Syntactic Features in Reanalysis: Positive and Negative Symptoms

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Meng and Bader have presented evidence that a Case conflict is a more effective cue for garden-path reanalysis than a number conflict is, for German wh-sentences with subject-object ambiguities. The preferred first-pass analysis has the wh-trace in subject position, although object position is correct. In a speeded grammaticality judgment task, perceivers accepted Case-disambiguated examples more often and more rapidly than number-disambiguated examples, although comprehension questions indicated that both were eventually understood correctly. For ungrammatical sentences, a Case mismatch error resulted in more false positive grammaticality judgments than a number mismatch error. We offer an explanation for why Case and number features differ in these two ways in their effects on sentence processing. We propose, within the Diagnosis Model of garden-path processing, that reanalysis triggered by a Case mismatch guides the parser more effectively toward the correct structure. Case is a positive symptom, which carries information about the new structure that must be built. By contrast, a number mismatch is a negative symptom; it invalidates the incorrect structure without showing how to rebuild it. This difference in the transparency of garden-path repair can also account for the greater overacceptance of Case-disambiguated ungrammatical sentences. The speeded grammaticality judgment task is designed to encourage hasty responses. Usually, these are hasty rejections of garden path sentences that, on calmer reflection, the parser would find acceptable. Conversely, over-hasty acceptance could occur if some initial progress is made in resolving a grammatical problem. Thus, a higher rate of false positives on ungrammatics is to be expected where reanalysis proceeds successfully for a while before blocking.

This paper derives from Fodor (1997), a response to the paper presented at AMLaP-96 by Michael Meng and Markus Bader, to whom we are deeply indebted. They have been generous in sharing with us their experimental findings, including as yet unpublished results, and we have sharpened our understanding of theoretical issues in a series of interesting discussions with them.

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SUBJECT–OBJECT GARDEN PATHS IN GERMAN

Meng and Bader (1996; in press) have discovered that in subject–object garden paths in German, disambiguation by Case is more effective than disambiguation by number (see also Schlesewsky et al., in press). Accepting here the experimental data that Meng and Bader present, we ask why Case and number features differ in this way.

The subject–object garden path occurs to a limited extent in English, in examples as in (1) (note that disambiguating words are italicized).

(1) a. Which students have . . . students = SUBJ or OBJ
    b. Which students have brought pencils? students = SUBJ
    c. Which students have pencils? students = SUBJ
    d. Which students have pencils been given to? students = OBJ
    e. Which students has . . . students = OBJ
    f. Which students must the . . . students = OBJ

The initial fragment (1a) is ambiguous. In (1b and c) the wh-phrase can only be the subject; in (1d–f) it must fill some later “gap” in the sentence, such as the direct object or other argument of the matrix clause or an argument of a subordinate clause (collectively designated here as OBJ).

The garden path in German is illustrated in examples (2) and (3), from experiment 3 of Meng and Bader (in press). Slightly different constructions have been tested in other experiments, but basically they are all cut to the same design. For reasons of space, we will not distinguish among them in discussing how they are processed. The ambiguity is more widespread in German because it occurs in subordinate wh clauses also and as a result of scrambling in non-wh-clauses. It is exemplified here in matrix wh-constructions in which the object is in initial position because it has been moved by wh-fronting.

(2) Welche Vertreterin der Gewerkschaft haben die Minister
   SG,NOM/ACC PL PL, NOM/ACC
   vorhin heftig kritisiert?
   “Which delegate of the trade union have the ministers just furiously criticized?”

Then later, either a number conflict as in (2) or a Case conflict as in (3), shows that this is wrong. Reanalysis must then occur to shift the wh-trace out of subject position and into object position.

