

Two ERP experiments challenging existing accounts of the N400 semantic illusion

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Unexpected words within a context elicit large N400 brain potentials. However, sometimes N400s at unexpected words are small when stereotypical agent and patient roles are reversed, such as at ‘*caught*’ in ‘*which ticket inspector the fare evader caught*’ (fare evaders don’t stereotypically catch ticket inspectors). Existing accounts propose that the small N400 results from an illusion of plausibility in which the reversed sentence is interpreted as the canonical sentence due to an incorrect or incomplete parse (“N400 semantic illusion”)^[1:6]. Subsequent to many of these accounts^[1:5], it has been observed that the illusion can be prevented if the presentation of ‘*caught*’ is delayed with an additional sentence fragment^[6] or by slowing the sentence presentation rate^[7]. This raises the questions: What is it about delaying the verb that prevents the illusion, more information or more time? And what implications does this have for theories about the initial illusion? We present empirical data from two ERP experiments manipulating the content and temporal aspects of the delay.

We constructed canonical and role-reversed sentence pairs in German which used case marking to swap the agent/patient roles of, for example, *ticket inspector* and *fare evader* (see **Table 1**). In Experiment 1, we delayed the verb with a sentence fragment that was either neutral (*further up*) or semantically associated with the context (*without a ticket*). We hypothesised that the neutral delay should prevent the illusion replicating previous findings^[6], but that the associated delay might sustain the illusion since lexical association is important to creating the illusion in the first place^[1:7]. In Experiment 2, we delayed the verb by either slowing the word presentation rate (stimulus onset asynchrony, SOA) or inserting a temporal pause between the verbal arguments and the verb. The duration of the temporal pause was matched to the length of the neutral sentence fragment in each respective experimental item. We hypothesised that the slow SOA should prevent the illusion, replicating previous research^[7], and that the temporal pause should also prevent it if time was a factor underlying the results in Experiment 1.

Methods. *Experiment design:* See **Fig 1**. *Analysis:* Bayesian linear mixed effects model of mean amplitude from 300-500 ms after verb onset across centro-parietal scalp electrodes.

Results (statistics in Fig. 2). *Exp. 1 (N=74, complete)*^[9]: Nested contrasts indicated an illusion in the no delay condition (similar N400 reversed vs. canonical). The illusion was prevented (larger N400 reversed vs. canonical) by the neutral sentence fragment and somewhat by the semantically associated fragment. *Exp. 2 (N=42, ongoing)*: The estimates so far are less precise than Exp. 1 (wider 95% CIs), but the no delay condition yields the illusion while both the slower word presentation rate and temporal pause appear to prevent the illusion.

Conclusions. Exp. 2 suggests that the delay effect is present even without new sentence information, indicating that time is a key factor in preventing the illusion. This finding challenges accounts of the initial illusion. For example, in the SG model^[5], the illusion results from uncertainty due to conflict between semantic cues (real-world event probabilities) and syntactic cues like word order. However, the current version of the model updates its activation states only once at each presented word and thus needs adaptation to show how conflict can be resolved over time between words (forthcoming work). The findings are partly consistent with the Slow Prediction hypothesis^[6]; however, without additional assumptions this hypothesis may not account for why time did not fully prevent the illusion in the semantically associated condition of Exp. 1. Other existing accounts of the illusion^[1:4,8] may also need adaptation to accommodate the delay effect.

Table 1. Example experimental stimulus (English translation from German). The target word is bolded. The additional sentence fragments in Exp. 1 are underlined>. Case marking indicates canonical / reversed thematic roles.

Both experiments:

no delay ...which.ACC / NOM fare evader the.NOM / ACC ticket controller **caught** had.

Experiment 1:

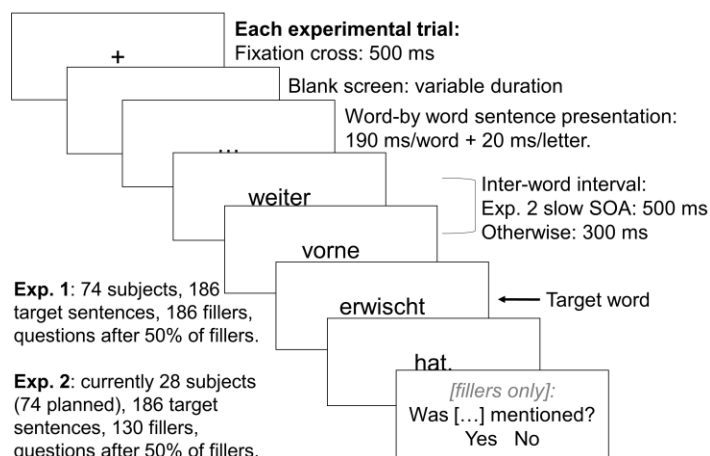
neutral delay ...which.ACC / NOM fare evader the.NOM / ACC ticket controller further up **caught** had.

associated delay ...which.ACC / NOM fare evader the.NOM / ACC ticket controller without a ticket **caught** had.

Experiment 2:

slow SOA ...which.ACC / NOM --- fare evader --- the.NOM / ACC --- ticket controller --- **caught** --- had.

temporal pause ...which.ACC / NOM fare evader the.NOM / ACC ticket controller <-----> **caught** had.



References. [1] Kuperberg et al. (2003) *Cog Brain Res* [2] Kim & Osterhout (2005) *JML* [3] Bornkessel-Schlesewsky & Schlesewsky (2008) *Brain Res Rev* [4] Kuperberg (2007) *Brain* [5] Rabovsky et al (2018) *Nat Hum Behav* [6] Chow et al. (2018) *Lang Cog Neuro* [7] Momma et al. (2015) *CUNY conference presentation* [8] Brouwer et al. (2017) *Cog Sci* [9] Stone & Rabovsky (2023) *OSF preprint*

Figure 1. Experimental design

Figure 2. Grand average ERP amplitudes and 95% CIs. Posterior probability estimates of the effect of role order nested within each delay level are overlaid. Stimulus onset asynchrony (SOA) refers to the presentation rate of the sentence stimulus.

