An Experimental Investigation of the Binding Options of Demonstrative Pronouns

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Abstract. This paper discusses three reading time studies which, first, provide empirical evidence for the claim made by Hinterwimmer (2015) that German demonstrative pronouns can in principle be bound under c-command as long as their binders are not grammatical subjects (Experiments 1 – 3). Second, Experiment 3, which compares demonstrative and personal pronouns, shows that demonstrative pronouns can not only be used in binding configurations in order to avoid ambiguity (as claimed in Patel-Grosz and Grosz, to appear). Rather, sentences containing them are processed as easily as ones containing personal pronouns, provided that the respective binders are direct or indirect objects.

1. Introduction

While the co-referential behaviour of German demonstrative pronouns (henceforth: DPros) of the *der/die/das* paradigm as opposed to that of personal pronouns (henceforth: PPros) has been an actively investigated research topic for quite some time (see for example Bosch et al. 2003, 2007, Bosch & Umbach 2006, and Schumacher et al. 2016), there is relatively little research on the binding options of German demonstrative pronouns. In Wiltschko (1998), it is claimed that DPros in contrast to PPros cannot be bound at all, while Hinterwimmer (2015) claims that DPros in principle allow binding as long as the binder is not the grammatical subject of the respective sentence. Finally, Patel-Gosz and Grosz (to appear) agree with Hinterwimmer (2015) that DPros can in principle be bound, but additionally assume that they can only be used in binding configurations in order to avoid ambiguity, indicating that they are to be bound by the less prominent of two potential binders.

This paper discusses three reading time studies which show, first, that DPros can be bound by DPs c-commanding them on the surface already, as long as those DPs are not grammatical subjects, and second, that ambiguity avoidance is not required in order to license their use. Rather, sentences containing DPros are processed as easily as sentences containing PPros, even in the absence of any ambiguity, if the respective binders are indirect objects.

The paper is structured as follows. In section 2, previous research on the co-referential and binding options of DPros as opposed to PPros is briefly discussed. In section 3 three experiments, their results and conclusions we draw from them are discussed in detail. Section 4 is the conclusion.

2. Previous Research

On the basis of corpus as well as experimental studies Bosch et al. (2003, 2007) claim that DPros avoid (the referents of) DPs as antecedents that have functioned as the grammatical subject of the immediately preceding sentence (see Kaiser & Trueswell 2008, Kaiser 2011 for related observations concerning DPros in Finnish and Dutch). PPros, in contrast, have a general preference for such antecedents, but accept (the referents of) other DPs as antecedents as well. The DPro in (1) (from Bosch et al. 2007), for example, can only be understood as picking up Peter, while the PPro has a preference for picking up Paul, although it can also be understood as picking up Peter:

(1)   Paul$_i$ wollte gestern mit Peter$_j$ joggen gehen, aber der$_{j/*i}$/er$_{i,j}$ war leider erkältet.   *Paul wanted to go running with Peter yesterday, but unfortunately he {DPro$_{*i/j}$/PPro$_{i/?j}$}had a cold.*

Bosch and Umbach (2006), however, argue on the basis of examples like the one in (2) that DPros do not actually avoid (the referents of) grammatical subjects, but rather discourse topics: The DPro in (2) can only be understood as picking up (the referent of) the grammatical subject of the preceding sentence, but not (there referent of) the indirect object, Karl. According to Bosch and Umbach (2006), this is due to Karl having been established as the discourse topic of the text fragment in (2): The first sentence poses a question concerning Karl that is answered by the two following sentences. Concerning PPros, in contrast, Bosch and Umbach (2006) assume that they have a (weak) preference for discourse topics, which is evidenced by the observation that the PPro in (2) is preferably understood as picking up Karl, but can also quite easily be understood as picking up Peter.

(2)   Woher Karl$_i$ das weiß? Peter$_j$ hat es ihm$_i$ gesagt. Der$_{*i/j}$/Er$_{i,j}$ war gerade hier.
        How does Karl$_i$ know? Peter$_j$ told it to him$_i$. He {DPro$_{*i/j}$/PPro$_{i/j}$} has just been here.

Finally, Bosch and Umbach (2006) propose to account for contrasts like the one in (1) by assuming that grammatical subjects are discourse topics by default. That is, what seems to be (strong) subject avoidance in the case of DPros and (weak) subject preference in the case of PPros is actually the indirect effect of grammatical subjects being default discourse topics.

