Syntactic Adaptation: An ERP study

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Evidence for adaptation to syntactic structures has been rather elusive, especially in sentence reading (Fine & Jaeger, 2013; Harrington-Stack et al. 2018; Kaan & Chun, 2019). One problem with prior studies is the use of self-paced-reading tasks: reading times become faster over the course of these tasks, which may confound potential effects of syntactic adaptation (Prasad & Linzen, 2019). The present preregistered study uses ERP (Event-Related Brain Potentials) with machine-paced presentation to investigate whether readers change their syntactic parsing preferences in response to recent exposure to sentences of a particular structure.

We present native English participants with three virtual blocks of sentences. The syntactic structure (noun phrase (NP) coordination or clausal (S) coordination) varies per block as illustrated in Table 1. Sentences are presented visually, word-by-word (500 ms/word), while the readers' EEG is recorded. Block 1 contains 72 sentences in which *and* conjoins two NPs. In half of the sentences, the noun after *and* (*movie*) is implausible given the preceding verb (*ate*, see condition a); in the other half, the noun is plausible given the preceding verb (*enjoy,* see condition b). Semantic anomalies typically elicit a larger N400. We therefore expect the implausible noun to elicit a larger N400 compared with its plausible control in block 1. In block 2, the sentences continued with a finite verb; here *and* connects two clauses rather than two NPs. Again, in half of the 72 sentences, the noun after *and* is plausible given the preceding verb (d); in the other half, it is implausible as an object of the preceding verb, but plausible as subject of the verb in the second clause (c). If readers adapt to the syntactic structure they have recently been exposed to and expect *and* to connect two clauses over the course of block 2, they will interpret the critical noun as a subject of the second clause , and not (only) consider it as an object of the preceding verb. We therefore predict that the N400 plausibility effect at the critical noun will be smaller in block 2 versus block 1. Block 3 again contains sentences with NP-coordinations, as in block 1. The N400 plausibility effect is predicted to be larger in block 3 than in block 2, since the critical noun can only be interpreted as the direct object of the preceding verb.

Per our pre-registration, we plan on collecting 36 complete data sets. We define the N400 as the mean amplitude between 300-500 ms after noun onset over the Cz/ 1/ 2/ 3/ 4/ CPz/ CP1/ CP2/ CP3/ CP4 electrodes. Eye movements will be corrected using ICA. We will conduct a linear-mixed effects model with Plausibility (2), Block (3), and their interactions as fixed effects. Block will be treatment coded with block 2 as a reference level. The model will include by-subject and by-item random intercepts. Initially Plausibility and Block will be included as by-subject and by-item random slopes. The random slopes with the smallest variance will be removed until the model converges without singularity warnings.

Thus far we have collected data from 20 participants (Figure 1). Exploratory analyses of the results so far suggest that our predictions are not entirely borne out: instead of the N400 effect being smallest in block 2, there is no difference between the first two blocks. However, the N400 effect reverses in block 3, with the plausible condition eliciting a larger N400 than the implausible. These results suggest that participants adapt to syntactic structures recently encountered and change their parsing strategies, but do not quickly revert to expecting an initially preferred structure (NP-coordination) after exposure to a less preferred structure (S-coordination).

Fine & Jaeger (2013). *Cognitive Science*. Harrington Stack, et al. (2018). *Memory and Cognition*. Kaan, & Chun, (2018). In Federmeier & Watson (Eds.), *Psychology of Learning and Motivation*. Prasad & Linzen (2019). *PsyArXiv*.

Table 1. Overview of the experimental conditions

Block	**Condition**	**Example**
1+3	a. NP-coordination, implausible	The child ate the popcorn and the movie about the superhero.
1+3	b. NP-coordination, plausible	The child enjoyed the popcorn and the movie about the superhero.
2	c. S-coordination, “implausible”	The child ate the popcorn and the movie about the superhero made him happy.
2	d. S-coordination, “plausible”	The child enjoyed the popcorn and the movie about the superhero made him happy.

Note: critical noun is underscored for illustration purposes

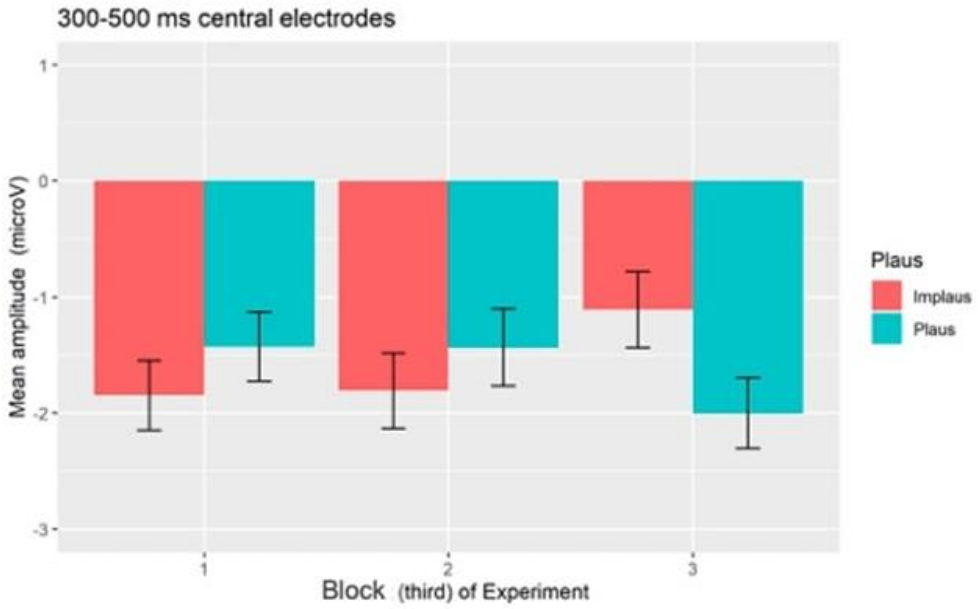

Figure 1. N400 amplitude over the three virtual blocks. Shown is the mean amplitude 300-500 ms after noun onset, collapsed over central electrodes (Cz/ 1/ 2/ 3/ 4/ CPz/ CP1/ CP2/ CP3/ CP4). Red: implausible (a/c conditions); Blue: Plausible (b/d conditions). Error bars are standard errors.