

**Prediction error and antecedent competition: ERPs on ambiguous plural pronouns in German**  
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In communication, we are frequently faced with referential ambiguities (1). A case that has received much attention is related to the resolution of singular personal pronouns, but only a few studies investigated incremental processing of ambiguous plural pronouns. It has been argued that ambiguous pronouns lead to enhanced processing costs (**ambiguity disadvantage**), attributed to an ongoing **competition process** for pronoun reference between potential antecedents (e.g. self-paced reading, 2), i.e. multiple competing interpretations (ERPs, 3). In contrast, other studies report a processing **advantage** for sentences containing ambiguous pronouns (e.g. eye-tracking) but only under circumstances that allow for **shallow processing** (4, 5, 6, for reviews 7 & 8). This effect has been interpreted as reflecting a sustained disequilibrium until disambiguating information is encountered (7). On the other hand, ERP studies report (i) an **Nref effect** at the point of ambiguity detection (9, 10, 11) interpreting it as higher costs for memory retrieval (12) or (ii) **N400** effects for referential ambiguity as instances of prediction error (13, 14). In other words, there seems to be a contrast between ERP literature and psycholinguistic research that argues for shallow processing. The following question arises: How do ERP effects for ambiguous pronouns align with the indications from psycholinguistic research suggesting that incremental interpretation profits from shallow processing? To tackle this question, we conducted an ERP study (2 x 2 design,  $N=63$ , 120 item sets) on German plural pronouns (*sie/they*; unspecific in grammatical gender) within a task environment to facilitate shallow / underspecified processing (4, 5, 6). We presented plural pronouns with contrasting groups (**set-subset**/conceptually overlapping vs. **non-subset**/conceptually non-overlapping) and subsequent verbal ambiguity (**ambiguous** vs. **unambiguous** verbs, as in (1), see Table 1).

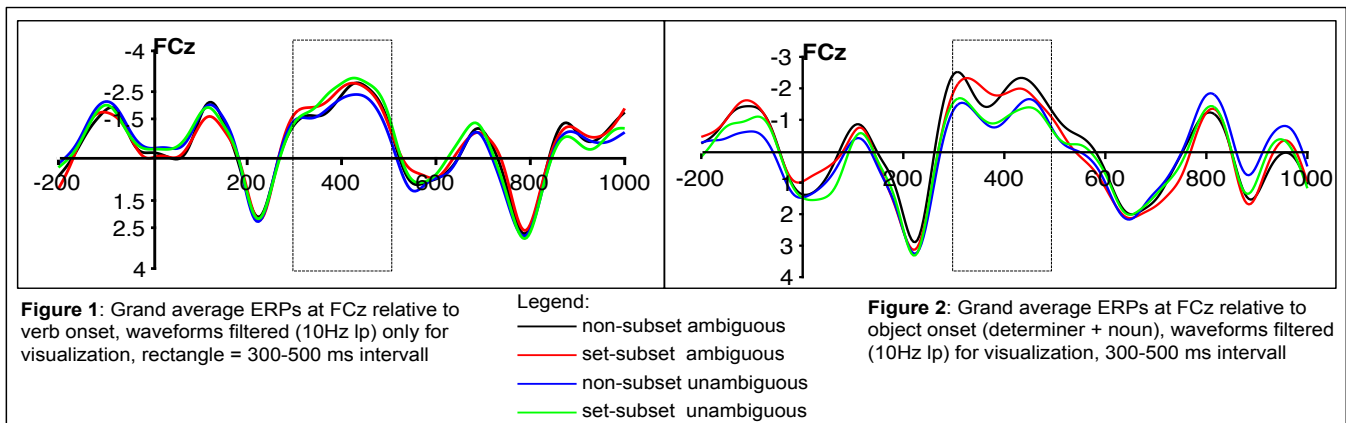
- (1) *It was in an exhibition room in Berlin. The modern artists were present. The (1a) sculptors / (1b) journalists were there too. (...) | Ambiguous verb for the set-subset and non-subset conditions: (2a/b) They browsed their catalogues (...) | Unambiguous verbs for the set-subset and non-subset conditions: (2c) They carved their statues (...) / (2d) They drafted their commentaries...*