As already mentioned in section 1, there is relatively little research on the binding behavior of DPros. In Wiltscko (1998), it is claimed that DPros are referential terms corresponding to definite DPs whose NP is empty. Consequently, DPros cannot be bound by c-commanding DPs and not be interpreted as bound variables, in contrast to PPros, which Wiltschko assumes to lack a DP-layer. Evidence for this claim comes from contrasts like the ones between the DPros and the PPros in (3a) and (3b).

(3)　　a. [Jeder Mann]ᵢ /Peterᵢ glaubt, dass *derᵢ/erᵢ, klug ist.
[*Every man*]ᵢ/*Peter*ᵢ *believes that he {*DProᵢ,/PProᵢ} is smart.*
b. [Jeder Mann]ᵢ /Peterᵢ glaubt, dass *dessenᵢ /seineᵢ Klugheit die seiner Kollegen bei weitem übersteigt.
[*Every man*]ᵢ/*Peter believes that his {*DProᵢ,/PProᵢ} smartness surpasses that of his colleagues by far.*

Hinterwimmer (2015) argues on the basis of examples like those in (4) that DPros *can* in principle be bound by DPs c-commanding them either on the surface or at LF, after Quantifier Raising has applied. They just cannot be bound by grammatical subjects. In other words, the contrasts between the PPros and the DPros in sentences like (3a) and (3b) are just due to DPros avoiding grammatical subjects not only as antecedents in discourse, but also as sentence internal binders.

(4)　　a. Peterᵢ glaubt von [jedem Kollegen]ⱼ, dass derⱼ klüger ist als erᵢ.
*Peter*ᵢ *believes of* [*every colleague*]ⱼ *that he {DProⱼ} is smarter than him {Dproᵢ}.*
b. Peter stellte [jedem Studenten]ⱼ mindestens eine Frage, die derⱼ nicht beantworten konnte.
*Peter*ᵢ *asked* [*every student*]ⱼ *at least one question that he {Dproⱼ}*
could not answer.

In order to account for the co-referential behaviour of DPros reviewed above as well as their binding behaviour, Hinterwimmer (2015) argues that DPros in virtue of being the marked pronoun variant in German (while PPros are the unmarked variant) signal that the default process of identifying the respective antecedent or binder does not apply. Consequently, they come with a lexical presupposition that keeps them from being interpreted as depending on the (currently) most prominent DP. What counts as the (currently) most prominent DP differs in binding and non-binding configurations, though. Binding configurations are defined in structural terms: The (potential) binder has to be contained in the same sentence as its bindee, and the former has to c-command the latter either on the surface or at LF the latest. It is thus to be expected that prominence is defined in structural, i.e. syntactic terms as well. Since grammatical subjects are the syntactically most prominent DPs within their sentences, the lexical presupposition of DPros precludes them from depending on grammatical subjects in (potential) binding configurations. Consequently, DPros may not be bound by grammatical subjects. In non-binding configurations, in contrast, prominence is defined in discourse terms. Consequently, their lexical presupposition precludes DPros from picking up antecedents functioning as discourse topics in such cases.

Patel-Grosz and Grosz (to appear) agree with Hinterwimmer (2015) that DPros can in principle be bound. Their analysis crucially differs from the one in Hinterwimmer (2015), however, as they do not assume DPros to come with a lexical presupposition that prevents them from being interpreted as dependent on the currently most prominent DP. Rather, they assume that the

contrast between PPros and DPros emerges as an indirect effect of DPros being structurally more complex than PPros insofar as they contain an additional functional layer above the DP-layer. The economy principle *Minimize Restrictors!* (Schlenker 2005) thus allows DPros only to be used when there is some benefit that could not be achieved by using a corresponding, structurally less complex and thus less costly PPro.

Concerning the binding behaviour of DPros, Patel-Grosz and Grosz (to appear) assume ambiguity avoidance to be the benefit that licenses the use of DPros: In (4a) and (4b), for example, there are two potential binders, and the DPro can then be used in order to signal binding by the DP that would be dispreferred by default. In (3a) and (3b), in contrast, there is no ambiguity. Using the DPro thus violates *Minimize Restrictors!*, and the sentences are consequently perceived as infelicitous (unless some other male individual has been made salient by the context that DPro could be understood as picking it up).

