The online application of structural and semantic biases during pronoun resolution

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Pronoun interpretation is known to be subject to semantic biases (e.g., implicit causality) and structural biases (e.g., subject bias). For p(ersonal)-pronouns, Koornneef and Van Berkum (2006) showed that implicit causality is used in a top-down fashion during on-line comprehension for predicting up-coming referents. In sentences as *Linda apologized to David because he according to the witnesses was not the one to blame.*, the bias-inconsistent pronoun *he* contradicts the gender of the predicted referent *Linda*, slowing down reading times. Anaphoric d(emonstrative)-pronouns in German are subject to the same semantic biases as p-pronouns, but have different structural preferences. P-pronouns have a moderate bias toward the subject, d-pronouns a strong bias toward the object (Authors, 2019; Patil et al., 2020). The main question of our experiments is whether the strong structural object-orientation of d-pronouns prevents the gender inconsistency effect (due to semantic biases) that Koornneef and Van Berkum (2006) found for p-pronouns.

We addressed this question in two self-paced reading experiments (word-by-word moving-window presentation). 20 sentences composed of a main and an embedded clause were created. The main clause contained an object-experiencer (OE) or a subject-experiencer (SE) verb (factor *Verb Type*). A pretest with a no-pronoun prompt confirmed a strong semantic bias toward the stimulus for both verb types. The embedded clause contained a p- or a d-pronoun (factor *Pronoun*).

Both experiments were presented on Ibex farm. In Experiment 1, sentences were presented in advance with characters replaced by understrikes. 97 participants recruited via Prolific read 20 sentences as well as 66 fillers. Results are shown in Figure 1. Accuracy on comprehension questions was higher for expected (SE verbs) than for unexpected continuations (OE verbs), especially when the question probed the embedded clause, with no difference between pronouns. Thus, the final interpretation was not affected by pronoun type. Reading times, however, showed a difference. Reading times on the complementizer *weil* were significantly faster for p-pronouns following a SE verb than for the remaining three conditions for which no further differences were significant. This replicates the gender inconsistency effect of Koornneef and Van Berkum (2006) for p-pronouns but at a position immediately preceding the pronoun. We hypothesize that this surprisingly early effect was caused by participants anticipating the upcoming pronoun from the word-length information given in the sentence preview. The male p-pronoun (*er*) is expected for SE verbs but the female p-pronoun (*sie*) for object-experiencer verbs. Thus, there is a match between expectation and preview information in the condition SE verb/p-pronoun, leading to fast reading times, but a mismatch in the remaining three conditions, resulting in increased reading times.

To corroborate the preview hypothesis, Experiment 2 (61 participants) was identical to Experiment 1, but sentences were no longer presented in advance by means of understrikes. Thus, preview information was not available while reading. Results for Experiment 2 are shown in Figure 2. Question accuracy was similar to Experiment 1, but reading times differed. On the complementizer, there was only a main effect of Verb Type. A significant interaction between Verb Type and Pronoun, however, was now visible on the pronoun and its spill-over region. A semantically unexpected p-pronoun caused longer reading times than an expected p-pronoun, whereas no significant difference was observed for d-pronouns. A comparison of Figures 1 and 2 reveals a similar overall pattern, except for the complementizer, which showed an interaction in Experiment 1 but not in Experiment 2. On the pronoun and its spill-over region, the interaction between Verb Type and Pronoun was significant in Experiment 2 but only numerically visible in Experiment 1.

In sum, our results replicate the top-down gender inconsistency effect for p-pronouns found by Koornneef and Van Berkum (2006). For d-pronouns, in contrast, no inconsistency effect showed up. We hypothesize d-pronouns to gain direct access to the object referent independently of the verb's semantic bias due to their strong structural preference.