Figure 1 shows partial results from a speeded grammaticality judgment task, from Meng and Bader’s experiments 1 and 2. The basic finding is that a Case conflict is quickly responded to without serious disruption and sentences are judged grammatical, while a number conflict takes the

![Fig. 1. Partial results from a speeded grammaticality judgment task; experiments 1 and 2 from Meng and Bader (in press). Percentage correct judgments.](image)
Instead, something goes wrong. In (2) where number is what goes wrong, the auxiliary haben is plural, so its trace in I is plural, and this trace is in an agreement relation with the subject position, so the trace in subject position must be made plural. That trace is in a binding relation with the wh-phrase, so the wh-phrase must be made plural too. But it cannot be. The lexicon says that Vertreterin can only be singular. So now some other kind of repair must be undertaken. The number features have been revised back as far as the wh-phrase, but the trail stops there. The only thing to do is to sever the relation between the wh-phrase and the trace in subject position. At the very least, they must be decoindexed. We can suppose the wh-phrase is assigned index k, while the empty subject retains index i. At this point, the original error has been eliminated. The error was assigning the trace of the wh-phrase to subject position. Now that error has been undone. This is an improvement, although of a rather negative sort. There is now some rebuilding to be done, to recreate a legitimate tree. Two
things need to be tidied up: the wh-phrase needs to be assigned a trace somewhere in the tree, and the empty subject position must be licensed. The right way to fix these things is to put the wh-trace into object position and let the next NP in the input fill up the subject position. However, the human sentence parsing mechanism apparently does not find it easy to arrive at this solution. This is where our explanation lies. There are two points. First, we have observed that the progress so far has been backward progress. Before, the parser thought it knew the grammatical role of the wh-phrase and it thought it had found the subject of the sentence. Now, the tree structure specifies neither one. In this respect, the number cue for repair is negative: it is useful, but in a destructive not a constructive way. This then feeds into another problem: the rebuilding process does not go smoothly.

In rebuilding the tree, the parser will do what comes naturally to it, just as on the first pass. This means that its preferred position for the wh-trace, which it must now recreate, is the subject position—the position the trace just escaped from. Why would the trace want to go back there? Because all the usual preference principles choose that position. The Minimal Chain Principle favors it, since the subject position is closest. Minimal Attachment favors it, because the subject node is already built, while the object node does not yet exist and would need to be created. It is not even clear, at this stage, that there will be an object position. Whether there will or not depends on the transitivity of the thematic verb which has not yet arrived. Moreover, the wh-phrase is still marked nominative, since that is what the parser guessed on the first pass. So of course it wants its trace to be in subject position. In the Diagnosis Model, the reanalysis routines recheck the properties of lexical items only if the diagnostic process specifically points toward them as needing to be remedied. So the wh-phrase could be changed to accusative, but only if some other influence urges object attachment for the trace. That is not the case here. As observed, all the other pressures urge the trace toward subject position instead.

In short, although it just broke away from the wh-subject analysis, the parser is drawn back to that same wrong analysis as it tries to rebuild the tree after the surgery. The parser repeats its subject-trace error. It might do so forever, except that eventually the input brings in the next NP and forward parsing proceeds again. This next NP would prefer to be attached as the subject, for much the same reasons as the wh-NP did. Thus it takes over the subject position and the wh-trace then has to take the object position—

\[\text{This would seem to imply that reanalysis is significantly more difficult in an otherwise comparable subordinate clause in which both NPs precede the disambiguating finite verb that disagrees in number with the presumed subject. There would now be two NPs to revise and no new input to jog the parser into the right revision. However, there is a possible alternative route to reanalysis in this situation. The finite verb might attach low into the VP, to avoid the number clash that would occur if it attached beneath the I node that agrees with the presumed subject trace. The VP would thereby be converted into IP, making the old object now the subject; the old subject position above this would be eliminated. The wh-trace would need to find a new position and only the object position would now be open.}\]

**Syntactic Features in Reanalysis**

**Diagnosis with Case Symptom**

Consider now what happens when the conflict concerns Case. It is quite easy to see why a Case symptom is more effective. Although it arrives later than the number symptom, it gets the right repairs moving. In (3) the auxiliary attaches without any problem. However, then comes an unmistakeably nominative NP, which has to be the subject. So the parser puts this NP into subject position, ousting the trace that was there. Here, in one step, the original error has been eliminated: the wh-phrase was incorrectly associated with the subject position and now it is not. This is progress, and of a forward, constructive kind: the parser used to have a subject for the sentence, and now again it has a subject (the right one). Where the number symptom was purely negative, the Case symptom is positive. It does not just break apart the wrong tree; it builds up the right tree.