The data considered in Hinterwimmer (2015) are compatible both with the analysis argued for in that paper and the one of Patel-Grosz and Grosz (to appear), since there are two potential binders (or antecedents) in each case. We thus conducted three self-paced reading experiments that allowed us to investigate which of the two analyses makes the right predictions. In addition to that, we aimed to gain reliable evidence that DPros can be bound by DPs c-commanding them at the surface already: In all sentences discussed in Hinterwimmer (2015) and Patel-Grosz and Grosz (to appear), the DPro is not contained in the same clause as its binder, but in a separate (adjunct or complement) clause that might have been right-adjoined to the matrix clause (see (4a) and (4b) – in (4a) the binder is furthermore contained in a PP and therefore clearly does not c-command the DPro on the surface, but only at LF, after Quantifier Raising has applied). It is therefore possible that DPros, while allowing for bound readings in principle (contra to Wiltschko (1998)), still differ from PPros insofar as they may not be bound by DPs c-commanding them on the surface.

As we will see in section 3, results of the three self-paced reading experiments we conducted

(a) provide empirical evidence for the claim that DPros receive bound readings as long as their binders are not grammatical subjects,

(b) show that DPros can be bound by DPs that c-command them on the surface already and are contained in the same clause, and

(c) suggest that DPros allow for bound readings as easily as PPros (as long as the binder is not a grammatical subject) even if there is no ambiguity involved since there is only one potential binder.

3. The Experiments

3.1 Overview of Experiments and Predictions

All three experiments were word-by-word self-paced reading experiments in which participants read single sentences containing two full (i.e. non-pronominal) DPs and the possessive masculine singular DPro DESSEN (Experiments 1, 2) or, in half of the test sentences, the possessive masculine singular PPro SEINEN, and in the other half DESSEN (Experiment 3). One full DP was always morphologically marked for masculine gender with the second full DP being marked for feminine gender. Importantly, the morphological marking of the included pronouns (i.e. masculine singular) only licensed their interpretation as being bound by the DP marked for masculine gender. We constructed two versions of each test sentence. In one version, the masculine DP was the grammatical subject and the feminine DP the indirect object, with both DPs occurring in canonical position. In the other version, the DPs were reversed, i.e. the masculine DP was the indirect object and the feminine DP the subject. The DPro or PPro was always contained in the DP functioning as the direct object. Note that there is clear empirical evidence that not only subjects, but also indirect objects c-command direct objects in their respective canonical positions in German: First, the reflexive pronoun in (5a) and (5b) cannot only be interpreted as bound by the respective subject, *Hans* in (5a), and *Peter* in (5b), but also as bound by the indirect object, *dem Studenten* ('the student'). Second, the observation that the proper name *Maria* in (6a) cannot be interpreted as co-referential with the PPro *ihr* can easily be accounted for as a Principle C violation if the indirect object c-commands the direct one and everything contained in it. The pronouns in our test sentences were thus always c-commanded by both full DPs.

(5)   a. Hans$_i$ zeigte [dem Studenten]$_j$ ein Bild von sich$_{i,j}$.
            Hans$_i$ showed [the student]$_{i,j}$ a picture of himself$_{i,j}$.
            b. Peter$_i$ stellte [dem Studenten]$_j$ eine Frage über sich$_{i,j}$.
            Peter$_i$ asked [the student]$_{i,j}$ a question about himself$_{i,j}$.

(6)   a. *Hans gab ihr$_i$ Marias$_i$ Buch.
            **Hans gave her$_i$ Maria$_i$'s book.*
            b. Hans gab Maria$_i$ ihr$_i$ Buch.
            Hans gave Maria$_i$ her$_i$ book.

Now, if DPros can

       (a) generally not be bound (as in Wiltschko 1998), or

(b) not be bound by DPs c-commanding them on the surface and contained within the same clause (see section 1 above),

(c) not be used when no ambiguity is involved (as in Patel-Grosz and Grosz to appear)

there should be no reading time differences between the two versions of experimental sentences in Experiments 1 and 2. That is, readers should always slow down when or shortly after reading the DPro DESSEN, independently of whether the masculine DP is the subject or the indirect object. The reason is that participants should not be able to interpret the DPro as being bound without violating a constraint. In addition to that, in the absence of a contextually provided alternative male individual there is no other option for interpreting the DPro, and accommodating such an individual should be costly and thus lead to a reading slow-down as well. If DPros only avoid grammatical subjects as binders (Hinterwimmer 2015), in contrast, a reading slow-down is only predicted in those cases where the subject is masculine and the indirect object feminine compared to when the positions are reversed.

