronoun die, the CAH and PFH make the same predictions although for different reasons. The CAH predicts that the relative pronoun die does not have any influence on the processing of the preceding NPs. OS sentences containing such a relative pronoun should therefore behave identical to analogous sentences without a relative clause. Sentences with a proper name are locally ambiguous and should therefore lead to a garden-path effect given the general SO-preference in German whereas sentences with the dative NP der Frau are unambiguous and consequently should not induce a garden-path effect. The PFH also predicts that unambiguous sentences should not induce a garden-path effect. Furthermore, in ambiguous sentences with a die-relative clause the relative pronoun is itself ambiguous and therefore cannot be used to disambiguate the preceding head noun. Therefore, the default-preference for the SO-word order will be invoked for these sentences and a garden-path effect is predicted given that the sentences are disambiguated towards the OS-word order.

The sentences described up to this point were all matched pairs of active and passive sentences. A final aim of Experiment 1 was to show that the phenomenon of case attraction

in no way depends on any peculiarities of the active-passive alternation. To this end, Experiment 1 did not investigate pairs of active-passive sentences but pairs like (13) where both sentences end in an active verb.

(13) a. Ich weiß, daß Maria das Buch las.

I know that Maria the book read "I know that Maria read the book."

b. Ich weiß, daß Maria das Buch gefiel.

I know that Maria the book pleased. "I know that the book pleased Maria."

The embedded clause of (13a) contains the verb las (read) which is a simple transitive verb with a subject and an accusative object. (13b), in contrast, contains the verb gefiel (pleased) which belongs to the class of psych-verbs in German which express the experiencer as a dative object and the target-of-emotion as the subject. The sentences in (13) therefore contain the same kind of local ambiguity as the sentences in (5): Until the clause final verb is encountered, these sentences are compatible with both an SO- and an OS-analysis. In (13a), this local ambiguity is resolved towards the SO-structure and in (13b) towards the OS-structure. With respect to their syntactic structures, (13a) and (13b) do not differ from active and passive sentences as in (5a) and (5b), respectively.

Method

Subjects. 30 students of the University of Jena participated in this experiment. All were native speakers of German and naive with respect to the purpose of the experiment. Subjects received either 5 DM or course credits for participating in the experiment.

Materials. 30 sentence sextets were constructed according to the two factors word-order (SO vs. OS) and first NP (control vs. ambiguous with relative clause vs. unambiguous with relative clause). A complete stimulus set is shown in Table 3.

Insert Table 3 about here

All sentence sextets were constructed around pairs of simple SO- and OS-sentences as in (14). These sentences are identical to the sentences in (13) with the single exception that the ambiguous proper name has been replaced by an unambiguous definite NP which always was feminine. Simple sentences as in (14) will serve as control sentences that define the baseline for measuring possible garden-path effects.

(14) a. Ich weiß, daß meine Schwester das Buch las.

I know that my sister the book read

"I know that my sister read the book."

b. Ich weiß, daß meiner Schwester das Buch gefiel.

I know that my sister the book pleased.

"I know that the book pleased my sister."

Unambiguous sentences with relative clause were obtained from control sentences by inserting a relative clause behind the first NP. The first NP in an SO-sentences was always modified by a relative clause headed by the relative pronoun der which is unambiguously marked for dative case (cf. Table 1). Relative clauses inserted in OS-sentences were headed by the relative pronoun die which can either bear nominative or accusative case. In 21 sentence sextets, die received nominative case, in the remaining 9 sextets die received accusative case. The relative clause of an SO-sentence and the relative clause of the corresponding OS-sentence were always matched with respect to the number of words.

In ambiguous sentences containing a relative clause, a proper name replaced the initial definite NP of unambiguous sentences with relative clause. Otherwise, ambiguous and unambiguous sentences with relative clause were identical.

The experimental sentences were divided into 6 sets, each set containing only one version of a sentence and an equal number of sentences in each condition. The resulting lists of experimental sentences were randomly intermixed with 110 filler sentences. A repeated measures design incorporating a Latin square was used. Each subject was exposed to all conditions but saw each experimental sentence only once.

Procedure. This experiment - as well as all following experiments - was run using the DMASTER software developed by K. Forster and J. Forster at Monash University and the University of Arizona. Subjects were seated in front of a computer monitor. They were told that they would be presented sentences on the screen and that their task was to judge the grammaticality of each sentence as quickly and accurate as possible. The concept of grammaticality was explained by examples. Subjects initiated each trial by pressing the space-bar. After pressing the space-bar, a fixation point appeared in the center of the screen for 1,050 milliseconds. Thereafter, the sentence appeared on the screen in a word by word fashion with each word appearing at the same position (mid-screen). Each word was presented for 224 milliseconds plus an additional 14 milliseconds for each character to compensate for length effects. There was no interval between words. Immediately after the last word of a sentence, three red question marks appeared on the screen, signaling to the subjects that they now were to make their judgment. Subjects indicated their judgment by pressing the left shift-key for ungrammatical and the right shift-key for grammatical sentences. If subjects did not respond within 2000 ms, a warning line "zu langsam" (too slow) appeared on the screen and the trial was finished.

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

Results

Insert Table 4 about here

Judgments. Table 4 shows the percentages of correct judgements for Experiment 1. In this and all following experiments, percentages of correct judgments were analyzed with both subjects (F1) and items (F2) as random effects. Two-way ANOVAS (2 word orders \times 3 first NP) revealed that the factor word-order was insignificant in the subject analysis and marginally significant in the item analysis (F1(2,58) = 1.87, $p > .1$; F2(2,58) = 3.81, $p < .1$). The factor first NP was significant both in the subject and the item analysis (F1(2,58) = 4.78, $p < .05$; F2(2,58) = 4.78, $p < .05$). The interaction between the two factors word-order and first-NP, finally, was highly significant in both analysis (F1(2,58) = 6.23, $p < .01$; F2(2,58) = 5.77, $p > .01$).

Planned comparisonsⁱ were conducted to test the hypothesis derived in the introduction to Experiment 1. Within the category of OS sentences, there were no significant differences between control sentences, ambiguous sentences with relative clause, and unambiguous sentences with relative clause. Within the category of SO-sentences, ambiguous sentences with a relative clause received significantly less correct responses than control sentences (77% vs. 92%; t1(29) = 3.39 $p < .01$, t2(29) = 3.39 $p < .01$). Unambiguous sentences with a relative clause received even less correct responses than ambiguous sentences with a relative clause, but this difference was not significant (74% vs. 77%, t_1 and $t_2 < 1$).

Judgment times. Response times for correct judgments are shown in Table 4. In this and all following experiments, response time data were corrected for outliers in the following way. Before analysis of response times, all response times more than 2.5 standard deviations (SD) away from an individual subject's mean were replaced with the cut-off value for the subject (the value equal to 2.5 SD above or below the mean). Less than 5% of the response times were replaced by this criterion. Response times were analyzed with both subjects (F1) and items (F2) as random effects.

Two-way ANOVAS (2 word orders \times 3 first NP) showed that the main effect of word-order was not significant (both F 's $< .1$) but the main effect of first NP was (F1(2,58) = 11.08, $p < .01$; F2(2,58) = 4.94, $p < .05$). The interaction between word-order and first-NP failed to reach significance in the subject-analysis but was significant in the item analysis (F1(2,58) = 2.11, $p = .131$; F2(2,58) = 3.61, $p < .05$).

Planned comparisons revealed the following. Within the condition SO, ambiguous sentences with a relative clause took longer to be judged as grammatical than control sentences but this difference reached significance only in the subject analysis (686ms vs. 605ms; t1(58) = 2.52, $p < .05$; t2(58) = 1.40, $p > .1$). The further difference between ambiguous and unambiguous sentences with relative clause was not significant (686ms vs. 697: both t -values < 1). Within the condition OS, unambiguous sentences with a relative clause did not differ significantly from control sentences (647ms vs. 626ms: both t -values < 1) but ambiguous sentences with relative clause received significantly longer reaction times than unambiguous sentences with relative clause (759ms vs. 647ms; t1(58) = 3.47, $p < .01$; t2(58) = 2.54, $p < .05$).