Table 1: A complete stimulus for Experiment 1 and Experiment 2

| *Condition* |
| --- |
| *Object-experiencer verb: semantic bias toward the subject* |
| Sabine beeindruckt den Fischer, weil **er**/**dieser** niemand anderen mit derart viel Erfolg kennt. |
| "Sabine impresses the fisher because **he**/**lit. this** does not know anybody else with as much success." |
| *Subject-experiencer verb: semantic bias toward the object* |
| Sabine achtet den Fischer, weil **er**/**dieser** immer die bei weitem höchsten Fangzahlen aufweist. |
| "Sabine respects the fisher because **he**/**lit. this** has by far the highest catch counts." |
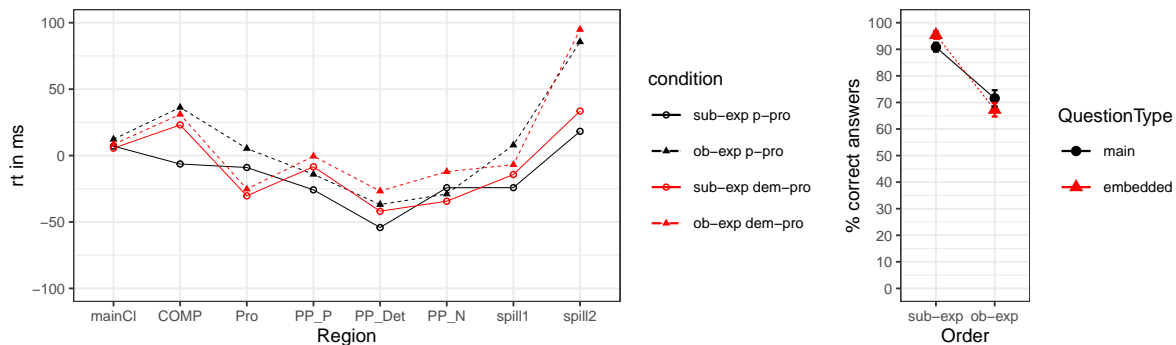
Figure 1: Residual reading times (left) & percentages of correct answers (right) in Experiment 1.
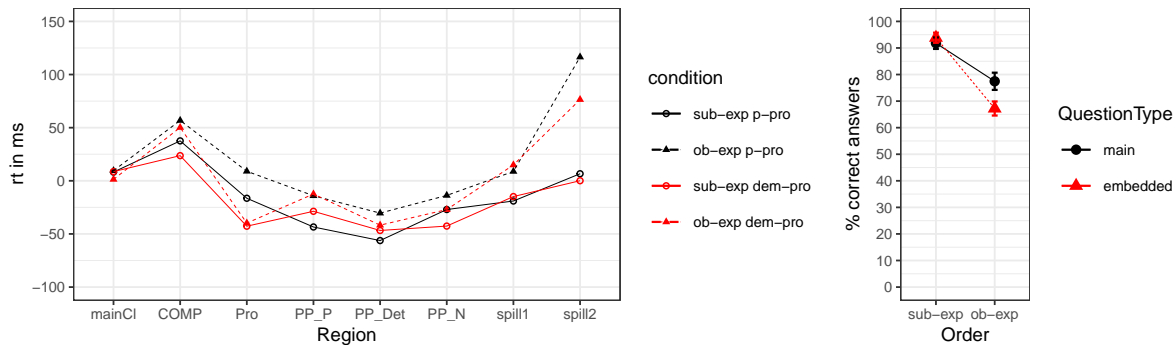

Figure 2: Residual reading times (left) & percentages of correct answers (right) in Experiment 2.

References

Koornneef, A. W. and Van Berkum, J. (2006). On the use of verb-based implicit causality in sentence comprehension: Evidence from self-paced reading and eye tracking. *Journal of Memory and Language*, 54(4):445–465.

Patil, U., Bosch, P., and Hinterwimmer, S. (2020). Constraints on German *diese* demonstratives: Language formality and subject-avoidance. *Glossa: a journal of general linguistics*, 5(1).