The new analysis is less specific than before in just one respect: it needs a new trace for the wh-phrase. As before, the parser has to find a position for that trace. However, this time it has more guidance and will not make the same mistake. The second NP has already taken over the subject position, so the wh-trace is forced to make do with object position—which is correct. A lexical check will be made to establish that the wh-phrase can be accusative and the reanalysis is finished. [The closest analog in English of this efficient Case disambiguation in German is example (1f) above, in which the NP following the auxiliary makes it easy to recognize that the wh-phrase is not the subject. In English, the cue is the presence of this NP regardless of its Case marking.]

**SYNTACTIC FEATURES IN THE DIAGNOSIS MODEL**

**Positive and Negative Symptoms**

To summarize so far: We have observed (i) that (at least in this construction) a Case symptom provides positive information while a number...
Universals of Symptom Effectiveness?

These observations are not limited to the repair of this particular garden path. If the Diagnosis Model is correct, there should be some universal trends concerning symptom effectiveness. Any agreement feature (not just number but also gender, person, definiteness, honorific, etc.) is likely to carry only negative information for the parser. Two situations can arise. (1) Featural disagreement between two elements shows that they do not stand in a grammatical relation requiring agreement (such as subject–verb). This can be useful information, but it is only negative. It says: X cannot be the subject of Y. It does not say what role X does have, and it does not say what is the subject of Y. (2) On the other hand, agreement between two elements shows nothing at all. It certainly does not guarantee that they stand in an agreement relation. A noun phrase may have the same agreement features as the verb, but that does not make it the subject of the verb. Every noun phrase in a sentence might agree with the verb, but only one of them is its subject (or none of them, if the subject is an empty category) (see also MacWhinney & Pléh, 1997).

For Case features, the situation is very different. A Case feature is typically associated with a unique structural position in a clause. (Exceptions exist; some Cases in some languages are nontransparent or “quirky.”) At least if the parser knows what clause it is in (as it might not in Japanese, for example), a Case feature can often place a noun phrase exactly in a tree. This is positive information which builds trees rather than just invalidating them. Case is not always perfectly informative, of course. It can fail because of morphological neutralization. Sometimes it is impossible to tell a nominative from an accusative from a dative. However, that is not our concern here. Our question was: When Case and agreement markings are unambiguously present, why do they differ in their leverage in shifting the parser from a wrong analysis to the right one? The Diagnosis Model gives an answer, and also predicts that the pattern goes beyond the particular constructions studied so far. It predicts a very general difference between agreement features and “absolute” features like Case, since they carry very different types of information for the diagnostic process.

UNGRAMMATICAL SENTENCES

Finally, we consider the ungrammatical examples in Meng and Bader’s experiments 1 and 2. These are shown in (6) and (7). They begin with a nominative NP, which must be the subject. Then later, either a number or a Case conflict (in 6 and 7, respectively) shows that it cannot be the subject.

(6) *Alle wollten wissen, welcher Politiker die Minister
   SG,NOM PL,NOM/ACC
   all wanted know which politician the minister
getroffen haben.
   PL
   get have

(7) *Welcher Politiker glaubst du, traf der Minister?
   SG,NOM SG,NOM
   which politician believe you met the minister

The number–symptom ungrammaticals are successfully rejected most of the time. The Case–symptom ungrammaticals are overaccepted at a high rate. How can this be related to garden-path recovery?

LF-Interpretability

It is the symptom that is so good for garden-path recovery (i.e., Case), which is so bad at getting ungrammaticality detected. For this reason, the explanation cannot depend on the salience of the feature or the memorability of the feature, since these should affect both phenomena in a similar way.