Discussion

Experiment 1 has replicated earlier findings (Bader, 1997; Schlesewsky, 1996) that dative relative clauses can induce attraction errors by which an otherwise preferred SO-structure is turned into an OS-structure. Since, in contrast to Bader (1997), we did not use pairs of active and passive sentences but active sentences throughout, we can conclude that the phenomenon of case attraction in no way depends on any peculiarities of the active-passive alternation. In addition to replicating the basic phenomenon of case attraction, Experiment 1 has provided two new results. First, dative relative pronouns induced case attraction errors independent of whether the head noun was compatible with dative case (proper names) or not (definite NPs). This finding was predicted by the Case Attraction Hypothesis but not by the Parallel Function Hypothesis. Second, attraction errors for sentences where the head NP was a definite NP only occurred with dative relative clauses but not with relative clauses headed by a relative pronoun specified for either nominative or accusative case. Whereas ambiguous OS-sentences showed the usual garden-path effect in accordance with the general SO-preference found in German, unambiguous OS-sentences containing a relative clause did not differ from OS-control sentences. Finding case attraction only in sentences containing a dative relative clause supports the assumption that dative case, as the marked option within the German case system, is represented by a case flag within the CPPM whereas nominative or accusative case are not.

The fact that we did not find a performance difference between unambiguous OS-sentences with and without relative clause shows that the insertion of a relative clause per se did not increase processing difficulty in the speeded grammaticality judgment task. The finding of a reduced accuracy and higher reaction times for SO-sentences containing a dative relative clause in comparison to SO-sentences without a relative clause can therefore be completely attributed to the effect of case attraction. In order to get an estimate of the

frequency of case attraction, one might subtract the percentages of correct responses for attraction sentences from the percentages of correct responses for control sentences (92% - ca. 75.5%). However, there are two reasons why this gives only a rather crude lower bound of the true percentages of case attraction. First, the possibility of reanalysis has to be taken into account. When the parser detects a case violation on processing the clause final verb in sentences where case attraction has occurred, it might invoke processes which, when completed successfully, will lead to the response grammatical despite the prior occurrence of an attraction error. That reanalysis indeed occurs in the sentences under consideration is suggested by the finding that judging attraction sentences correctly as grammatical took more time than judging corresponding control sentences as grammatical, a finding which is regularly found when garden-path sentences are judged as grammatical.

A second reason why simply subtracting the raw percentages gives only a lower bound on the true probability of attraction errors lies in the fact that - even when the possibility of reanalysis is taken into account - one cannot assume a priori that on each trial where dative case has been attracted people will give the response "ungrammatical". This assumption would only be licit if corresponding ungrammatical sentences would be judged as ungrammatical with near perfect accuracy. However, for ungrammatical sentences containing case violations, prior research has shown that this assumption is often not true (cf. Meng, 1997; Bader, Meng, & Bayer, in press). To get a better estimate of the frequency of case attraction, Experiment 2 will therefore include ungrammatical sentences which contain the same kind of ungrammaticality as is present when case attraction has happened in sentences like (11).

A certain concern one might have with respect to Experiment 1 lies in the fact that the crucial first NP in this experiment was always a feminine NP. For feminine NPs, with the exception of feminine proper names, nominative and accusative case share the same form

while dative case has a form of its own (for example die for nominative and accusative but der for dative). The two-way ambiguity of die opens up several alternative explanations of the results provided by the current experiment. For example, it might be that the crucial difference between die and der has nothing to do with the opposition of structural and lexical case but with the opposition of ambiguous and unambiguous marking of case instead. Furthermore, given the two-way-ambiguity of die, the HSPM might consider to apply a syntactic ambiguity resolution strategy like the Parallel Function Strategy and in doing so overlook that an NP like die Frau is not compatible with dative case. Experiment 2 will take up these concerns by comparing the processing of feminine NPs to the processing of masculine NPs for which not only dative case but also nominative and accusative case have distinct lexical forms.

Experiment 2

Experiment 1 has shown that there is an asymmetry between the two feminine relative pronouns der and die. Whereas the former triggers case attraction errors, the latter does not. We have interpreted this asymmetry in terms of syntactic markedness. Whereas die bears unmarked structural case, either nominative or accusative, der bears marked dative case. However, there is a further asymmetry between die and der. As a feminine relative pronoun, der is unambiguously marked for dative case whereas die is two-way ambiguous between nominative and accusative (cf. Table 1). Therefore, a purely morphological definition of markedness, according to which ambiguous items are unmarked and unambiguous items marked, would be as compatible with the results of Experiment 1 as our definition of markedness in syntactic terms.

In order to distinguish between a syntactic definition of markedness (structural versus lexical case) and a morphological definition (ambiguous versus unambiguous form), we

have to consider masculine NPs. When applied to masculine NPs, the two definitions of markedness give different results. Masculine NPs (besides proper names) have a separate morphological form for each case. Under a morphological definition of markedness, they are therefore all on a par, namely marked. Under a syntactic definition of markedness, in contrast, the same asymmetry holds as for feminine NPs: nominative and accusative NPs are unmarked whereas dative NPs are marked. The syntactic and the morphological definition of markedness therefore make differing predictions when it comes to sentences like (15). These sentences are identical to the sentences in (11) investigated in the preceding experiment with the single exception that the first NP is a masculine NP instead of a feminine one. In (15a), the masculine proper noun Peter is followed by the relative pronoun dem, which is unambiguously marked for dative case. (15b) also contains a dative relative clause which, in this sentence, modifies the definite NP der Mann, which is unambiguously marked for nominative case.

(15) a. Ich glaube, daß **Peter, dem** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that Peter who I just met am a book sent has

"I believe that Peter, who I just met, sent the book"

b. Ich glaube, daß **der Mann, dem** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that the man who I just met am a book sent has

"I believe that the man who I just met sent the book"

Partial syntactic structures for the sentences in (15) are shown in Figure 5. The top of Figure 5, which shows the representation of a proper name modified by a relative clause, corresponds to (15a) both under a morphological and a syntactic definition of markedness. It does not differ from the syntactic structure for a NP with a feminine proper name (cf. Figure 3). The tree on the bottom left side of Figure 5 corresponds to (15b) under a syntactic

definition of markedness. It is again identical to the analogous syntactic structure for feminine NPs (cf. Figure 3). The bottom right side of Figure 5 finally shows the distribution of case flags under a morphological definition of markedness. As can be seen in Figure 5, under a morphological definition masculine NPs with a determiner differ both from masculine NPs with a proper name and from corresponding feminine NPs with a determiner. The crucial difference is that not only the relative pronoun but also the determiner bears a case flag under a morphological definition of markedness because both items unambiguously signal their respective case.

Insert Figure 5 about here

As can be seen by comparing the top tree with the bottom left tree in Figure 5, under a syntactic definition of markedness no difference is to be expected between sentences containing a proper name and sentences with a definite NP with respect to the occurrence of attraction errors. As with corresponding feminine sentences, both sentence types should elicit attraction errors. Furthermore, the frequency of these errors should not depend on whether the head NP is ambiguous or not.

