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## **Proximity in agreement errors**

*Barbara Hemforth\**

*Lars Konieczny \*\**

*\*\* Laboratoire Parole et Langage, CNRS, Université de Provence, Aix en Provence, France*

*\*\*University of Freiburg, Germany*

*Laboratoire Parole et Langage, UMR 6057, Univ. de Aix en Provence*

*29, av. Robert Schuman, 13621 Aix en Provence, France*

*([barbara.hemforth@lpl.univ-aix.fr](mailto:barbara.hemforth@lpl.univ-aix.fr))*

### **Abstract**

Across languages subject-verb agreement errors have been established when subjects are producing complex (NP PP) noun-phrases (see Bock, 1995, for an overview). Very recently, Haskell & MacDonalds (2002) proposed a locality-based principle, the principle of proximity, to explain a variety of agreement errors in production. They base their argument partly on preferences in verb number marking in sentences with disjunctive noun phrases (e.g., "the hat and the gloves" vs. "the gloves and the hat"), where they found a preference for number marking that matched the local noun. We will present a series of five written production experiments on German constructions with disjunctive Subjects, NP PP Subjects and Subject-Object-verb subordinate clauses. We will show that - although comparable effects can be established for German sentences with disjunctive Subjects - a proximity based principle fails to cover major portions of the results. We propose an account that highlights the dynamics of plural-feature activation and percolation.

### **Introduction**

It is well known by now that occasionally subjects erroneously produce plural verbs following a plural modifier in constructions like (1; quoted from Bock & Miller, 1991).

(1) The readiness of our conventional forces are at an all-time low.

The mechanism underlying this error is attributed to the marked plural feature percolating up the tree too far (Vigliocco & Nicol, 1998). This account is substantiated by the fact that no comparable singular/plural mismatch effect for constructions with marked plural heads has been established so far.

Very recently, Haskell and MacDonald (2002) proposed a principle of proximity as an alternative explanation. They showed that in disjunctions like (2), subjects have a strong preference to match the number marking on the verb with the more local noun. In addition to distributional evidence, this was taken to indicate that the classical attraction error at least partially and at least in English is caused by number marking on a close interfering noun.

- (2) a. The hat or the gloves is/are red.  
b. Is/are the hat or the gloves red?

We ran a series of five written production experiments to test the proposed mechanisms in German. The logic of the argument is that if we can replicate the mismatch effect (Experiment I) as well as the effect of order in disjunctions (Experiment II) a proximity based explanation should work in German as in English. However, proximity should also work in a case that is special for German, i.e. verb final subordinate clauses where the number marking on an object NP might interfere with number marking on the Subject (Experiments III, IV, and V). Since number marking on the object cannot percolate to the Subject in any way, no effect of an interfering object NP is expected from a “feature-percolating”-approach.

### Experiment I

In Experiment I we tried to replicate the well-known mismatch effect in NP PP constructions. Materials were tested for plausibility (all four conditions were approximately equally plausible).

#### Design

Two factors were varied in this first experiment: The factor “Match”: matching (1,4) or mismatching (2,3) number marking on head noun and local noun, and the factors “Number of the head noun”: singular (1,2) or plural (3,4) head noun.

- (1) Die Farbe auf der Leinwand \_\_\_\_\_ trocken.  
The color on the canvas \_\_\_\_\_ dry.  
(2) Die Farbe auf den Leinwänden \_\_\_\_\_ trocken.  
The color on the canvasses \_\_\_\_\_ dry.  
(3) Die Farben auf der Leinwand \_\_\_\_\_ trocken.  
The colors on the canvas \_\_\_\_\_ dry.  
(4) Die Farben auf den Leinwänden \_\_\_\_\_ trocken.  
The colors on the canvasses \_\_\_\_\_ dry.

#### Materials

Sixteen sentence sets (four per condition) were constructed following the pattern in (1) to (4). The materials were pre-tested such that all four NP PP combinations were equally plausible, since effects of plausibility on production errors have been established in earlier experiments (Branigan et al., 1995; Hölscher & Hemforth, 2000; Vigliocco et al., 1995, 1996).

#### Methods

In Experiments I to IV, 62 subjects (all native speakers of German) received a booklet with constructions missing an auxiliary which they had to fill in. All materials were part of the same

booklet. Materials were individually randomized. Participants were paid a small amount or received course credits for participation.