Now, it is conceivable that while subject binding violates a separate constraint, DPros are generally dispreferred as compared to PPros in the absence of ambiguity (cf. Patel-Grosz and Grosz to appear). It would thus be predicted that, in Experiment 3, sentences with DESSEN should always be read slower than ones with SEINEN (while ones with DESSEN where the masculine DP is the subject should be read even slower than ones with DESSEN where the masculine DP is the indirect object). If DPros are not generally dispreferred, but only disallow binding by subjects (Hinterwimmer 2015), no difference between sentences with PPros and ones with DPros is predicted in cases where the masculine DP is the indirect object, but only in cases where the masculine DP is the subject.

3.2 Experiment 1

In Experiment 1, participants read single sentences and occasionally answered comprehension questions. In this experiment, we manipulated the gender of the subject and the indirect object DP while introducing a DPro shortly after indirect object encounter. Both full DPs were always referential, i.e. proper names or definite DPs. In the masculine indirect object condition, the subject was marked for feminine gender. In the masculine subject condition, the indirect object was marked for feminine gender. We predicted a general tendency of readers to interpret the DPro as bound by the indirect object rather than the subject of the sentence, resulting in faster reading times when the indirect object was masculine than when it was feminine.

Method

Participants. 24 students from the University of Cologne participated in this experiment for course credit or monetary compensation (EUR 4). All participants were native speakers of German and reported normal or corrected-to-normal vision.

Materials. We constructed a total of 20 experimental sentences. All sentences introduced exactly two human referents. Referents were introduced with a proper name (e.g., MR. BRUNN) or with a definite DP (e.g., THE ARTIST). One referent was male (masculine gender) and the other one female (feminine gender). In each sentence, one referent was the subject and the other the indirect object. Importantly, the sentences were constructed such that the referents could be reversed without any further changes to the materials. Sentences therefore either appeared in a male subject/female indirect object condition, which we refer to as the *male subject condition*, or in a female subject/male indirect object condition, which we refer to as the *male indirect object condition*. Reversing subjects and indirect objects lead to a total of 40 experimental sentences, half of which were male subject and half of which were male indirect object. An example along with the English translations is provided in (7a) and (7b).

All experimental sentences contained the DPro DESSEN (HIS), which occurred shortly after the second, i.e. the indirect object referent. Crucially, the morphological marking of the DPro only allowed its interpretation as bound by the referent marked for masculine gender, regardless of whether the referent was the subject or indirect object. That is, DESSEN could only be interpreted as bound by MR. BRUNN in both (7a) and (7b).

(7)   a. Frau Meyer kocht Herrn Brunn **dessen liebstes Essen, weil er** sich das gewünscht hatte. (*male indirect object condition*)
        Mrs. Meyer cooks Mr. Brunn his favorite dish, because he had asked for it.
        b. Herr Brunn kocht Frau Meyer **dessen liebstes Essen, weil er** sich das gewünscht hatte. (*male subject condition*)
        Mr. Brunn cooks Mrs. Meyer his favorite dish, because he had asked for it.

In all experimental sentences, our region of interest started with the DPro and spanned over the subsequent four words (marked in boldface in (7a,b)). Most importantly for our comparison of male indirect object and male subject readings, regions of interest were exactly the same across conditions.

In addition to experimental sentences, we also constructed 20 distractor sentences to distract participants from the manipulation of interest. Distractor items contained semantically ambiguous words (homonyms) such as BANK and CALF. The first part of these sentences contained the homonym while the second part disambiguated the homonym towards the less frequent meaning (e.g., the river meaning of BANK). Finally, materials also included 40 additional filler sentences, which resembled experimental sentences in length and structure.

All experimental, distractor, and filler sentences were counterbalanced across two presentation lists. Each list contained 20 experimental, 20 distractor, and 40 filler sentences. All sentences that were in the male indirect object version in one list were in the male subject version in the other list. Finally, to make sure that participants carefully read our stimuli, 20 of the filler sentences were followed by a yes-no comprehension question.

Procedure

All trials started with sequences of underscores. Each sequence represented a word and each underscore within a sequence a letter. Participants read the first word of a sentence by pressing the space bar. Each subsequent button press triggered the presentation of the next word while letters of the preceding word were again replaced by underscores. Thus, participants read all sentences word by word.

