

## Mental simulations during sentence comprehension (#72048)

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### 1) Have any data been collected for this study already?

No, no data have been collected for this study yet.

### 2) What's the main question being asked or hypothesis being tested in this study?

We aim at conducting a high-powered direct replication of an experiment that we have run to investigate the emergence and nature of mental simulations during sentence comprehension. Participants are presented with garden-path sentences (e.g., "As Mary ate the egg was in the fridge.") and unambiguous control sentences derived from the garden-path sentences (e.g., "As Mary ate the egg the fish was in the fridge."). Typically, comprehenders interpret the first verb of such garden-path sentences as being transitive and have to re-analyze the sentence when reaching the second verb. In each experimental trial, participants read either a garden-path sentence or a control sentence. Subsequently, they see the picture of a target entity that corresponds to the initial or the final interpretation during garden-path processing (e.g., a ready-to-eat egg vs. an unpeeled egg). The task is to judge whether the depicted entity was mentioned in the sentence or not (as experimental items always demand a "yes" response, we insert fillers requiring a "no" response). If comprehenders create sentence-based mental simulations, response times to pictures should be faster when the picture matches the sentence-based interpretation of the target entity (garden-path sentences: final interpretation during garden-path processing; control sentences: initial interpretation during garden-path processing as control sentences were respective modifications of garden-path sentences). Moreover, we suggest that sentence-based effects could be attenuated in garden-path sentences, because comprehenders may create and retain incremental simulations reflecting intermediate processing steps (i.e., simulations corresponding to the initial interpretation during garden-path processing).

### 3) Describe the key dependent variable(s) specifying how they will be measured.

We will measure response times to pictures (i.e., the time period from picture onset until pressing one of the two keyboard response keys).

### 4) How many and which conditions will participants be assigned to?

The experiment has a  $2 \times 2$  within-subjects design, with the factors sentence type (garden-path sentence vs. control sentence) and picture type (initial vs. final entity interpretation). Importantly, the levels of the factor "picture type" are labeled in reference to garden-path sentences. Therefore, the level "final entity interpretation" always corresponds to the sentence-based interpretation in garden-path sentences, whereas the level "initial entity interpretation" always corresponds to the sentence-based interpretation in control sentences.

### 5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.

We will conduct a linear mixed effect analysis (see Baayen et al., 2008) on response times to pictures. We will determine an appropriate random effect structure by using the data-driven model selection criterion of Matuschek et al. (2017), which aims at balancing Type I error rate and power. When performing the procedure, we will omit models that have a singular fit or do not converge. However, we will try to resolve such issues by trying different optimizers. For hypothesis testing, we will perform likelihood ratio tests.

### 6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.

We will recruit right-handed native English speakers with an age between 18 and 60 years. Crucially, we will exclude participants that have an error rate higher than 25% in at least one experimental condition or in filler trials. In order to reach our target sample size and prevent power reduction, we will compensate any dropout by recruiting further participants. On trial level, we will remove response times indicating anticipatory responses ( $< 150$  ms) and response times indicating disruption of performance ( $> 3000$  ms). For identifying further outliers, we will employ the two-step procedure proposed by Kaup et al. (2006), which incorporates response differences among items and participants. Accordingly, we will transform the response times of each participant to z-scores. Following this, we will delete trials with z-scores differing more than two and a half standard deviations from the mean z-score of the respective item in the respective experimental condition.

### 7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.

For determining the target sample size, we referred to the original experiment we will replicate. A simulation-based power analysis using the R package "mixedpower" (Kumle et al., 2021) revealed that about 200 participants would be needed for having a test power of .90 with respect to the effect in question.

### 8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)

We may perform post-hoc contrasts to evaluate whether sentence-based simulation effects exist for both garden-path sentences and control sentences.