An investigation of the time-course of syntactic and semantic interference in online sentence comprehension

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Introduction. One central question in sentence comprehension research is when syntactic and semantic information are used during the formation of non-adjacent dependencies (e.g., [1:6]). In the cue-based parsing literature, this question has been addressed by studying the time-course of similarity-based interference effects (e.g., [9:14]). Cue-based parsing theories assume that items are encoded and later retrieved from memory using retrieval cues [7:10]. These cues can be syntactic or semantic, and both sources of information can be used in parallel during retrieval. Interference occurs when the retrieval cues cannot uniquely identify a target item because other syntactically and/or semantically similar (distractor) items are encoded in memory. In subject-verb dependencies, interference from syntactically similar distractors was observed at the retrieval point (a verb), while semantic interference was reported at a later, sentence-final region [10]. This finding may suggest that syntactic information is used to reactivate dependents in memory before semantic information. A similar proposal was made for antecedent-reflexive dependencies in [14] [see also 12]. However, the time-course for semantic interference remains unclear: [11] reports a different time-course than [10] for semantic interference in subject-verb dependencies. Cue-based theories predict that syntactic and semantic interference occur simultaneously during retrieval. We reinvestigated this prediction in English. Furthermore, to study the generality of these effects, we conducted a second, large-sample experiment in German.

Design and materials. Our two eye-tracking (reading) experiments (English, N=61; German, N=121) used a 2 x 2 design with the factors distractor subjecthood (–subject, +subject) and distractor animacy (–animate, +animate) [10]. Table 1 shows an English example item. In all conditions, the manipulated distractor (the meeting/visitor) intervenes between the critical verb (complained) and the target subject (the attorney).

Predictions. Cue-based theories predict a reading time slowdown for +subject compared to –subject conditions, indicating syntactic interference. Similarly, a reading time slowdown is expected for +animate compared to –animate conditions (semantic interference). Crucially, both effects should be observable at the critical verb.

Results. Figure 1 shows the results from our Bayesian analysis. For both languages, +subject conditions showed reading time slowdowns in regression-path durations and total reading times at the critical verb, consistent with a syntactic interference effect. Only English exhibited semantic interference (a slowdown for +animate conditions) at the critical verb; in German there was an indication of this slowdown post-critically. Surprisingly, both languages exhibited slower reading times at the pre-critical adverb for +subject and +animate distractors.

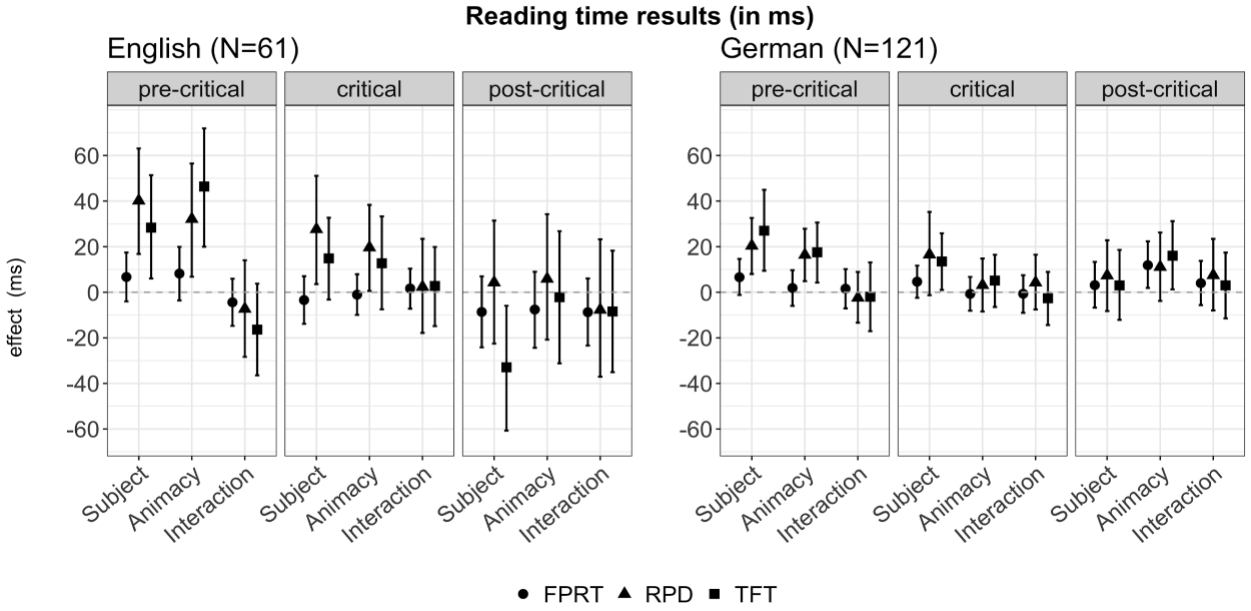
Discussion. In English, the observed reading time slowdowns indicate that both syntactically and semantically similar distractors can cause interference during retrieval. These results are compatible with cue-based theories' predictions. The pattern in our German data is consistent with the observation that semantic effects can continue to slow down processing in later sentence regions [10]. In both languages, the unexpected pre-critical effects are consistent with spillover from prior regions. Further analyses are underway to investigate this possibility.

Conclusions. We tentatively conclude that both syntactic and semantic interference can arise simultaneously, i.e., both types of information can be used in parallel during real-time dependency formation. However, in line with previous research, the German data show that semantically similar distractors may continue to interfere further downstream in the sentence.

Table 1. English example item. The critical target subject and the critical verb (the retrieval point) are shown in bold. The manipulated distractor is underlined. +/–subject: distractor is (not) a subject; +/–animate: distractor is (not) animate.

a. –subject, –animate
It turned out that **the attorney** whose secretary had forgotten about the important meeting frequently **complained** about the salary at the firm.
b. –subject, +animate
It turned out that **the attorney** whose secretary had forgotten about the important visitor frequently **complained** about the salary at the firm.
c. +subject, –animate
It turned out that **the attorney** whose secretary had forgotten that the meeting was important frequently **complained** about the salary at the firm.
d. +subject, +animate
It turned out that **the attorney** whose secretary had forgotten that the visitor was important frequently **complained** about the salary at the firm.

Figure 1. Reading measure results for the English and the German experiment. We fit maximal Bayesian hierarchical models [15]. Shown are the means of the posterior distributions with their 95% Bayesian credible intervals. These give the range in which the true parameter lies with 95% probability, given the data and model. A positive sign means that a slowdown is observed for +subject or +animate conditions. FPRT = first-pass reading times, RPD = regression-path duration, TFT = total fixation times. Pre-critical: adverb, critical: verb, post-critical: prepositional phrase



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