To derive predictions for the morphological definition of markedness, the top tree has to be compared with the bottom right tree in Figure 5. The crucial difference between these two structures is that a proper name does not have a case flag whereas a definite NP has one. For number attraction errors, Eberhard (1997) has found that the frequency of such errors is dependent on whether the head NP contains a number flag of its own. In a sentence production experiment where subjects had to complete given preambles, preambles like one key to the cabinets elicited less number attraction errors than preambles like the key to the cabinets. According to Eberhard (1997), the reason for this finding is that the determiner the

is completely unspecified with respect to number whereas the number word one is positively specified for singularity and therefore is associated with a number flag for singular. The presence of this singular flag within the head NP prevents the plural flag of the embedded NP to be attracted as often as without a flag on the head NP. Applying the same logic to the phenomenon of case attraction, a morphological definition of markedness leads to the prediction that less case attraction errors should occur when the head NP contains an unambiguous determiner than when it does.

Table 5 summarizes the predictions made by the syntactic and the morphological definition of markedness within the German case system. These predictions are cast in terms of whether a difference in the frequency of case attraction errors is predicted between sentences where the head NP is a proper name and sentences where the head NP is a definite NP. For feminine NPs, the syntactic and the morphological definition of markedness both predict an equal amount of attraction errors for proper names and definite NPs. For masculine NPs, the syntactic definition makes the same prediction as for feminine NPs. The morphological definition, in contrast, predicts that attraction errors should be more probable with a masculine proper name than with a masculine definite NP.

Insert Table 5 about here

A second aim of Experiment 2 was to provide additional evidence for the Case Attraction Hypothesis and against the Parallel Function Hypothesis. In Experiment 1 we found that SO-sentences containing a definite feminine NP like die Frau modified by a dative relative pronoun did not differ from corresponding sentences containing a feminine proper name like Maria. Attraction errors occurred in both types of sentences to the same extent. Since a feminine NP like die Frau is incompatible with dative case this speaks

against the PFH insofar as it is implausible that the parser will resolve the case ambiguity of an NP in favor of a case that this NP is not compatible with. An even stronger point against the PFH could be made should we find evidence for case attraction in analogous masculine sentences, that is, in sentences like (15b). Here, the head NP der Mann is completely unambiguous. It is definitely a nominative marked NP. Therefore, there is nothing to disambiguate and an ambiguity resolution strategy like the PFH is inapplicable. The PFH therefore predicts that the presence of a dative relative clause should have no effect whatsoever on a sentence which contains the unambiguous NP der Mann. Unambiguous masculine SO-sentences containing a dative relative pronoun should behave equal to unambiguous masculine SO-sentence without any relative clause. This prediction is in marked contrast to the prediction made by the CAH in conjunction with a syntactic definition of markedness. As just shown, under this hypothesis sentences containing der Mann modified by a dative relative pronoun are predicted to be no different than ambiguous sentences containing a dative relative clause.

A final aim of Experiment 2 was to get a better measure of the frequency of attraction errors. As already explained above, one prerequisite for getting such a measure is that one has to know how accurate subjects detect the temporary ungrammaticality that arises if the dative feature is attracted. In addition to ambiguous and unambiguous grammatical sentences, Experiment 2 will therefore also contain matched ungrammatical sentences of the type shown in (16). In these ungrammatical sentences, the initial NP (feminine in (16a), masculine in (16b)) is unambiguously marked for dative case instead of nominative case. The sentences in (16) thus contain the same ungrammaticality as sentences exhibiting case attraction, the only difference being that the dative feature on the offending first NP is morphologically enforced in (16) whereas it stems from the process of case attraction in sentences like (11) or (15).

(16) a. Ich glaube, daß **der Frau**, **der** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that the woman who I just met am a book sent has

b. Ich glaube, daß **dem Mann**, **dem** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that the man who I just met am a book sent has

Method

Subjects. 80 students of the University of Jena participated in this experiment. All were native speakers of German and naive with respect to the purpose of the experiment. Subjects received either 5 DM or course credits for participating in the experiment.

Materials. The material for Experiment 2 consisted of 40 SO-sentences with each sentence appearing in 8 different versions according to the two factors gender (feminine vs. masculine) and first NP (control vs. ambiguous with relative clause vs. unambiguous with relative clause vs. ungrammatical). A complete stimuli set for Experiment 2 is shown in Table 6. For feminine sentences, the three conditions control, ambiguous with relative clause and unambiguous with relative clause were identical to the SO-conditions of Experiment 1. In control sentences, the first NP was a definite NP that was not followed by a relative clause. In unambiguous sentences with a relative clause, the first NP again was a definite NP but this time followed by relative clause where the relative pronoun was marked for dative case. Ambiguous sentences with a relative clause were identical to unambiguous sentences with a relative clause but with a proper name as first NP instead of a definite NP. Sentences in the new condition ungrammatical were obtained from unambiguous sentences with relative clause by turning the first NP into a dative marked NP. This change makes the sentences ungrammatical because the verbs in these sentences always assigned nominative case to the first NP.

Masculine sentences were obtained from feminine sentences by simply replacing the first NP with a masculine NP and by turning all relative pronouns accordingly into masculine pronouns.

The experimental sentences were divided into 8 sets, each set containing only one version of a sentence and an equal number of sentences in each condition. The resulting lists of experimental sentences were randomly intermixed with 99 filler sentences. A repeated measures design incorporating a Latin square was used. Each subject was exposed to all conditions but saw each experimental sentence only once.

Insert Table 6 about here

Procedure. The same speeded grammaticality judgments procedure was used as in Experiment 1.

Results

Insert Table 7 about here

Judgments. Table 7 shows the percentages of correct responses for Experiment 2. Two-way ANOVAS (2 gender \times 4 first NP) revealed that the factor first NP was highly significant in the subject as well as in the item analysis ($F_1(3,237) = 46.55, p < .01$; $F_2(3,117) = 50.03, p < .01$). The factor gender was also significant under both analyses ($F_1(1,79) = 5.55, p < .05$; $F_2(1,39) = 7.21, p < .05$). Furthermore, there was a significant interaction between gender and first-NP ($F_1(3,237) = 3.97, p < .01$; $F_2(3,117) = 4.13, p < .01$).

Planned comparisons were conducted to test the hypothesis of interest. In the condition feminine, unambiguous sentences with a relative pronoun received significantly less correct answers than control sentences (77% vs. 93%; $t_1(237) = 4.52, p < .01$; $t_2(117) = 4.62, p < .01$). Unambiguous and ambiguous sentences with relative clause did not differ from each other (77% vs. 76%, both t_1 and $t_2 < 1$). Ungrammatical sentences finally received less correct answers than ambiguous sentences with a relative clause (63% vs. 76%; $t_1(237) = 2.94, p < .01$; $t_2(117) = 3.04, p < .01$). For sentences in the condition masculine, exactly the same differences showed up. Unambiguous sentences with relative clause received less correct answers than control sentences (84% vs. 94%; $t_1(237) = 2.74, p < .01$; $t_2(117) = 2.83, p < .01$), Ambiguous and unambiguous sentences did not differ from each other (84% for both sentence types), and ungrammatical sentences received less correct answers than ambiguous sentences with relative clause (61% vs. 84%; $t_1(237) = 5.95, p < .01$; $t_2(117) = 6.18, p < .01$).

Comparisons across the factor gender revealed no significant differences for either control or ungrammatical sentences (all t -values < 1). For ambiguous and unambiguous sentences with relative clause, in contrast, feminine sentences received significantly less correct judgments than masculine sentences (ambiguous sentences: 76% vs. 84%; $t_1(79) = 2.97, p < .01$; $t_2(39) = 3.38, p < .01$; unambiguous sentences: 77% vs. 84%; $t_1(79) = 2.36, p < .05$; $t_2(39) = 2.55, p < .05$).