After participants had read the last word of a sentence and pressed the space bar again, they either saw the word WEITER? (CONTINUE?) and pressed the "yes" key to read the next sentence, or they encountered a comprehension question which was either true, requiring a "yes" response or false, requiring a "no" response. The interstimulus interval was 1 s. Prior to the main experiment, participants received four practice sentences to familiarize themselves with the reading paradigm. Feedback was provided during the practice session but not during the main experiment.

Results and Discussion

Overall accuracy to comprehension questions was 94%. Reading times were elicited and analyzed for the five words of interest. For example, we analyzed reading times for the words DESSEN LIEBSTES ESSEN, WEIL ER, in (7a-b). Reading time comparisons were conducted between male indirect object (7a) and male subject versions (7b). Thus, we individually compared reading times of DESSEN, LIEBSTES, ESSEN, WEIL, and ER, in (7a) and (7b). Recall that our prediction was that reading times should be longer for the male subject than the male indirect object versions.

Mean reading times and 95% confidence intervals for each word region (word 1 – word 5) are plotted in Figure 1. Prior to statistical analysis, reading times faster than 200 ms and slower than 2000 ms were classified outliers and excluded (0.5% of the data). All other reading times were log-transformed individually for each word region (word 1 – word 5) using Box-Cox power transformations. We tested differences between the male indirect object and male subject versions performing linear mixed effects regressions including random intercepts and slopes for participants and items. While reading times were included as dependent measure, preference (male object vs. male subject reading) was included as independent variable and included as a random slope for participants and items. Preference was centered prior to analysis. P-values were calculated on the assumption that our models' intercepts are normally distributed. For each word region, we fitted an individual model.

For first, fourth, and fifth words of interest, we did not obtain any reliable reading time differences between the male object and the male subject reading of the pronoun, ts < 1.4, ps > .1. However, for the second word, the observed reading time difference trended in the predicted direction, β = 7.00e-04, SE = 4.27e-04, t = 1.64, p = .1, while it reached full significance for the third word, β = 6.11e-04, SE = 2.02e-04, t = 3.02, p = .003.

Figure 1: Mean reading times and 95% confidence intervals of words of interest (1 – 5) in Experiment 1.
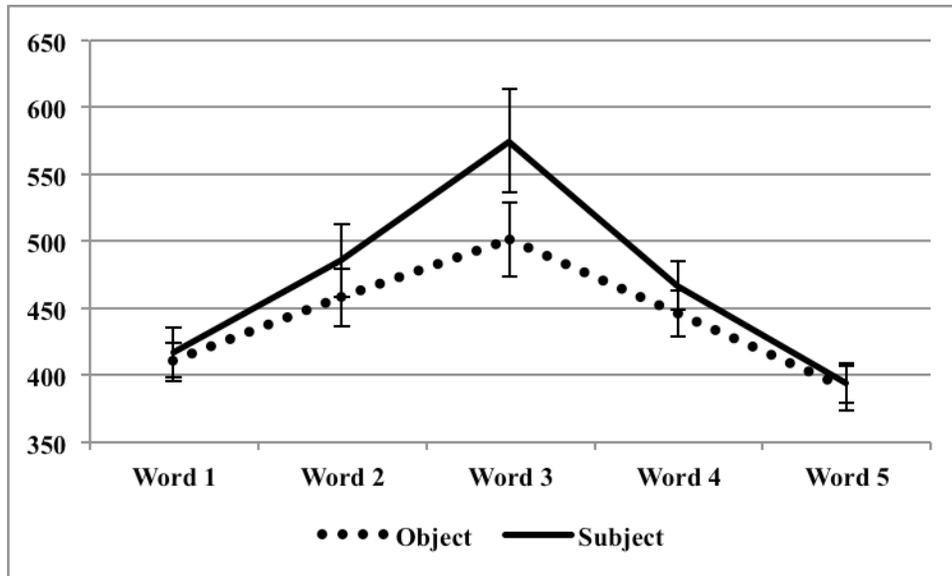
Taken together, then, our region of interest was read faster when the referent functioning as the indirect object was marked for masculine gender compared to when it was marked for feminine gender. That is, participants read the five words of interest faster when they could interpret the DPro as bound by the indirect object, because it matched in gender, than when they needed to interpret it as bound by the subject, because indirect object and DPro were of different gender. This finding indicates that DPros (a) can in principle be bound by DPs that are contained within the same clause and c-command them on the surface already, even in the absence of any ambiguity, and (b) avoid DPs functioning as grammatical subjects as binders.

