

## ERP evidence for long-distance lexical predictions in German particle verb constructions

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ERP evidence suggests that features of up-coming words are pre-activated when the context is constraining [1-7, cf. 8]. It is unclear, however, under which circumstances this pre-activation leads to a specific lexical prediction, i.e. the selection of just one lexical entry which is then integrated into the sentence interpretation ahead of time. German particle verb constructions are ideally suited for investigating this question. In these constructions, a base verb occurs in second position (V2 word order) whereas a particle that gives the verb its full meaning remains in sentence-final position (see example on page 2). Unlike in English, there can be an almost arbitrary amount of material between the base verb and the particle. Lexical prediction of the particle can therefore facilitate incremental sentence interpretation by giving early access to verb semantics.

To investigate whether such long-distance lexical predictions are being made, we used sentences that either constrained the set of plausible particles to just one (condition a) or to a small set of two or more highly plausible particles of which just one was shown (c). In addition, we used two violation conditions (b, d) where the presented particle was not compatible with the context. We hypothesized that the parser would more likely commit to a lexical prediction when there was only one high-cloze particle (low entropy, a and b) than when there were multiple high-cloze particles (high entropy, c and d). Any ERP differences in (a) vs. (c) could be due to differences in cloze probability. We therefore focused on the violation conditions (particle cloze = 0) and predicted that a violation would cause greater difficulty (indexed by an N400 effect) in the presence of a specific lexical prediction (b), than when a commitment presumably had not been made (d). This prediction and the experimental design were pre-registered on OSF.

**Methods:** EEG was recorded from 50 participants with 44 target items and 62 filler sentences. A norming study showed that cloze probability of particles in (a) was 90% and the difference between the top two particles (when two were given) was 74%. In (c), cloze probability was 73% and the top-two difference 29%. ERPs were analyzed using Bayesian LMMs that modeled by-trial mean amplitude. A sanity check established that violations elicited the expected N400 and P600 effects (b/d vs a/c). The N400 prediction was tested at electrode *Pz* in the window 250-500 ms. To test for late positivities which follow N400 effects in some studies of context-based word predictability [9], an additional analysis was conducted in the window 600-900 ms at electrode *Cz*.

**Results:** Contrary to our prediction, there was no indication of an N400 difference between the two violation conditions (b vs d,  $\hat{\beta} = -0.25\mu V$ ,  $CrI = [-1.21, 0.72]\mu V$ ,  $Pr(\beta < 0) = 0.71$ , see Fig. 1). This result on its own could be interpreted as suggesting no lexical prediction of distant verb particles. However, as shown in Fig. 2, we found an effect in the time window 600-900 ms: a more positive-going amplitude in the violation condition with just one plausible particle (b) than in the violation condition with two or more plausible particles (d) ( $\hat{\beta} = 0.96\mu V$ ,  $CrI = [-0.20, 2.11]\mu V$ ,  $Pr(\beta > 0) = 0.95$ , see also Fig. 3).

**Conclusions:** Late positive components have been observed for anomalous words in strongly constraining contexts [9]. They are thought to reflect attempts at reanalysis, revision, and repair, depending on their topography [7,10]. We propose that in the 1-particle condition (b), a lexical prediction was triggered and a richer mental representation of the sentence built before the particle was seen. This representation then had to be overhauled or discarded once the violating particle was encountered and the late positivity reflects this cost. To establish the reliability of our findings, we are currently preparing a pre-registered replication with high statistical power. Tentatively, we conclude that German native speakers make long-distance lexical predictions if constraint is not just high but also strongly favors a single lexical item.

(1)

Die gemeine Bande **hing** dem unschuldigen Mann eine schreckliche Straftat völlig skrupellos

(a) **an**, ...

(b) **\*nieder**, ...

*The nasty gang **blamed** the innocent man of a terrible crime completely without scruple [particle]*

Die gemeine Tante **hing** das schreckliche Porträt von ihrem Mann völlig skrupellos

(c) **ab (auf)**, ...

(d) **\*nieder**, ...

*The mean aunt **hung** the terrible portrait of her husband completely without scruple [particle]*

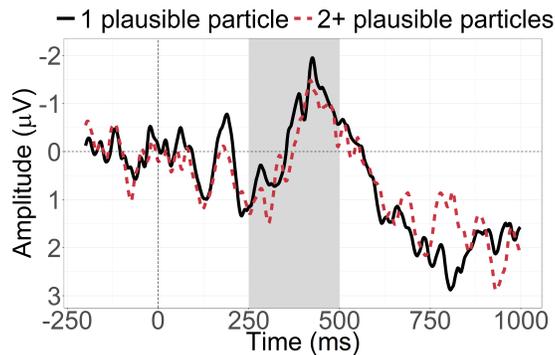


Figure 1: ERPs elicited by violation particles. Shaded is the pre-registered N400 analysis window.

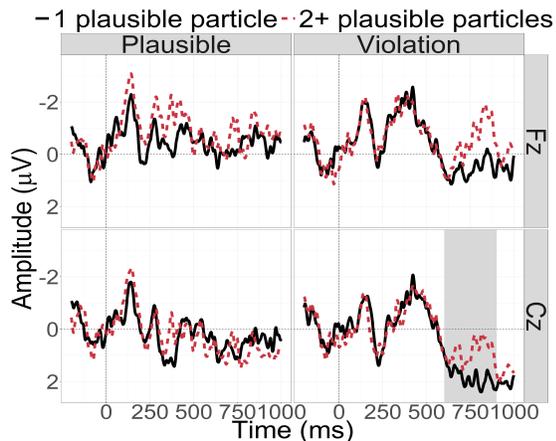


Figure 2: Shaded is the analysis window of the late positivity.

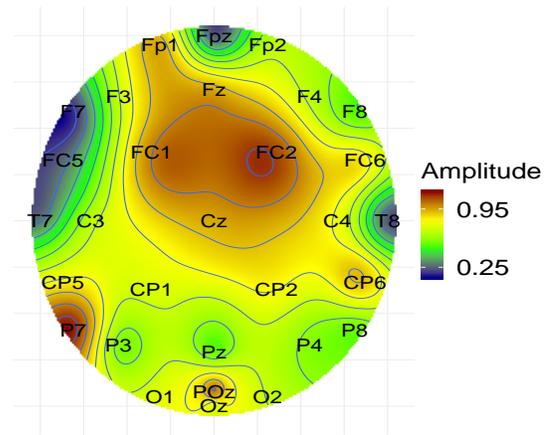


Figure 3: Topographical plot of condition (b) minus condition (d), 600-900 ms.

**References:** [1] Wicha et al. (2004) *J Cogn Neurosci* [2] Van Berkum et al. (2005) *J Exp Psych* [3] De Long et al. (2005) *Nat Neurosci* [4] Otten & Van Berkum (2008) *Discourse Processes* [5] Szewczyk & Schriefers (2018) *Lang, Cogn, Neurosci* [6] Ito et al. (2018) *AMLaP Proceedings* [7] Kuperberg & Wlotko (2018) *bioRxiv* [8] Nieuwland et al. (2018) *eLife* [9] Van Petten & Luka (2012) *Int J Psychophys* [10] De Long et al. (2014) *Neuropsychologia*