Judgment times. Reaction times for correct answers are shown in Table 7. Outliers were treated as in Experiment 1. In the subject analysis, 8 subjects had to be excluded because of empty cells. Two-way ANOVAS (2 gender \times 4 first NP) showed both a main effect of first NP ($F_1(3,213) = 43.14, p < .01$; $F_2(3,117) = 34.99, p < .01$) and a main effect of gender that was significant in the subject but only marginally significant in the item analysis ($F_1(1,71)$

= 6.98, $p < .05$; $F_2(1,39) = 3.35$, $p < .1$) but no interaction between gender and first-NP ($F_1(3,213) = 0.68$, $p > .1$; $F_2(3,117) = .122$, $p > .1$). The main effect of gender was due to masculine sentences needing slightly less time to be judged as grammatical than feminine sentences (743ms vs. 775ms). Planned comparisons for the factor first NP showed that control sentences received faster reaction times than unambiguous sentences with a relative clause (650ms vs. 734ms; $t_1(213) = 3.82$, $p < .01$; $t_2(117) = 3.42$, $p < .01$). The difference between unambiguous and ambiguous sentences with relative clause was not significant (734ms vs. 754ms; $t_1(213) = 1.01$, $p > .1$; $t_2 < 1$) but the difference between ambiguous sentences with relative clause and ungrammatical sentences was (754ms vs. 903ms; $t_1(213) = 6.34$, $p < .01$; $t_2(117) = 5.67$, $p < .01$).

Discussion

Experiment 2 has two major outcomes. First, dative relative pronouns induced attraction errors in sentences with feminine NPs as well as in sentences with masculine NPs. Second, neither for feminine NPs nor for masculine NPs did the frequency of attraction errors depend on whether the first NP was a proper name or a definite NP. This finding is particularly noteworthy for masculine NPs since masculine definite NPs are introduced by a determiner which is morphologically only compatible with nominative case. Taken together, the results of Experiment 2 clearly favor a syntactic definition of markedness over a morphological one.

Experiment 2 had also an unexpected outcome, namely that there were more attraction errors in feminine sentences than in masculine sentences. Given that this difference held equally for sentences with proper names and sentences with definite NPs, and that no difference obtained for either control or ungrammatical sentences, we tentatively conclude that the source for this difference has to lie in the relative pronouns that gave rise to case

attraction. The only relevant difference between feminine and masculine dative relative pronouns that we can offer at the moment might have to do with the frequency of these two relative pronouns. For NPs containing definite articles or demonstrative pronouns, frequency counts show that feminine dative NPs are more frequent than masculine dative NPs (Ruoff, 1990). Should the same frequency difference also hold for relative pronouns, the stronger attraction effect induced by feminine dative relative pronouns might be traced back to a higher activation level of feminine dative relative pronouns which in turn would reflect their higher rate of occurrence in the language.

Let us finally come to the question as to how often case attraction occurs in sentence comprehension. When case attraction has happened, the first NP in the sentences under consideration will become dative marked. This will lead to a case violation at the end of the sentence since the subcategorization features of the verb require that the first NP bears nominative case. Would this case violation always lead to the response "ungrammatical", we could simply subtract the percentages of correct answers for attraction sentences from the percentages of correct answers for control sentences in order to get the frequency of case attraction. However, there are two reasons why a case violation will not always lead to the response "ungrammatical". First, as indicated by the higher reaction time for attraction sentences than for control sentences, subjects at least sometimes tried to reanalyze the sentences. Since successful reanalysis would remove the case violation, a correct judgment "grammatical" would result, with the only trace of a prior case attraction being visible in the prolonged reaction times. Second, even if reanalysis is not successful or perhaps not even attempted, the case violation at the end of the sentence might still not lead to the sentence judged as "ungrammatical", for example because subjects do not reliably detect the case incongruency present in the sentence. To control for this possibility, Experiment 2 included truly ungrammatical sentences where the dative feature on the first NP was unambiguously

signaled by the morphological form of the determiner. As the results show, these ungrammatical sentences are judged as ungrammatical with an accuracy of only ca. 62%. We assume that this rather low accuracy is the joint result of both the length of the sentences under consideration and the considerable time pressure induced by the speeded grammaticality judgment task.

Given a difference of ca. 18% between control sentences and attraction sentences in the condition feminine, and taking into account that the particular type of case violation was detected with a probability of 0.63, we can conclude that case attraction must have occurred with a frequency of at least 29% (since 29% instances of case attraction multiplied with a detection probability of 0.63 results in 18% observed responses "ungrammatical"). For masculine sentences, the corresponding value would be 16%. Such frequencies, which are still a lower bound given the possibility of reanalysis, are in the upper range of what is usually found in experiments inquiring number attraction errors in speech production. For number attraction errors in speech production, the attraction rate varies from somewhat below 5% up to somewhat above 30% (cf. Bock & Miller, 1991; Bock & Cutting, 1992; Eberhard, 1997). The reason for the high rate of case attraction errors in comparison to number attraction errors can probably be attributed to the fact that in the sentences investigated in this paper, there is a much stronger connection between the source and the target of attraction in case attraction errors than in number attraction errors. In the sentences used in our experiments, there was a close grammatical dependency between the target, i.e. the head noun, and the source, i.e. the relative pronoun. In particular, these two elements are not simply adjacent, but they have to agree in number and gender. In typical instances of number attraction (e.g., *The editor of the history books are ...), in contrast, there is no agreement relation between the two NPs involved.

The finding that the same number of attraction errors occurred for masculine NPs like der Mann (the man), which are unambiguously specified for nominative case, and masculine proper names like Peter, which are three-way case ambiguous, adds further evidence to the hypothesis that dative case has a distinct representation within the CPPM but nominative case has not, be it morphologically signaled or not. Otherwise, one would have expected that the frequency of attraction errors would be lower if the head NP contains an article that is unambiguously specified for nominative case. However, an alternative possibility that we cannot exclude at this point would be that a case flag on the determiner of the head NP is unable to prevent the case flag of the relative pronoun to be attracted. For example, it might be that the dative case flag is attracted to the noun of the head NP and that the parser first looks at the noun when checking case, thereby overlooking that the article has a different case specification. In order to exclude this latter interpretation, we ran a third experiment that compared masculine nominative NPs modified by a dative relative clause with masculine dative NPs modified by a nominative relative clause.

Experiment 3

Experiment 3 will provide a final test of the asymmetry between nominative and dative case with respect to markedness. In the preceding experiments, we have found that a dative relative clause induces case attraction errors in unambiguous NPs like der Mann as often as in ambiguous NPs like Peter. We have interpreted the fact that the unambiguous nominative determiner der in no way prevents the dative feature from being attracted to the head NP as evidence in favor of a syntactic definition of markedness. Experiment 3 was designed to strengthen this interpretation by comparing unambiguous nominative NPs modified by a dative relative clause to unambiguous dative NPs modified by a relative clause where the

relative pronoun unambiguously bears nominative case. Two sample sentences illustrating this comparison are provided in (17).

(17) a. Ich glaube, daß **der Mann, dem** ich gerade begegnet bin, das Buch geschickt **hat**.

I believe that the man who I just met am the book sent has
 ”I believe that the man who I just met sent the book”

b. Ich glaube, daß **dem Mann, der** mich gerade getroffen hat, das Buch geschickt **wurde**.

I believe that the man who me just met has the book sent was
 ”I believe that the book was sent to the man who just met me.”

Under our syntactic definition of markedness, there is an asymmetric distribution of case flags in (17), as shown in Figure 6. When the head NP is specified for nominative case and the relative pronoun for dative case, there is a flag on the relative pronoun (cf. the left side of Figure 6); when the head NP is specified for dative case and the relative pronoun for nominative case, the case flag is on the determiner of the head NP (cf. the left side of Figure 6). With respect to attraction errors, the asymmetric distribution of case flags leads to the prediction that such errors should occur for sentences like (17a) but not for sentences like (17b). The first prediction has already been confirmed in Experiment 2. What is new in Experiment 3 is the inclusion of sentences like (17b) which should not show any evidence for attraction errors under our syntactic definition of markedness.