### Results

Number marking on the head noun clearly affected the percentage of agreement errors (Factor “Number of head noun”:  $F(1,61) = 22,5$ ;  $p < 0.001$ ). Neither the factor “Match” nor the number \* match interaction reached significance. However, whereas no difference in matching versus mismatching local nouns could be established for sentences with plural marked head nouns ( $F1, F2 < .5$ ), planned comparisons showed a marginal effect with singular marked head nouns ( $F(1,61) = 3.88$ ,  $p < 0.06$ ;  $F(1, 14) = 3.71$ ;  $p < 0.08$ ). Matching the literature, more agreement errors can be found for singular-plural ordering than for plural singular (e.g. Vigliocco & Nicol, 1998).

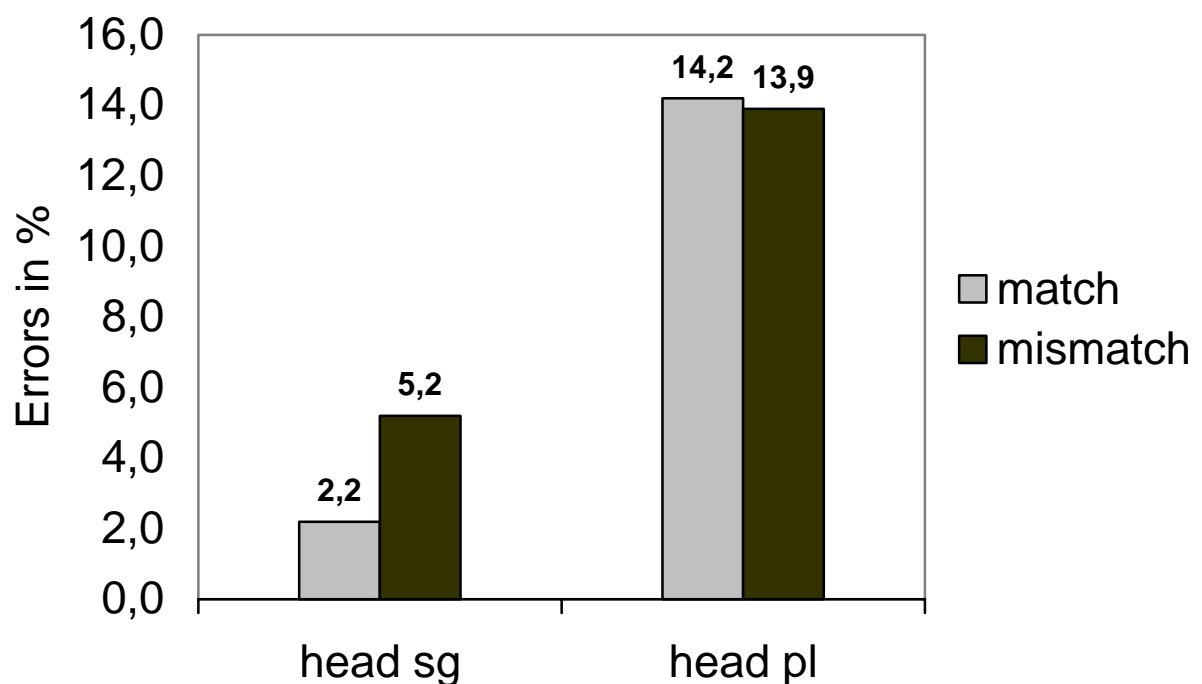


Figure 1: Agreement errors for NP PP constructions

### Discussion

In Experiment I we replicated the well-known mismatch effect (e.g. Bock & Miller, 1991). In those cases, where the local mismatching noun was marked for plural, the number of agreement errors increased. In line with earlier experiments on written production (e.g., Branigan et al., 1995; Fayol, Largy, & Lemaire, 1994; Hölscher & Hemforth, 2000), we found a considerably high number of agreement errors for plural marked head nouns, presumably reflecting a tendency to produce singular marked verb.

## Experiment II

Experiment II closely follows the design by Haskell & MacDonalds (2002), trying to replicate the effect of number marking of a local noun on the (written) production of German finite auxiliaries.