3.3 Experiment 2

Experiment 2 was identical to Experiment 1 in all respects except for the choice of non-pronominal DPs: The male DP was always quantificational. By this, we wanted to ensure that DPros are indeed capable of receiving a bound variable interpretation under local conditions, i.e. in cases where the quantificational DP is contained within the same clause.

Method

Participants. 24 students from the University of Cologne participated in this experiment for course credit or monetary compensation (EUR 4). All participants were native speakers of German and reported normal or corrected-to-normal vision.

Materials. We constructed 24 experimental sentences, each again containing exactly one masculine marked and one feminine marked full DP. While the general structure of the sentences was identical to the items of Experiments 1, the masculine marked DP was always a quantificational DP headed by JEDER (EVERY/EACH). An example is provided in (8).

(8)   a. Frau Bauer bringt jedem Buchhalter **dessen neue Daten, die schon** lange fällig waren. (*male indirect object condition*)
Mrs. Bauer brings every accountant his new data, which have been overdue for a while.
b. Jeder Buchhalter bringt Frau Bauer **dessen neue Daten, die schon** lange fällig waren. (*male subject interpretation*)
Every accountant brings Mrs. Bauer his new data, which have been overdue for a while.

Like for Experiments 1, we were interested in reading time differences between male indirect object and male subject conditions for the five regions of interest. The first word of these regions was again the DPro DESSEN. We included the same 20 distractor items in Experiment 2 that were included in Experiment 1 along with an additional 60 filler sentences that were similar in structure to the experimental sentences. All items were counterbalanced across two presentation lists, such that each list contained 12 experimental sentences with a masculine and 12 with a feminine DP functioning as the indirect object. Comprehension questions were presented for 40 filler sentences.

Procedure

The procedure was the same as in Experiment 1.

Results and Discussion

Participants answered correctly to 97% of the comprehension questions. Reading times were elicited and analyzed for the five regions of interest individually, comparing male indirect object with male subject versions. Mean reading times and 95% confidence intervals for each word (word 1 – word 5) are plotted in Figure 2. Prior to statistical analyses, reading times faster than 200 ms and slower than 2000 ms were excluded as outliers (1% of the data). The remaining reading times were log-transformed for each word of interest individually using Box-Cox power transformations.

Mixed effects models were fitted for each word of interest. The dependent measure was reading time. The independent variable was preference (male indirect object vs. male subject), and was centered. Random intercepts and a random slope (preference) were included for participants and items. P-values were calculated on the assumption that our models' intercepts are normally distributed.

Figure 2: Mean reading times and 95% confidence intervals of words of interest (1 − 5) in Experiment 2.
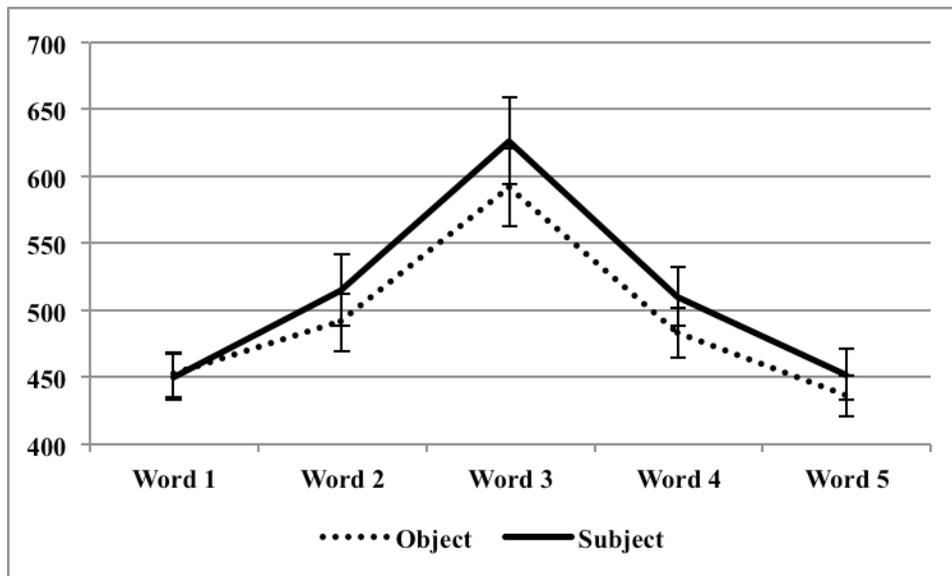
Results for Experiment 2 replicate those of Experiment 1. We failed to find a statistically reliable reading time difference between male indirect object and male subject condition for the first, second, and fifth word, ts < 1.5, ps > .2. However, we did elicit a reliable difference for the third, β = 2.71e-03, SE = 1.28e-03, t = 2.11, p = .035, and a marginal difference for the fourth word of interest, β = 7.69e-05, SE = 4.05e-05, t = 1.90, p = .058. The close resemblance of the obtained data of Experiments 1 and 2 strongly suggests that DPros can be interpreted as locally bound variables as long as the (potential) binder is not the grammatical subject of the respective sentence.