Insert Figure 6 about here

According to the competing morphological definition of markedness, the distribution of case features for the head NP and the relative pronoun would look as shown in Figure 7. The main point to note with respect to these structures is the completely symmetric distribution of case features. Given this symmetric distribution of case features, sentences

like (17a) and (17b) should not differ from each other with respect to case attraction errors. Since Experiment 2 already showed that sentences like (17a) elicit case attraction errors, the morphological definition of markedness predicts that sentences like (17b) should elicit attraction errors, too.

Insert Figure 7 about here

Table 8 summarizes the predictions of the syntactic and the morphological definition of markedness with respect to both ambiguous and unambiguous masculine sentences. These predictions are cast in terms of whether a garden-path effect is predicted, that is, a decrement in performance in comparison to control sentences that are unambiguous and do not contain a relative clause. For ambiguous sentences, the syntactic and the morphological definition make the same prediction, namely that both SO-sentences and OS-sentences should elicit a garden-path effect. A crucial difference emerges only for unambiguous sentences. According to the syntactic definition of markedness, a garden-path effect should be observed for sentences containing a dative relative pronoun but not for sentences containing a nominative relative pronoun, since only relative pronouns of the former type bear a case flag that can be attracted. The morphological definition of markedness, in contrast, predicts that unambiguous SO- and OS-sentences should behave alike. Given that unambiguous SO-sentences have been shown in the preceding experiment to elicit garden-path effects, the same should be true of OS-sentences. That is, when an unambiguous dative relative pronoun can induce case attraction in an unambiguous nominative head NP, then, under a morphological definition of markedness, an unambiguous nominative relative pronoun should induce attraction errors in an unambiguous dative head NP as well.

Insert Table 8 about here

Method

Subjects. 48 students of the University of Jena participated in this experiment. All were native speakers of German and naive with respect to the purpose of the experiment. Subjects received either 5 DM or course credits for participating in the experiment.

Materials. Experiment 3 used the same 30 sentence sextets as Experiment 1 with the following changes made. First, the first NP in the embedded clause, which was a feminine NP in Experiment 1, was replaced by a masculine NP and the relative pronoun in the condition with relative clauses changed accordingly. Second, all relative clauses in the condition OS-word order were turned into relative clauses headed by the relative pronoun der which is unambiguously specified for nominative case. This latter change affected the 9 sentence sextets that head an accusative relative pronoun in Experiment 1.

The experimental sentences were divided into 6 sets, each set containing only one version of a sentence and an equal number of sentences in each condition. The resulting lists of experimental sentences were randomly intermixed with 102 filler sentences. A repeated measures design incorporating a Latin square was used. Each subject was exposed to all conditions but saw each experimental sentence only once.

Procedure. The same speeded grammaticality judgments procedure was used as in Experiment 1 and Experiment 2.

Results

Insert Table 9 about here

Judgments. Table 9 shows the percentages of correct responses for Experiment 3. The factor first NP was highly significant in the subject as well as in the item analysis ($F_1(2,94) = 25.36, p < .01$; $F_2(2,58) = 22.05, p < .01$). The factor gender was significant under both analyses ($F_1(1,47) = 2.81, p > .1$; $F_2(1,29) = 2.47, p > .1$). Furthermore, there was a significant interaction between the two factors gender and first-NP ($F_1(2,94) = 4.03, p < .05$; $F_2(2,58) = 3.98, p < .05$).

We again conducted planned comparisons to test the hypothesis of interest. In the condition SO-word order, unambiguous sentences with a relative clause received significantly less correct responses than control sentences without a relative clause (81% vs. 93%; $t_1(94) = 3.59, p < .01$; $t_2(58) = 3.34, p < .05$). Ambiguous sentences with a relative clause received even less correct responses than unambiguous sentences with a relative clause, but this difference was not significant (78% vs. 81%; both t-values < 1). In the condition OS-word order, unambiguous sentences with a relative clause did not differ significantly from control sentences (93% vs. 95%; both t-values < 1), but ambiguous sentences with a relative clause received significantly less correct responses than unambiguous sentences with a relative clause (76% vs. 93%; $t_1(94) = 4.82, p < .01$; $t_2(58) = 4.50, p < .01$).

Judgment times. Reaction times for correct answers, which are shown in Table 9, closely mirror the picture provided by the percentages of correct responses. There was no effect of word-order (both F 's $< .1$) but an effect of first NP ($F_1(2,94) = 12.14, p < .01$; $F_2(2,58) = 5.71, p < .01$). The interaction between word-order and first-NP was significant in the subject and the item analysis ($F_1(2,94) = 3.72, p < .05$; $F_2(2,58) = 3.37, p < .05$). Planned comparisons revealed no significant differences for sentences with SO-word order. In the condition OS, unambiguous sentences with a relative clause did not differ from control sentences (both t-values < 1) but ambiguous sentences with a relative clause took

significantly longer to be judged as grammatical than unambiguous sentences with a relative clause (570ms Vs 716ms; $t_1(94) = 4.56, p < .01$; $t_2(58) = 3.46, p < .01$).

Discussion

The main outcome of Experiment 3 is the finding of a clear asymmetry between nominative NPs modified by a dative relative clause and dative NPs modified by a nominative relative clause. While the former led to attraction errors the latter did not. Since for masculine NPs both nominative and dative case are unambiguously specified on both articles and relative pronouns, this asymmetric behavior with respect to attraction errors can only be explained under recourse to a syntactic asymmetry between nominative and dative case: Whereas dative case is signaled by a case flag nominative case is not.

Experiment 3 therefore strengthens the conclusion that case attraction errors are sensitive to syntactic markedness but not to morphological ambiguity. However, there is also some hint in the results of Experiment 3 that morphological ambiguity might have an effect on syntactic processing, namely on processes of second-pass parsing or reanalysis. This hint is given by the strength of the garden-path effect obtained for ambiguous OS-sentences in Experiment 3 when compared to the same sentences in Experiment 1. Recall that the material for Experiment 3 was identical to the material of Experiment 1 with the single exception that the first NP was a masculine NP in Experiment 3 whereas it was a feminine NP in Experiment 1. Despite this small difference, OS-sentences with a feminine proper name elicited a garden-path effect that was only visible in prolonged reaction times whereas the garden-path effect elicited by sentences with a masculine proper name showed up in both prolonged reaction times and a drop in the percentages of correct judgments of almost 20%. Under the assumption that the ease of reanalysis does not depend on the gender of the proper name which has to be assigned dative case on second-pass parsing, the only

relevant difference between feminine and masculine sentences seems to be that the former contain the relative pronoun die, which is two-way ambiguous between nominative and accusative case, whereas the latter contain the relative pronoun der, which is unambiguously specified for nominative case. We will consider the question as to why morphological ambiguity might have an influence on processes of second-pass parsing, but not on the process of case attraction, in the general discussion section.

Taken in conjunction, the preceding three experiments allow two major conclusions. First, the phenomenon of case attraction is not amenable to an explanation in terms of syntactic ambiguity resolution. This is amply shown by the fact that case attraction occurs whether the head NP is ambiguous (consisting of a proper name) or not (consisting of a definite NP). In particular, as shown in Experiment 2 and Experiment 3, case attraction even occurs if the head NP is completely unambiguous and therefore no ambiguity exists which could be resolved. Second, nominative and dative case behave differently with respect to case attraction. A dative relative pronoun can induce case attraction in a nominative head NP but not vice versa. This supports the syntactic assumption introduced at the beginning, namely, that dative case is the marked option within the German case system and as such distinctly marked within the CPPM. However, one piece of evidence is still missing with respect to the syntactic assumptions introduced by Bader et al. (1996). While we have established a clear distinction between nominative and dative case, the role of accusative case has only played a minor role in the experiments so far. What has yet to be shown is that accusative case behaves like nominative case in not being able to induce attraction errors. This prediction will be tested in Experiment 4.