### Design

In Experiment II, the two experimental factors were “number marking on the local noun: singular (6,7) vs. plural (5,8), and “position of the auxiliary: auxiliary following disjunctive NP (5,6) vs. auxiliary preceding disjunctive NP (7,8).

(5) Der Hut oder die Handschuhe \_\_\_\_\_ rot.

The hat or the gloves \_\_\_\_\_ red.

(6) Die Handschuhe oder der Hut \_\_\_\_\_ rot.

The gloves or the hat \_\_\_\_\_ red.

(7) \_\_\_\_\_ der Hut oder die Handschuhe rot?

\_\_\_\_\_ the hat or the gloves red?

(8) \_\_\_\_\_ die Handschuhe oder der Hut rot?

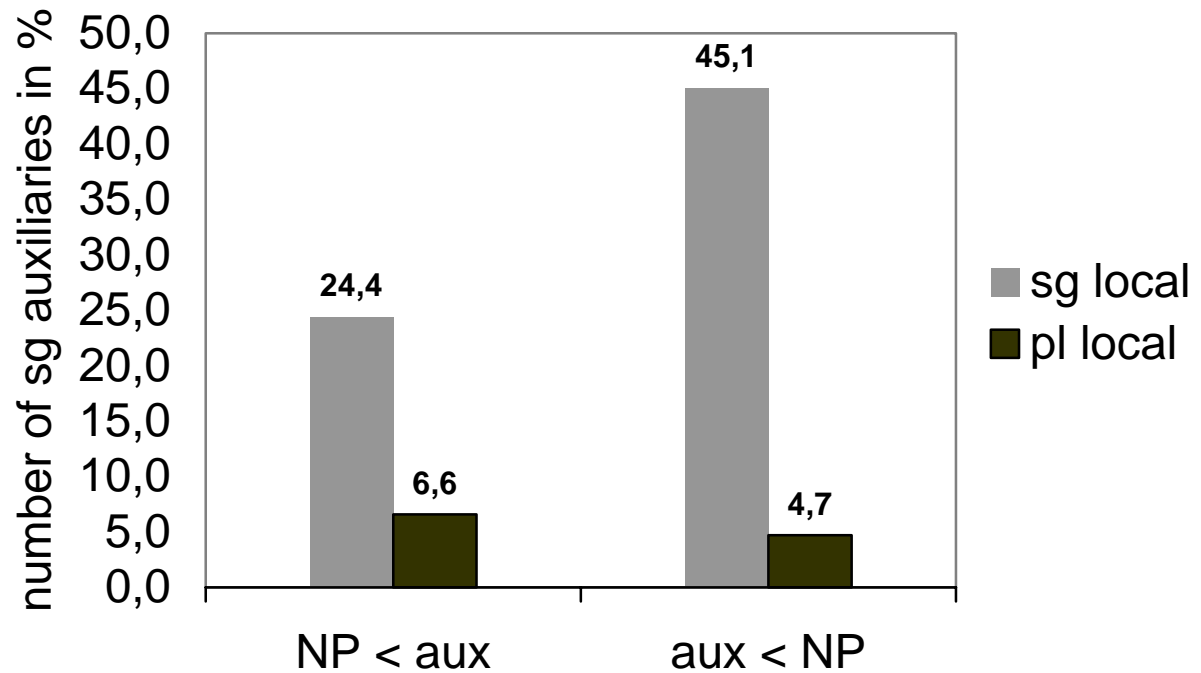
\_\_\_\_\_ the gloves or the hat red.

### Materials

Twenty sentence sets following the pattern exemplified in (5) to (8) were constructed.

### Results

As can be seen from Figure 2, number marking on the verb was strongly influenced by the number marking on the local noun ( $F(1, 61) = 60,88$ ;  $p < 0.001$ ;  $F(1, 19) = 42,3$ ;  $p < 0.001$ ). Moreover, more singular marked verbs were produced when the auxiliary preceded the disjunctive NP. However, this effect was mainly due to the particularly high number of singular marked auxiliaries preceding a singular local noun, which shows up in a reliable interaction (local noun \* position:  $F(1,61) = 19,79$ ;  $p < 0.001$ ;  $F(1,19) = 37,38$ ;  $p < 0.001$ ).