3.4 Experiment 3

The results of Experiments 1 and 2 provide clear empirical evidence that DPros can be bound by non-subjects c-commanding them on the surface already. They also provide evidence against the analysis proposed by Patel-Grosz and Grosz (to appear) insofar as it predicts a slow-down in reading times in both subject and indirect object conditions: Since there is no ambiguity, using a DPro instead of a PPro should be infelicitous or, at least, dispreferred in both cases. It is still conceivable, though, that Patel-Grosz and Grosz (to appear) are correct in their assumption that DPros are in fact dispreferred in binding configurations that not involving any ambiguity, but that interpreting a DPro as bound by a grammatical subject violates an additional constraint. In other words, since we only compared sentences with DPros, it could be the case that both the male subject and male indirect object versions of our test sentences are read more slowly than otherwise identical sentences with PPros, but that the male subject versions are read even more

slowly than the male indirect object versions. In addition, so far we cannot exclude an alternative explanation of the reading time differences between the two conditions in terms of recency: In the male subject condition the number of words intervening between the binder and the DPro is higher than in the male indirect object condition.

We therefore conducted a third experiment that would allow us to (a) gain evidence that DPros are not generally dispreferred in the absence of ambiguity and (b) exclude the alternative account of the results of Experiments 1 and 2 just sketched. In Experiment 3, we generated four versions of each test sentence: One in the male indirect object condition with a DPro and one with a PPro, and one in the male subject condition with a DPro and one with a PPro. If DPros are generally dispreferred in binding configurations without ambiguity, the variants with the DPro should generally be read slower than the ones with the PPro (while the male subject versions with the DPro should be read even more slowly than the male indirect object versions with the PPro, in line with the results of Experiments 1 and 2). If the alternative explanation of the results of Experiments 1 and 2 in terms of linear distance holds, the sentences in the male subject conditions should consistently be read more slowly than the ones in the male indirect object condition, irrespective of pronoun type, i.e. there should be no reading time differences between the versions with a DPro and the ones with a PPro. The analysis proposed by Hinterwimmer (2015), in contrast, predicts that only the male subject versions with a DPro should lead to a reading slow-down since they violate a constraint, while there should be no great reading time differences between the remaining three conditions.

Method

Participants. 56 students from the University of Cologne participated in this experiment for course credit or monetary compensation (EUR 4). All participants were native speakers of German and reported normal or corrected-to-normal vision.

Materials. The same materials as in Experiment 1 were used with the exception that sentences either included the DPro DESSEN or the PPro SEINEN. An example is provided in (9).

(9)   a. Frau Meyer kocht Herrn Brunn **dessen liebstes Essen**, **weil er** sich das gewünscht hatte.
a´. Frau Meyer kocht Herrn Brunn **sein liebstes Essen**, **weil er** sich das gewünscht hatte.
Mrs. Meyer cooks Mr. Brunn his (DPro/PPro) favorite dish, because he had asked for it.
b. Herr Brunn kocht Frau Meyer **dessen liebstes Essen**, **weil er** sich das gewünscht hatte
b.´ Herrn Brunn kocht Frau Meyer **sein liebstes Essen**, **weil er** sich das gewünscht hatte.
Mr. Brunn cooks Mrs. Meyer his (DPro/PPro) favorite dish, because he had asked for it.

Procedure

The procedure was the same as in Experiments 1 and 2.

Results and Discussion

Overall accuracy for the comprehension questions was again high, with 94%. Mean reading times and 95% confidence intervals for each word region (word 1 – word 5) are plotted in Figure 3. As for Experiments 1 and 2, prior to statistical analysis, reading times faster than 200 ms and slower than 2000 ms were excluded (0.1% of the data). All remaining reading times were log-transformed individually for each word region (word 1 – word 5) using Box-Cox power transformations. Linear mixed effects regressions were used to test for differences between male indirect object and male subject versions. We included random intercepts and random slopes for participants and items. While reading times were included as dependent measure, reading (male indirect object vs. male subject) and pronoun type (DPro vs. PPro) were included as independent variables and also included as a random slope for participants and items. Reading and pronoun type were centered prior to analysis and p-values calculated on the assumption that our models' intercepts are normally distributed. For each word region, we fitted an individual model.

