Reassessing the evidence for syntactic adaptation from self-paced reading studies

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Introduction: Sentences such as (1a), in which *cooked* is temporarily ambiguous between a main verb and a reduced relative clause (RRC) reading, cause processing difficulty when the sentence is disambiguated in favor of the RRC reading; this difficulty is reflected in longer reading times (RTs) at the disambiguating region (underlined) compared to controls (1b):

    (1a) The experienced waitress cooked the grilled chicken <u>sent her food</u> back.
    (1b) The experienced waitress who was cooked the grilled chicken <u>sent her food</u> back.

Recent self-paced reading (SPR) studies found that the difference in reading times between sentences like (1a) and (1b) (i.e. the garden path effect) decreased over the course of the experiment (Fine et al., 2013; Fine & Jaeger, 2016, henceforth FJ16). The authors interpreted these results as evidence that participants learned to expect that RRCs will occur frequently in the experimental context — i.e. they *adapted* to the statistics of the environment. There is an alternative explanation, however: as the experiment progressed, people became more familiar with the SPR paradigm and read sentences more rapidly; due to floor effects, there was more potential for RTs to decrease in difficult sentences, which are initially read slowly. In other words, familiarity with the paradigm may have impacted difficult sentences more than it did easy ones (see Figure 1). We ran two experiments to distinguish these two accounts.

Experiment 1: The goal of this experiment was to replicate the decrease in the magnitude of the garden path effect from FJ16. We presented 80 participants recruited online (71 included in the analyses) with the same materials as in FJ16: 20 RRCs (like 1a), 20 unreduced RCs (like 1b) and 80 fillers. A linear mixed effects analysis showed that this experiment replicated FJ16's results in both direction and magnitude (see Figure 2). If this decrease in the garden path effect was a result of syntactic adaptation rather than increased familiarity with SPR, we expect participants exposed to RRCs to exhibit a smaller garden path effect than participants who were not exposed to RRCs. The goal of Experiment 2 was to test this hypothesis.

Experiment 2: We assigned 203 participants recruited online (166 included in the analyses) to one of two groups. In the training phase, the RRC-exposure group was presented with 24 RRCs and 24 fillers, and the Filler-exposure group was presented with 48 fillers. In a subsequent test phase, both groups were presented with 16 new RRCs and fillers (the distinction between the phases was not indicated to the participants). The difference between the RTs in the disambiguating region in the RRC sentences and RTs on the corresponding words in the fillers decreased over the course of the experiment to a similar extent in both groups (no significant interaction between group and sentence type; see Figure 3): <u>we did not find evidence that the decrease in RTs for RRCs was caused by syntactic adaptation</u>.

Explaining the decrease in garden path effect: We ran exploratory analyses to test our alternative explanation that the speed up for a sentence due to familiarity with the paradigm is proportional to the difficulty of the sentence. We divided the stimuli into quartiles based on the RTs at the beginning of the experiment for half the participants in the RRC exposure group and calculated the RTs for these quartiles over the course of the experiment for the other half of the participants. We repeated this process for 1000 random splits of participants. <u>Consistent with our alternative explanation, we found that for both RRCs and fillers, sentences which were read most slowly at the beginning of the experiment showed the highest rate of decrease in RT over the course of the experiment.</u> **Overall**, we conclude that the decrease in garden path effect in FJ16 may be driven entirely by increased familiarity with the SPR paradigm over the course of the experiment; as such, it does not provide unambiguous evidence for syntactic adaptation.
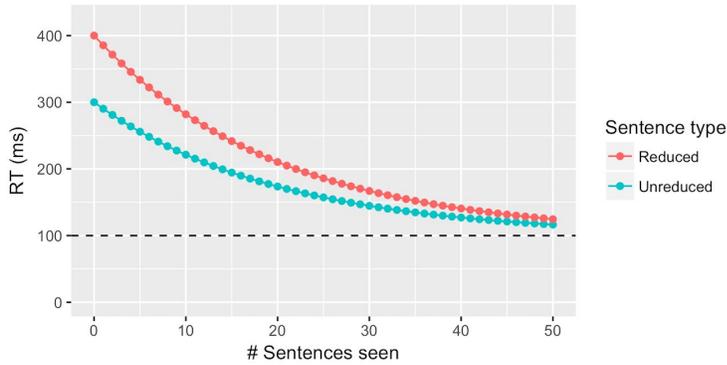
Fig1: Applying an exponential speedup function that is proportional to sentence difficulty on simulated data (c.f. Heathcote et al, 2000):