**Figure 2: Number marking for disjunctive Subjects**

### Discussion

Experiment II clearly shows that proximity does have an effect on verb number marking for sentences with disjunctive Subjects. This is fully compatible with data on English number marking presented by Haskell and MacDonalds (2002). However, for disjunctive Subject NPs, there does not exist a clear grammatical rule for number marking. Intuitively, singular as well as plural marking are acceptable when the local noun is singular marked. Experiments III to V will investigate in how far the proximity effect extends to more strongly constrained domains.

### Experiment III

A proximity based explanation of the mismatch effect should result in a comparable pattern of errors in German subject-object-verb clauses. This was investigated in Experiment III.

### Design

The experimental factors varied in Experiment III were

“Match”: matching (9,12) or mismatching (10,11) number marking on Subject NP and local object NP, and “Number of Subject”: singular (9,10) or plural (11,12) Subject NP.

- (9) Ich habe gehört, dass der Mann die Frau besucht \_\_\_\_\_.  
I have heard that the man(masc,nom) the woman visited \_\_\_\_\_.
- (10) Ich habe gehört, dass der Mann die Frauen besucht \_\_\_\_\_.  
I have heard that the man(masc,nom) the women visited \_\_\_\_\_.
- (11) Ich habe gehört, dass die Frauen den Mann besucht \_\_\_\_\_.

- I have heard that the women the man (masc, acc) visited \_\_\_\_\_.
- (12) Ich habe gehört, dass die Frauen die Männer besucht \_\_\_\_\_.
- I have heard that the men the women visited \_\_\_\_\_.

### Materials

Sixteen sets of sentences were constructed, following the pattern in (9) to (12). To be sure that the first noun phrase was interpreted as the subject of the sentence, either NP1 (9, 10) or NP2 (11) were unambiguously case marked (nominative Subject in 9,10; accusative Object in 11). Only the plural-Subject/plural-Object condition (12) did not allow for unambiguous case marking.

### Results

Number marking on the Subject had a strong effect on the number of agreement errors: more errors were produced following a plural Subject ( $F(1,61) = 17.04$ ,  $p < 0.001$ ;  $F(1,14) = 14.65$ ;  $p < 0.001$ ). For these sentences, planned comparisons also showed a marginal mismatch effect, in that more errors were produced when the local Object-NP was singular marked ( $F(1,61)=3.83$ ;  $p < 0.06$ ; ( $F(1,14)=3.46$ ,  $p < 0.09$ ).