While the verbs in (2a/b) are kept ambiguous (e.g. possible competing interpretations in (2a), entire set [modern artists + sculptors] or only one group [e.g. modern artists or sculptors]), unambiguous verbs in (2c) and (2d) always disambiguated *they* referring to the second group. Therefore, semantically overlapping antecedents (**modern artists, sculptors**) might increase the effort for anaphoric reference resolution (conceptually competing interference), whereas the semantic distinction of non-overlapping antecedents (**modern artists, journalists**) might help to overcome referential ambiguity. We predict that ambiguous verbs result in an N400 effect (**prediction error**) by violating the prediction of receiving disambiguating information regarding anaphoric reference. This would indicate ongoing competition between the two antecedents. We further predict that this competition effect might interact with conceptual interference (**set-subset**). For unambiguous verb conditions, conceptual interference is assumed to impede antecedent selection. Under the assumption of shallow-like processing, no ERP effects should be observed as long as ambiguity persists since comprehension questions did not lead to any referent interpretations. Our analysis (single trial mean ERPs, linear mixed-effects models with random slopes and intercepts) revealed that, while there is no difference at the pronoun, there was an interaction between set-subset/non-subset and ambiguity relative to the verb ( $t = -2.331$ ;  $p < .05$ ) in the form of a negativity between 300-500 ms (see Figure 1). Compared to the **non-subset unambiguous** condition, both **ambiguous** conditions (**non-subset, set-subset**) exhibited a negativity effect. In addition, the **set-subset unambiguous** condition showed a negativity too in comparison to the **non-subset unambiguous** condition. At the postverbal object noun, ERPs (300-500 ms) depicted again a negativity for both **ambiguous** conditions in comparison to both **unambiguous** conditions ( $t = -2.797$ ;  $p < .01$ ; see Figure 2). In line with our predictions, we interpret these negativities as N400 effects: prediction error and ongoing competition for ambiguous conditions (both: at verb and object) and conceptual interference for the set-subset unambiguous condition (at the verb). Overall, we conclude that prediction-based competition might explain the findings for the verb and the object region appropriately. Independent support also comes from psycholinguistic as well as neurolinguistic literature that argues for ongoing competition processes (e.g. 2 for antecedent competition, 3 & 15 for agent-role competition). Moreover, our ERP results might not support the predictions drawn from the shallow processing accounts, possibly owing to methodological differences.

Table 1 (Item example in German and corresponding English translation)

Context: <b>set-subset</b> resp. <b>non-subset</b>	Critical target	Condition
<i>Es war in einem Ausstellungssaal. Die zeitgenössischen <b>Künstler</b> waren anwesend. Die <b>Bildhauer</b> / Die <b>Journalisten</b> waren auch da.</i> [It was in an exhibition room. The <b>modern artists</b> were present. The <b>sculptors</b> / <b>journalists</b> were there too.]	<i>Es war ein nettes Ambiente. <b>Sie überflogen*</b> ihren Katalog...</i> [It was a nice ambience. They browsed their catalogues...]	<b>ambiguous</b> together with <b>set-subset</b> and <b>non-subset</b>
<i>(...)Die zeitgenössischen <b>Künstler</b> waren anwesend. <b>Die Bildhauer</b> waren auch da.</i> [(...) <b>modern artists</b> (...) <b>sculptors</b> ]	<i>Es war ein nettes Ambiente. <b>Sie schnitzten*</b> ihre Skulpturen.</i> [It was a nice ambience. They carved their statues.]	<b>unambiguous set-subset</b>
<i>(...)Die zeitgenössischen <b>Künstler</b> waren anwesend. Die <b>Journalisten</b> waren auch da.</i> [(...) <b>modern artists</b> (...) <b>journalists</b> ]	<i>Es war ein nettes Ambiente. <b>Sie verfassten*</b> ihre Kolumnen.</i> [It was a nice ambience. They wrote their commentaries.]	<b>unambiguous non-subset</b>

\* Transitive verbs were used all target sentences.



## References

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