Under this heading, we must reluctantly reject a linguistic explanation that at first sight seems promising. As always, it is of interest when theoretical linguistic concepts and psycholinguistic phenomena converge, but this appears not to be so with regard to symptom effectiveness. As noted above, number, but not Case, is an LF-interpretable property of an NP. It is plausible, therefore, to suppose that a Case feature is erased once it has ushered its NP into a position in the syntactic tree. By contrast, number features
would remain in the mental representation in order to be present at LF. This could explain why the parser sometimes thinks it can repair a problem when, in fact, no repair is possible: if it is the Case feature that blocks the repair, but the Case feature has been dropped from the representation, the sentence will seem fine. However, this approach fails for three reasons.

First, it cannot be the Case feature of the second NP (the garden-path symptom) that is overlooked in the ungrammaticals, because Meng and Bader (in press) report comprehension question data indicating that by the time the sentence is over, the interpretation has flipped from subject–object to object–subject, showing that reanalysis was triggered. Second, it cannot be the Case feature of the first NP that is overlooked or forgotten in the ungrammaticals, because that is the same regardless of whether the symptom is Case or number; so this would not explain why the error rate is so different for the two symptom types. Finally, the features hypothesized to be overlooked in the parsing do not line up precisely with LF-interpretability, because (in the theory of Chomsky, op. cit.) the number feature on a verb is an uninterpreted feature. With regard to LF, therefore, number on the verb should behave like Case, not like number on an NP. Yet, Meng and Bader’s subjects, when they were asked to correct the ungrammaticalities, most often did so by altering the Case of the first NP (Meng & Bader, personal communication). They did not solve the problem by changing the number of the first NP from singular to plural or by changing the number of the verb from plural to singular. The LF-interpretability hypothesis does not explain why verb number was not “corrected.”

Hasty Judgments

In order to explain what we propose instead, it is useful to reorganize the data by considering the percentage of “yes” answers rather than percentage correct. This is shown in Fig. 2; only the presentation format differs from Fig. 1.

This makes it more obvious that it is the Case Conflict sentences that give rise to the most “yes” judgments, and the number conflict sentences that receive the fewest “yes” judgments, whether “yes” is correct (for the garden paths) or is incorrect (for the ungrammaticals). It looks as if ungrammaticality judgments are mimicking garden-path repair for some reason.

Next, we note that a judgment of ungrammaticality necessarily involves the garden-path recovery routines. The way to tell that a sentence is ungrammatical is to try to parse it and discover that no parse is possible. However, this will not be accurate unless the parser tries very hard to reanalyze the sentence before declaring it ungrammatical. Otherwise, the result may be a false negative judgment. Note, however, that this is the whole point of the speeded grammaticality judgment task. The task is used to obtain evidence of garden paths by enticing subjects to make hasty negative judgments on sentences that they might well say “yes” to, if they had time to consider. In other words, the point of this task is to tap into the revision process before it is complete. This can work both ways, however: it can give rise to false positives as well as false negatives.

The garden-path data indicate a period of uncertainty for a number symptom reanalysis, but rapid success for a Case symptom. Therefore, if the perceiver is making early judgments, there is some probability that the reanalysis will be looking bleak at that point for the number symptom, but will be looking quite rosy for the Case symptom. For ungrammaticals, of course, revision will never really work. However, it could look as if it is working, for a Case symptom which is making good progress in ousting the wrong subject and substituting the right one. The parser will reanalyze the structure successfully up to the moment of fitting the wh-trace into object position. Full of confidence at that point, it may launch its positive judgment. Then it checks the Case feature (of welcher Politiker in 7) and finds, too late, that it is nominative-only. By contrast, for the number symptom, there is a nasty period during which the parser knows that something is wrong but does not yet know how to put it right; so if it launched a judgment then, it would be a negative one.

In short, a higher rate of false positives on ungrammaticals is to be expected just where revision can proceed successfully a large part of the way. Thus, the data for the ungrammaticals also fall out from the Diagnosis Model. The model needs no changes or special adjustments in order to make sense of both the Case versus number distinction, and the garden-path/ungrammatical correlation.
REFERENCES