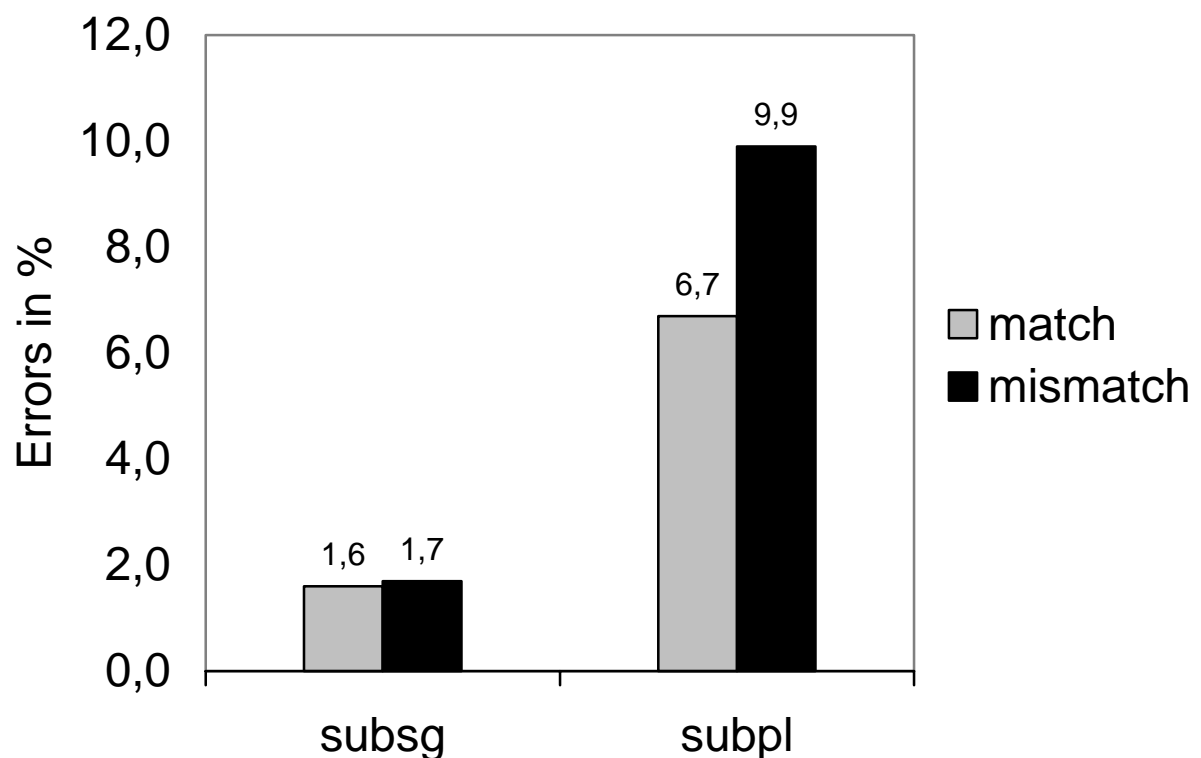


Figure 3: Agreement errors in SOV-constructions

### Discussion

With respect to the proximity principle, the results from Experiment III are rather mixed and somewhat surprising. The typical singular/plural mismatch effect that we established in

Experiment I for NP-PP-Subjects did not show up here. However, a mismatch effect was found for sentences with plural marked Subjects followed by singular marked objects. Before we discuss this result in more detail, we want to make sure, that in particular the lack of a mismatch effect in sentences with singular marked Subjects is not due to the use of masculine NPs (9,10) as Subjects. Schriefers and van Kempen (1993) only found agreement errors in German in constructions with feminine head nouns.

### **Experiment IV**

Experiment IV replicates Experiment III with the only difference that subject-object ordering is marked by semantic plausibility instead of case marking.

#### **Design**

As in Experiment III the two experimental factors varied in this experiment were “Match”: matching (13,16) or mismatching (14,15) number marking on Subject NP and local object NP, and “Number”: singular (13,14) or plural (15,16) Subject NP.

- (13) Es ist unwahrscheinlich, dass die Krankenschwester die Spritze vergessen \_\_\_\_\_.  
It is not probable that the nurse the injection forgotten \_\_\_\_\_.
- (14) Es ist unwahrscheinlich, dass die Krankenschwester die Spritzen vergessen \_\_\_\_\_.  
It is not probable that the nurse the injections forgotten \_\_\_\_\_.
- (15) Es ist unwahrscheinlich, dass die Krankenschwestern die Spritze vergessen \_\_\_\_\_.  
It is not probable that the nurses the injection forgotten \_\_\_\_\_.
- (16) Es ist unwahrscheinlich, dass die Krankenschwestern die Spritzen vergessen \_\_\_\_\_.  
It is not probable that the nurses the injections forgotten \_\_\_\_\_.