Experiment 4

Our final experiment was explicitly designed to test whether a relative pronoun bearing accusative case can induce case attraction errors. To this end, Experiment 4 will compare locally ambiguous SO-sentences with an accusative relative clause to analogous sentences but with a nominative or dative relative clause (cf. (7) and (10) from above, respectively). Both sentences with a feminine and with a masculine first NP will be used. For sentences containing a dative relative pronoun, including feminine as well as masculine NPs will allow us to test how robust the difference in the frequency of attraction errors is that we found in Experiment 2 between feminine and masculine NPs. Two example sentences with an accusative relative pronoun are provided in (18). In (18a) the accusative relative clause modifies a feminine proper name, in (18b) it modifies a masculine proper name. Note that the masculine relative pronoun den is unambiguously specified for accusative case whereas the feminine relative pronoun die is two-way ambiguous between nominative and accusative case. The fact that die bears accusative case in (18a) is therefore only determined by its sentential context, namely the fact that the relative clause contains the pronoun ich which is unambiguously marked for nominative case. Including both feminine and masculine NPs therefore allows for a further test of our prior finding that morphological ambiguity has no effect on case attraction errors.

(18) a. Ich glaube, daß **Maria, die** ich gerade getroffen habe, das Buch geschickt **hat**.

I believe that Maria who I just met have the book sent has
"I believe that the man who I just met sent the book"

b. Ich glaube, daß **Peter, den** ich gerade getroffen habe, das Buch geschickt **hat**.

I believe that Peter who I just met have the book sent has
"I believe that the man who I just met sent the book"

Under the syntactic assumptions introduced above, accusative case equals nominative case in being unmarked. An accusative relative pronoun, be it ambiguous or not, should therefore not be able to induce attraction errors. It is therefore predicted that sentences containing an accusative relative clause should not differ from control sentences containing a nominative relative clause whereas sentences with a dative relative clause should induce attraction errors as in the experiments before.

There are several alternatives to the hypothesis just outlined. For example, one could postulate a three-way hierarchy within the German case system, with dative being more marked than accusative and accusative in turn being more marked than nominative. Under such a three-way hierarchy it might be expected that both dative and accusative case can induce case attraction, but that dative is attracted more often than accusative.

Method

Subjects. 30 students of the University of Jena participated in this experiment. All were native speakers of German and naive with respect to the purpose of the experiment. Subjects received either 5 DM or course credits for participating in the experiment.

Materials. For Experiment 4, 30 sentences with a SO-word-order were constructed with each sentence appearing in six versions according to the two factors gender of the first NP (feminine vs. masculine) and case on the relative pronoun (nominative vs. accusative vs. dative). A complete sample item from Experiment 4 is shown in Table 10.

The sentences had the same overall syntactic structure as the sentences used in the prior three experiments. The head NP was always a proper name, either a feminine or a masculine one, and the sentences were therefore locally ambiguous until the end the sentence. The relative pronoun immediately following the head NP was either marked for nominative, accusative or dative case. In contrast to the former experiments, sentences in this

experiment ended in a combination of participle and auxiliary. Since only sentences with SO-word-order were tested, the final auxiliary was always a finite form of the perfect auxiliary haben (to have). However, all sentences would also have been compatible with a passive auxiliary in which case an OS-word-order would have to be assigned (cf. the active-passive pair in (5)). In accordance with the preceding experiments, it was therefore the last word of each sentence that provided the final disambiguating information.

The experimental sentences were divided into 6 sets, each set containing only one version of a sentence and an equal number of sentences in each condition. The resulting lists of experimental sentences were randomly intermixed with 107 filler sentences. A repeated measures design incorporating a Latin square was used. Each subject was exposed to all conditions but saw each experimental sentence only once.

Insert Table 10 about here

Procedure. The same speeded grammaticality judgments procedure was used as in the preceding experiments.

Results

Insert Table 11 about here

Judgments. Percentages of correct judgments are shown in Table 11. Sentences with a dative relative clause received less correct judgments than either sentences with a nominative or an accusative relative clause, resulting in an highly significant effect of relative clause ($F_1(2,58) = 9.60, p < .01$; $F_2(3,117) = 11.96, p < .01$). Both the factor gender

and the interaction between gender and relative clause did not reach significance (all F 's < 1). Planned comparisons revealed only one significant effect: Sentences with a dative relative pronoun received less correct responses than sentences with either a nominative or accusative relative clause (68% vs. 83%; $t_1(58) = 4.38, p < .01$; $t_2(58) = 4.89, p < .01$). All other comparisons were not significant.

Judgment times. Reaction times for correct answers are shown in Table 11. Before reaction times were analyzed, the same outlier procedure was applied as in the preceding experiments. Analyses of variance revealed no significant differences between any conditions (all F -values for the two main effects and the interaction between them < 1.2).

Discussion

The main outcome of Experiment 4 is that dative relative clauses induced case attraction errors but accusative relative clauses did not. This is the predicted outcome given our hypothesis that accusative case, in contrast to dative case, is unmarked and therefore not signaled by a case flag within the CPPM. In contrast to Experiment 2, there was no significant difference between feminine and masculine sentences with respect to the frequency of dative attraction errors. Whatever the reason for finding such a difference in Experiment 2 might have been, this suggests that this difference is not a systematic and reliable one.

General Discussion

The four experiments reported in this paper allow two major conclusions. First, the phenomenon that we have labeled CASE ATTRACTION is indeed an instance of feature attraction, in the sense that it is caused by the erroneous migration of a case feature from a relative pronoun to the head NP. This conclusion is based on the finding that case attraction

is found independent of whether the head NP is ambiguous or not. In this respect, case attraction errors are on a par with number attraction errors in English and other languages. As with number attraction errors, case attraction errors are not dependent on the head noun being ambiguous. The finding of case attraction errors with unambiguous head nouns excludes a range of alternative hypotheses that have attributed case attraction in ambiguous sentences to some kind of syntactic ambiguity resolution strategy (cf. Bader, 1994; Schlesewsky, 1996; Sauerland, 1996). Such hypotheses must be rejected because they cannot explain why case attraction occurs as often with unambiguous head NPs as with ambiguous head NPs.

The second major conclusion that the preceding experiments allow is that the pattern of case attraction errors closely mirrors the markedness relations within the German case system. Whereas dative case is sometimes attracted when subjects comprehend sentences, neither nominative nor accusative is, independent of whether the latter two are unambiguously signaled by morphological means or not. This particular pattern of case attraction supports the syntactic assumption that markedness within the German case system has to be captured by the notion of underspecification. This conclusion stems from the fact that case attraction errors show an "anti-frequency effect" in the sense of Stemberger (1991). Stemberger (1991) points out that in certain phonological speech errors a less frequent element replaces a more frequent element more often than the reverse. For example, in one of the experiments reported by Stemberger, alveolar consonants were replaced by palatoalveolar consonants (e.g., SHO instead of so) more often than the other way around (e.g. SO instead of show). This is an anti-frequency effect since alveolar consonants are more frequent in English than palatoalveolar consonants. Stemberger argues that such anti-frequency effects strongly argue for underspecification in the underlying phonological representation of words. Working within an activation based framework, his

argument is as follows. More frequent features will have an higher base-level activation than less frequent features. This implies that when a more frequent feature competes with a less frequent one, as in certain speech errors, the more frequent feature should win over the less frequent one. For speech errors showing an anti-frequency effect, this implication is in the opposite direction to what is actually found. However, this implication only holds if both of the competing features are actually present in the underlying representation. If instead one operates with the notion of underspecification, one can assume that the more frequent feature is absent from the underlying representation whereas the less frequent feature is specified. Such an assumption would be compatible with the finding of anti-frequency effects. In speech errors exhibiting an anti-frequency effect, what happens under the assumption of underspecification is that a less frequent, specified feature can erroneously crop into the empty place of the more frequent feature but not vice versa. Eberhard (1997) has used the same logic to argue for underspecification within the English number system given what is known about number attraction errors.