For first, fourth, and fifth words of our region of interest, we failed to find any reliable reading time differences between conditions, ts < 0.9, ps > .3. However, for the second word region, male indirect object versions were read faster than male subject versions, but only when the sentence included a DPro, leading to a Reading x Pronoun Type interaction $\beta = 12.75e\text{-}04$, $SE = 5.57e\text{-}04$, $t = 2.29$, $p = .022$. The same was true for the third word region, $\beta = 5.63e\text{-}04$, $SE = 2.85e\text{-}04$, $t = 1.97$, $p = .049$. For this region, the model also revealed a main effect of pronoun type, $\beta = 4.49e\text{-}04$, $SE = 1.85e\text{-}04$, $t = 2.42$, $p = .015$, which was due to male subject versions with a DPro being read much more slowly than the three other conditions.

Figure 3: Mean reading times and confidence intervals of words of interest (1 – 5) in Experiment 3.
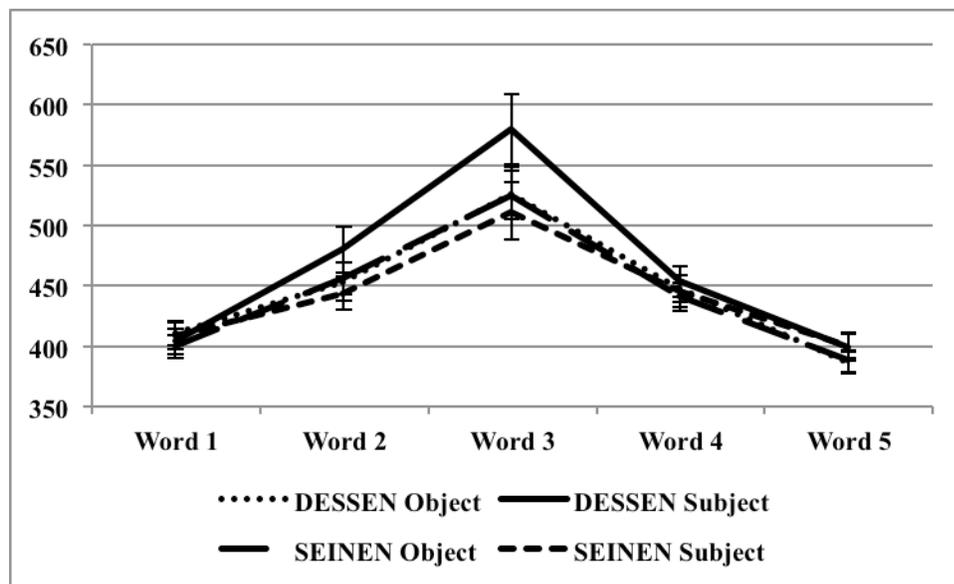
Taken together, sentences with DPros were read more slowly than sentences with PPros in the male subject condition, but as fast as sentences with PPros in the male indirect object condition. Sentences with PPros in the male subject condition were read as fast as sentences with PPros in the male indirect object condition. This provides good empirical evidence that, first, DPros are not generally dispreferred in binding configurations in the absence of ambiguity, but only when the only available binder is the grammatical subject of the respective sentence. Second, our data clearly show that linear distance does not play a significant role since we should then have elicited a reading slow-down not only in the male subject versions with a DPro, but also in the ones with a PPro, compared to its indirect object version.

4. Conclusion

In this paper we investigated the conditions under which DPros can be bound. We have discussed three self-paced reading time studies which provide empirical evidence for the analysis proposed by Hinterwimmer (2015). According to Hinterwimmer, DPros are prohibited from being interpreted as the dependent on the currently most prominent DP. Since syntactic prominence is decisive in (potential) binding configurations, and since grammatical subjects are the syntactically most prominent DP within the respective clause, DPros are in effect prohibited from being bound by grammatical subjects. Nothing precludes them from being bound by other DPs c-commanding them on the surface or at LF the latest, however. The experiments also show that ambiguity avoidance is not required in order to license the use of DPros in binding configurations, contra Patel-Grosz and Grosz (to appear).

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