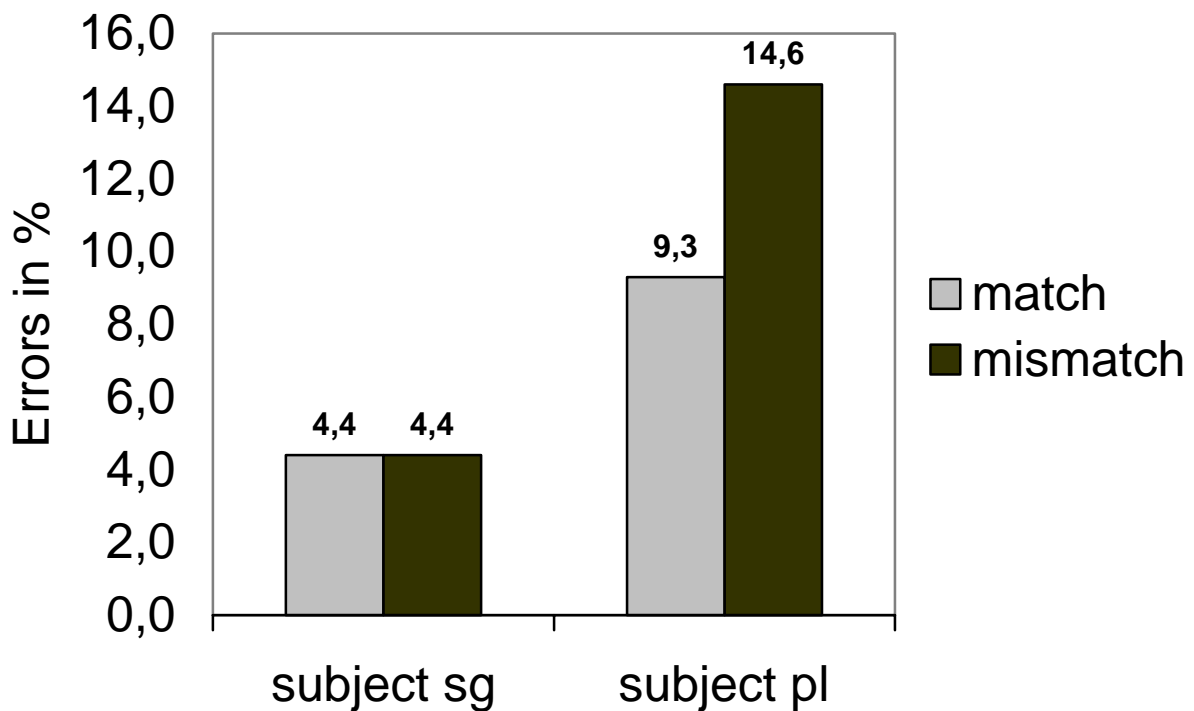
#### **Materials**

Twenty sentence sets following the pattern in (13) to (16) were constructed. Whereas in Experiment III case marking was applied to assure that NP1 was interpreted as the Subject and NP2 as the Object of the sentence, sentences in Experiment IV were disambiguated by semantic plausibility.

#### **Results**

As in Experiment III, we found a clear effect of number marking on the Subject: More errors were produced in sentences with plural marked Subjects. ( $F(1,61)=13,72$ ;  $p < 0.001$ ;  $F(1,19)=14.84$ ;  $p < 0.001$ ). Again, we did not find a mismatch effect for sentences with singular subjects (all  $F_s < 0.5$ ). However, the number of errors increased, when a plural Subject was followed by a singular Object ( $F(1,61) = 3.90$ ;  $p < 0.06$ ;  $F(1,19) = 3,28$ ;  $p < 0.09$ )





**Figure 4: Agreement errors in SOV-constructions**

### Discussion

The pattern of results is strikingly similar to that in Experiment III. Therefore the lack of a mismatch effect in sentences with a singular marked Subject-NP cannot be due to the use of masculine NPs. Admittedly, we only found marginal effects in both experiments. However, marginal effects that reliably reappear in every experiment should be taken seriously.

### Experiment V

One of the reasons why attraction errors occur in NP PP verb constructions may be that the local noun is erroneously taken as the Subject of the sentence (Hartsuiker, pers. comm.). So maybe we did not find object attraction in Experiments III and IV because explicit case marking in Experiment III and semantic plausibility in Experiment IV prevented the object from being mistakenly interpreted as the Subject of the sentence. We therefore ran a further study derived from the materials in Experiment III, where case marking could not be used to assign functional roles. Although there is a very strong preference to interpret these sentences as subject-object-verb orderings, they are, strictly speaking, ambiguous. Therefore, we ran a pre-test in order to take care that subjects understood the first noun phrase as the Subject and the second noun phrase as the object of the sentence.

### Design

The design was identical to that in Experiment III:

## Materials

Materials in Experiment V were identical to those from Experiment III with the only difference that masculine NPs were replaced by feminine NPs, so that neither case marking nor semantic plausibility could be used as a cue for Subject selection.

## Methods

In Experiment V, 32 subjects (all native speakers of German) received the same booklet as in the previous experiments. The only difference was that the materials for Experiment III were replaced by those from Experiment V.

## Results

A reliable effect of the number marking on the Subject-NP could be established as in the earlier experiments ( $F(1,31)=37,73$ ;  $p < 0.001$ ;  $F(1,19) = 50,03$ ,  $p < 0.001$ ). Although the pattern looks very similar to Experiments III and IV, there was no reliable mismatch effect for sentences with plural head nouns. However – though only across subjects – the interaction match by Subject number marking was marginally reliable ( $F(1,31) = 3,61$ ,  $p < 0.06$ ;  $F(2) ns$ ).