$$RT = m*e^{T/20} + 100$$

Where T is the trial number and m+100 is the RT for the sentence at T = 0

The dashed line represents the floor
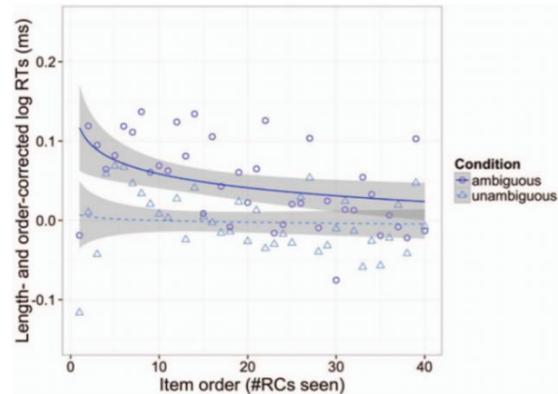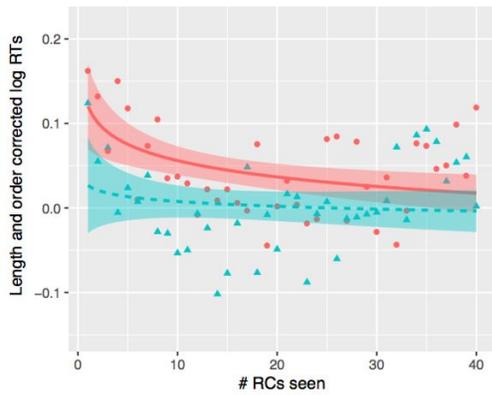
**Fig 2:** Results of experiment 1 (left) and Fine & Jaeger (2016) results (right)
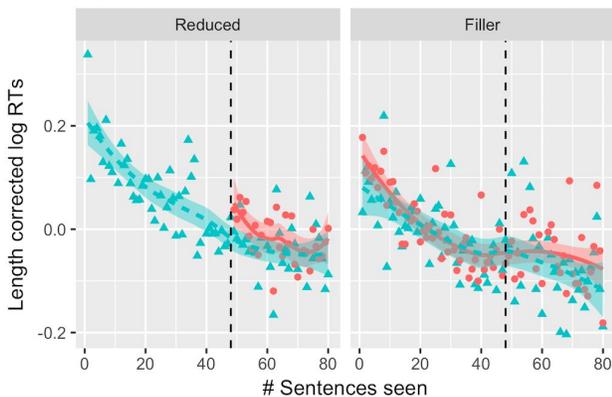
Fig 3: Results of experiment 2 plotting the difference between groups for RRC and filler sentences. Dotted line marks the beginning of test phase.
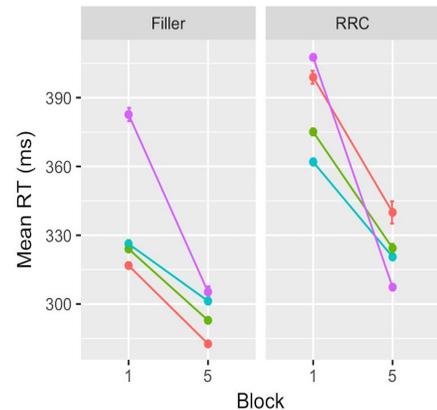
Fig 4: RTs for half of the RRC-exposed group grouped by the RTs in block 1 for the other half. RTs averaged across 1000 random splits.

References:

- Fine, A. B. and Jaeger, T. F. (2016). The role of verb repetition in cumulative structural priming in comprehension. *JEP: Learning, Memory, and Cognition*, *42*(9):1362–1376.
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- Heathcote, A., Brown, S., & Mewhort, D. J. K. (2000). The power law repealed: The case for an exponential law of practice. *Psychonomic Bulletin & Review*, *7*(2), 185-207.