For the German case system, frequency counts show that nominative is more frequent than dative case (König, 1983). This means that attraction errors exhibit an anti-frequency effect in that a less frequent case feature can overwrite a more frequent one. Applying the argumentation of Stemberger (1991), this strengthens the syntactic assumptions followed throughout this article, namely that structural cases (nominative, accusative) are underspecified whereas dative case is specified. Otherwise one should expect that the more frequent nominative feature can override the less frequent dative feature but not the reverse that is actually observed.

As a final question, we should ask what implications our results on case attraction errors have for the mental processes that implement case assignment and case checking during language comprehension. Before addressing this question, we would like to point out that

our finding that dative case can erroneously override nominative case but not vice versa is not confined to case attraction errors. A further area where this kind of asymmetry between dative and nominative case shows up is in the processing of ungrammatical sentences containing case violations. An ungrammatical active sentence and a corresponding ungrammatical passive sentence are provided in (19a) and (19b), respectively. Sentence (19a) contains an active verb which requires an animate subject and an inanimate object. The only animate NP in (19a), however, namely the NP der Mutter, is marked for dative case, and the sentence is therefore ungrammatical. The passive verb in (19b) requires an inanimate subject and optionally an animate dative object. Since the only animate NP in (19b), the NP die Mutter, is not marked for dative case, the sentence is again ungrammatical.

(19) a. *... daß der Mutter das Buch geschickt **hat**.

that the-DAT mother the book sent has

b. *... daß die Mutter das Buch geschickt **wurde**.

that the-NOM/ACC mother the book sent was

In several experiments using the same method of speeded-grammaticality judgments as used in the experiments reported in this paper, we have found that ungrammatical active sentences are judged as ungrammatical with much higher reliability than ungrammatical passive sentences (cf. Bader, Meng, and Bayer, in press; Meng & Bader, 1999). For example, in an experiment reported in Bader et al. (in press), ungrammatical sentences like (19a) were rejected as ungrammatical to 90% whereas ungrammatical sentences like (19b) received only 60% correct rejections.

In terms of markedness, the finding concerning ungrammatical sentences as in (19) can be described as follows: Whereas a marked case (dative) tends to erroneously override an

unmarked one (nominative) (cf. (19b)), the reverse does not happen (cf. (19a)). This is exactly the same pattern that we found for attraction errors. However, there is also a difference between case attraction errors and the processing of ungrammatical sentences. As shown by the results of Experiment 2 and Experiment 3, morphological ambiguity is not a factor relevant for case attraction. Case attraction occurs with definite NPs whether the NP contains a feminine determiner like die, which is two-way ambiguous between nominative and accusative case, or a masculine determiner like der, which is only compatible with nominative case. For ungrammatical sentences, in contrast, there is a pronounced effect of morphological ambiguity (cf. Bader et al., in press). Whereas ungrammatical passive sentences like (19b) are judged as ungrammatical rather poorly, performance gets much better when the feminine NP die Mutter is replaced by the masculine NP der Vater. Since the only relevant difference between these two kinds of NPs lies in the fact that a feminine NP like die Mutter is two-way ambiguous whereas a masculine NP like der Vater is unambiguous, we may conclude that for ungrammatical sentences, nominative case is more easily overwritten by dative case when the nominative NP is morphological ambiguous than when it is not.

Taken together, the findings on case attraction errors and on errors occurring during the processing of ungrammatical sentences present the following picture. Both phenomena display the same kind of sensitivity with respect to the markedness distinction inherent in the case system of German: A marked case can override an unmarked one but not vice versa. Morphological ambiguity, in contrast, has no effect on case attraction errors but it affects the processing of ungrammatical sentences and the processing of garden-path sentences, as suggested by the finding that ambiguous passive sentences elicited a stronger garden-path effect in Experiment 3 (masculine first NP) than in Experiment 1 (feminine first NP). This particular pattern of case-related effects suggest the following picture of the

mental processes that implement case assignment and case checking during on-line language comprehension. First, case attraction errors occur during first-pass parsing whereas the processing of ungrammatical sentences crucially involves processes of second pass parsing. Second, the syntactic structure computed during first-pass parsing – the current partial phrase marker - does not encode information about morphological ambiguity. What is encoded within the CPPM is only positive information, for example, that a NP bears nominative case, but no negative information, for example, that a NP is not compatible with a case other than nominative. Under this assumption, proper names do not differ from definite NPs, and masculine NPs do not differ from feminine NPs, insofar potential case ambiguity is concerned. If this is so, and case attraction errors occur during first parsing in that a dative feature on a relative pronoun is attracted by the head NP, it follows that morphological ambiguity had no effect on the frequency of case attraction. With respect to second-pass parsing, or reanalysis, finally, we assume that morphological ambiguity has an influence when reanalysis involves checking the lexical items involved in the temporary or permanent ungrammaticality that signals the need to reanalyse (cf. Bader et al, in press, for further discussion). This is the case in ungrammatical sentences of the sort shown in (19b). In order to determine that such a sentence is indeed ungrammatical, the lexicon has to be consulted to make sure that the determiner is incompatible with dative case, and effects of morphological ambiguity therefore are possible.

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AUTHORS' NOTE

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Footnotes

- ⁱ All planned comparisons reported in this paper are based on two-tailed tests.

Table 1
The inflection paradigm for German relative pronouns

	Singular			Plural
	Masculine	Feminine	Neuter	
Nominative	der	die	das	die
Accusative	den	die	das	die
Dative	dem	der	dem	denen
Genitive	dessen	deren	dessen	deren

Table 2
Predictions of the Case Attraction Hypothesis (CAH) and the Parallel Function Hypothesis (PFH)
concerning garden-path effects in ambiguous and unambiguous SO- and OS-sentences

	CAH	PFH
SO		
Maria, der (11a)	yes	yes
die Frau, der(11b)	yes	no
OS		
Maria, die (10)	yes	yes
der Frau, die (12b)	no	no

Table 3

A complete sample item from Experiment 1. All clauses shown in the table were preceded by the main clause Wir alle konnten gut verstehen, ("We could all understand well")

Subject before object	
control	daß unsere Chefin ein so gutes Angebot annahm.
(simple unambiguous NP)	<u>that our boss a so good offer accepted</u> <u>"that our boss accepted such a good offer"</u>
ambiguous	daß Judith, der man übrigens das Auto geklaut hat,
with relative clause	<u>that Judith who one by the way the car stolen has</u> ein so gutes Angebot annahm. <u>a so good offer accepted</u> <u>"that Judith, who was stolen her car, accepted such a good offer"</u>
unambiguous	daß unsere Chefin, der man übrigens das Auto geklaut hat,
with relative clause	<u>that our boss who one by the way the car stolen has</u> ein so gutes Angebot annahm. <u>a so good offer accepted</u> <u>"that our boss, who was stolen her car, accepted such a good offer"</u>
Object before subject	
control	daß unserer Chefin ein so gutes Angebot schmeichelte.
(simple unambiguous NP)	<u>that our boss a so good offer pleased</u> <u>"that such a good offer pleased our boss"</u>
ambiguous	daß Judith, die übrigens wieder umgezogen ist,
with relative clause	<u>that Judith who by the way again moved is</u> ein so gutes Angebot schmeichelte. <u>a so good offer pleased</u> <u>"that such a good offer pleased Judith, who moved again"</u>
unambiguous	daß unserer Chefin, die übrigens wieder umgezogen ist,
with relative clause	<u>that our boss who by the way again moved is</u> ein so gutes Angebot schmeichelte. <u>a so good offer pleased</u> <u>"that such a good offer pleased our boss, who moved again"</u>

Table 4

Experiment 1: Percentage of Correct Judgments, and Mean Reaction Times (ms) to Make Correct Judgments, for Each of Two Word Orders (SO vs. OS) and Three First NPs (Control vs. Ambiguous vs. Unambiguous). Standard Errors (by Subjects) are Shown in Parentheses.