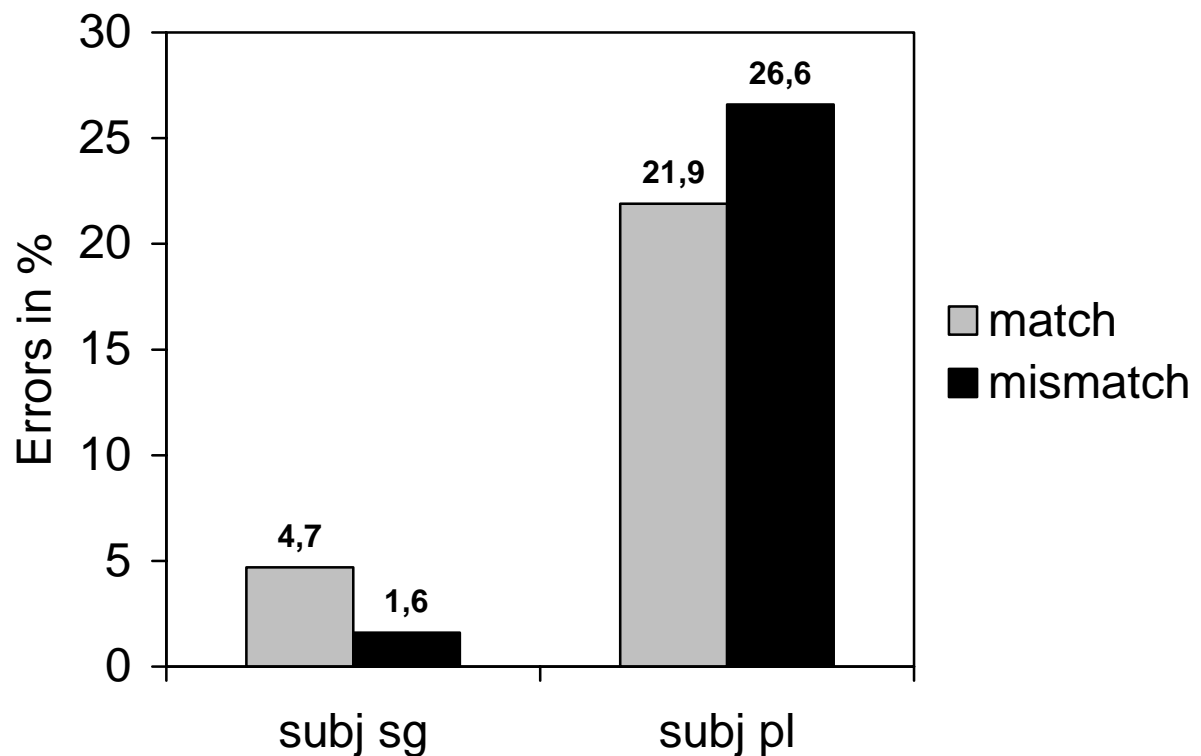


Figure 5: Agreement errors in SOV-errors

## Discussion

Although the results are not as clear as in the earlier experiments with respect to the mismatch effects for sentences with plural marked Subjects, the pattern is very similar. Very clearly, the

lack of a mismatch effects for sentences with singular marked subjects is not due to the fact that the Object-NP could not be interpreted as the Subject in Experiments III and IV.

### General Discussion

In Experiment I, we established the usual asymmetry between singular and plural head nouns with a mismatch effect showing up for singular head nouns but not for plural head nouns (though only marginally). Similar to Branigan (1995) and Hölscher & Hemforth (2000), more errors were found following plural head nouns but there was no effect of the number marking on the modifier.

In Experiment II we could show that our subjects were highly sensitive to the number marking on the local noun in disjunctions, although there was a general tendency for plural verbs. The proximity principle assumed by Haskell and MacDonald clearly seems to be at work in disjunctions in German as well. However, this result stands in contrast to Experiment I, where we found an asymmetry between singular and plural local nouns: only plural local nouns modulate the number of mismatch errors in Experiment I.

In Experiments III and IV, we wanted to find out in how far the proximity effect extends to different structures. In German sub-clauses the unmarked ordering of constituents is subject < object < verb. We presented our subjects with unambiguous orderings, disambiguated by case marking in Experiment III and by plausibility in Experiment IV. If a close plural marked noun has an effect on number marking on the verb, there should be an increased number of errors in sentences like (10) or (14) where a singular subject is followed by a plural object. However, no effect of the number marking on the object is expected if the “percolation-approach” is assumed. There is no way the number marking on the Object could percolate to the Subject of the sentence, which is a VP-external argument.

The results of experiments III and IV rule out surface proximity: No mismatch effect was established for sentences with singular Subjects. This part of the data is consistent with Vigliocco and Nicol’s approach as well as with evidence for syntactic proximity effects shown by Franck, Vigliocco, & Nicol, 2002).

However, in contrast to Experiment I, we found a marginal locality effect for sentences with plural subjects both in Experiment III, IV (and V). There were more errors (incorrectly produced singular verbs) following a singular object noun phrase than after a plural object noun phrase. While this part of the data appears to support proximity (more erroneous singular verb productions with singular objects), the earlier half of the results on singular Subjects does not; plural Objects did not increase the number of erroneous plural verb productions. Furthermore, Experiment I on NP-PP-V constructions lacks a proximity effect with plural Subjects, comprising a mirror image of the results obtained on SOV constructions. Apart from Experiment II, there is hence no consistent support for the proximity hypothesis. A plausible conclusion from these experiments is that proximity only shows (very strong) effects on number marking if syntactic constraints are very weak, as in the disjunctions employed in Experiment II.

The question remaining is why we do find a mismatch effect on singular Subjects in Experiment I, but on plural Subjects in Experiments III, IV and V? There are at least two possible explanations. Both presume a general tendency to produce singular (unmarked) verbs.

1. When Subjects in SOV constructions are marked for plural, the plural feature becomes activated, but its activation decays so that it eventually gets lost by the time the agreeing verb must be produced. More errors (singulars) will hence be produced with plural

Subjects because the reason to depart from the base tendency, the plural marking, gets lost in some cases. This is true for both Subject-PP (Experiment 1) and Subject-Object constructions (Experiments 3, 4, 5) followed by a verb. An intervening plural-Object, however, can reactivate the plural feature, so that it can be retrieved at the verb more easily. Errors in plural-plural-verb constructions are hence reduced compared to plural-singular-verb constructions. We assume that the reactivation of the plural feature is restricted to verb arguments like Objects. Objects are directly integrated with the verb, so that its features can interfere with those of other verb arguments. In contrast, modifiers of Subject NPs, like genitives or PPs, are not directly integrated with the verb, hence no reactivation of the plural marking of the head noun. The only way to interfere with the head noun is by percolation of the plural feature across the head, increasing the number of erroneous plural productions.

2. An alternative explanation is the use of a rather late monitoring stage, where the basic tendency to produce a singular verb even with plural subjects is inhibited by the plural marking on the object noun phrase. Because an object is a more salient referent than a noun modifier, it is more effective that the latter in inhibiting the singular preference.

It must be noted that our results seem to stand in contrast to those of Hartsuiker (2001), who did find an object attraction effect in Dutch SOV constructions. His study differs from ours in two important respects though. Firstly, Hartsuiker employed a different paradigm, a spoken production task, where subjects were forced to respond very quickly, yielding a much larger amount of overall errors. The increased cognitive load in these experiments may have enhanced the probability for agreement errors (for evidence on the role of cognitive load see Fayol, Largy, & Lemaire, 1994). Secondly, there is evidence that mismatch errors are generally much more frequent in Dutch than in German (Schriefers & van Kempen, 1993). A reason for this might be that German morphology is much richer than Dutch morphology, so that morphological cues are used more effectively in German. The lack of a mismatch effect in experiments III, IV and V could thus be due to a floor effect in those conditions where the error frequency is already extremely low. However, the floor explanation cannot be applied to experiment I, since the error frequency with plural Subjects is much higher than with singular Subjects and nevertheless no mismatch effect for plurals was found.

### **Conclusion**

A plausible conclusion from these experiments is that proximity effects on number marking are restricted to constructions where syntactic constraints are very weak. Otherwise erroneous number marking appears to depend on the dynamics of plural feature activation and percolation and maybe late pragmatic processing stages.

### **Acknowledgments**

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