	Subject-Object			Object-Subject		
	control	ambiguous	unambiguous	control	ambiguous	unambiguous
Percentage correct	92 (3.1)	77 (4.2)	74 (3.9)	85 (3.0)	85 (3.8)	85 (2.7)
Judgement time	605 (31.3)	686 (38.6)	697 (30.9)	626 (33.8)	759 (44.3)	647 (33.5)

Table 5
Predictions of the syntactic definition of markedness and the morphological definition of markedness with respect to the processing difficulties in feminine and masculine SO-sentences

	Syntactic definition of markedness	Morphological definition of markedness
Feminine	Maria, der = die Frau, der	Maria, der = die Frau, der
Masculine	Peter, dem = der Mann, dem	Peter, dem > der Mann, dem

Table 6

A complete sample item from Experiment 2. All clauses shown in the table were preceded by the main clause Wir alle konnten gut verstehen, (We could all understand well). The two types of NPs (feminine and masculine NPs) are given in braces. The first NP is always a feminine NP, the second NP a masculine one.

Control	daß {unsere Chefin/unsere Chef} ein so gutes Angebot annahm. that {our boss} a so good offer accepted "that our boss accepted such a good offer"
Ambiguous	daß {Judith/Dieter}, {der/dem} man übrigens das Auto geklaut hat, ein so gutes Angebot annahm. <u>that {Judith/Dieter} {who} one by the way the car stolen has a so good offer accepted</u> <u>"that {Judith/Dieter}, who was stolen her/his car, accepted such a good offer"</u>
Unambiguous	daß {unsere Chefin/unsere Chef}, {der/dem} man übrigens das Auto geklaut hat, ein so gutes Angebot annahm. <u>that {our boss} {who} one by the way the car stolen has a so good offer accepted</u> <u>"that our boss, who was stolen her/his car, accepted such a good offer"</u>
Ungrammatical	daß {unserer Chefin/unserem Chef}, {der/dem} man übrigens das Auto geklaut hat, ein so gutes Angebot annahm. <u>that {our boss} {who} one by the way the car stolen has a so good offer accepted</u>

Table 7

Experiment 2: Percentage of Correct Judgments, and Mean Reaction Times (ms) to Make Correct Judgments, for Each of Two Genders (Feminine vs. Masculine) and Four First NPs (Control vs. Ambiguous vs. Unambiguous vs. Ungrammatical). Standard Errors (by Subjects) are Shown in Parentheses.

	Feminine		Masculine	
	Percentage correct	Judgement time	Percentage correct	Judgement time
Control	93 (1.4)	669 (25.3)	94 (2.0)	632 (22.3)
Ambiguous	76 (2.9)	785 (30.5)	84 (2.0)	723 (27.0)
Unambiguous	77 (2.5)	750 (30.9)	84 (2.1)	719 (29.1)
Ungrammatical	63 (2.9)	899 (30.0)	61 (3.1)	906 (34.8)

Table 8
Predictions of the syntactic definition of markedness and the morphological definition of markedness with respect to garden-path effects in ambiguous and unambiguous SO- and OS-sentences

	Syntactic	Morphological
Ambiguous		
SO: Peter, dem	yes	yes
OS: Peter, der	yes	yes
Unambiguous		
SO: der Mann, dem	yes	yes
OS: dem Mann, der	no	yes

Table 9

Experiment 3: Percentage of Correct Judgments, and Mean Reaction Times (ms) to Make Correct Judgments, for Each of Two Word Orders (SO vs. OS) and Three First NPs (Control vs. Ambiguous vs. Unambiguous). Standard Errors (by Subjects) are Shown in Parentheses.

	Subject-Object			Object-Subject		
	control	ambiguous	unambiguous	control	ambiguous	unambiguous
Percentage correct	93 (1.7)	78 (3.9)	81 (2.9)	95 (1.4)	76 (3.0)	93 (1.7)
Judgement time	582 (27.8)	648 (40.2)	627 (33.2)	570 (28.1)	716 (33.8)	570 (26.0)

Table 10

A complete sample item from Experiment 4. All clauses shown in the table were preceded by the main clause Große Verwunderung hervorgerufen hatte auch (It also caused great wonder). The two types of NPs (feminine and masculine NPs) are given in braces. The first NP is always a feminine NP, the second NP a masculine one.

Nominative relative clause	<p>daß {Christine/Christian}, {die/der} mich nächste Woche besuchen kommt, <u>that Christine/Christian who me next week visit comes</u> das Päckchen bis nach Hamburg nachgeschickt hat. <u>the parcel up to Hamburg sent has</u> "that {Christine/Christian}, who will visit me next week, sent the parcel forward to Hamburg"</p>
Accusative relative clause	<p>daß {Christine/Christian}, {die/den} ich nächste Woche besuchen werde, <u>that Christine/Christian who I next week visit will</u> das Päckchen bis nach Hamburg nachgeschickt hat <u>the parcel up to Hamburg sent has</u> "that {Christine/Christian}, who I will visit next week, sent the parcel forward to Hamburg"</p>
Dativ relative clause	<p>daß {Christine/Christian}, {der/dem} ich erst kürzlich begegnet bin, <u>that Christine/Christian who I just recently met met</u> das Päckchen bis nach Hamburg nachgeschickt hat. <u>the parcel up to Hamburg sent has</u> "that {Christine/Christian}, who I met recently, sent the parcel forward to Hamburg"</p>

Table 11

Experiment 4: Percentage of Correct Judgments, and Mean Reaction Times (ms) to Make Correct Judgments, for Each of Two Genders (Feminine vs. Masculine) and Three Relative Pronouns (Nominative vs. Accusative vs. Dative). Standard Errors (by Subjects) are Shown in Parentheses.

	Feminine			Masculine		
	Nominative	Accusative	Dative	Nominative	Accusative	Dative
Percentage correct	84 (3.6)	83 (2.7)	67 (4.3)	81 (3.4)	83 (4.0)	70 (5.2)
Judgement time	690 (51.8)	710 (43.6)	728 (43.9)	698 (42.3)	700 (40.9)	724 (50.2)

Figure Captions

Figure 1: Syntactic representations of a VP containing an argument bearing structural case (left side) and a VP containing an argument bearing lexical case (right side).

Figure 2: Partial syntactic representations of a proper name followed by a dative relative pronoun. The left side shows the correct grammatical structure; the right side shows the structure resulting from case attraction.

Figure 3: Partial syntactic structures of a head NP followed by dative relative pronoun. On the left side, the head NP is a proper name; on the right side, the head NP is a definite NP.

Figure 4: Partial syntactic structures for a definite NP followed by a relative clause. On the left side, the head NP bears structural case and the relative pronoun dative case; on the right side, the head NP bears dative case and the relative pronoun structural case.

Figure 5: Partial syntactic structures for masculine NPs followed by a dative relative pronoun. When the head NP is a proper name (tree on the top), there is difference between the syntactic and the morphological definition of markedness; when the head NP is a definite NP, the syntactic definition of markedness leads to the structure on the bottom left and the morphological definition to the structure on the bottom right.

Figure 6: Partial syntactic structures for a definite NP followed by a relative clause under a syntactic definition of markedness. On the left side, the head NP bears structural case and the relative pronoun dative case; on the right side, the head NP bears dative case and the relative pronoun structural case.

Figure 7: Partial syntactic structures for a definite NP followed by a relative clause under a morphological definition of markedness. On the left side, the head NP bears structural case and the relative pronoun dative case; on the right side, the head NP bears dative case and the relative pronoun structural case.













