

Tracking the activation of scalar alternatives with semantic priming

Introduction. We investigate the psycholinguistic mechanisms underlying scalar implicature. Using semantic priming with lexical decision, we find facilitated reaction times to scalar alternatives, which provides evidence that they are retrieved and activated in the computation of scalar implicature.

Background. In calculating scalar implicature (SI), hearers infer messages beyond what is literally, explicitly said by the speaker. In (1), the SI *not all* is inferred, while in (2), *not excellent* is inferred.

(1) Mary ate some of the cookies. → SI: Mary ate some, but not all, of the cookies.

(2) The movie is good. → SI: The movie is good, but not excellent.

The standard assumption is that the inferential process that gives rise to SI involves hearers reasoning about what the speaker could have said, but did not. But it is an open question precisely what psycholinguistic mechanisms underlie this inferential process. Additionally, theoretical accounts disagree on what is involved in the inferential process. Neo-Gricean accounts typically assume that hearers infer the negation of informationally stronger alternatives that the speaker could have said, and that these alternatives are determined via the lexicon or grammar (i.a. Horn, 1972; Katzir, 2007) —e.g., because *<some, all>* form a lexical scale, and *all* is stronger than *some*, hearers derive *not all* upon encountering *some*. But there exist other, Post-Gricean accounts, which take scalar inference to be a contextually driven, conceptual process, whereby utterances undergo strengthening as an instance of ad hoc concept construal, with lexical scales playing no special role (i.a. Sperber and Wilson, 1995).

In this study, we investigate the psycholinguistic reflexes of SI. Specifically, we use semantic priming with lexical decision to test whether lexical alternatives are retrieved and activated in the processing of SI-triggering sentences. The general logic of our experiments is to probe whether alternatives like *all* and *excellent* are recognized with facilitated reaction times in a lexical decision task when they follow a relevant SI-triggering sentence. Similar methods have been successfully used to investigate the activation of alternatives in sentential focus. For instance, Husband and Ferreira (2015) (see also Braun and Tagliapietra, 2009; Yan and Calhoun, 2019) auditorily presented participants with sentences such as *The murderer killed the NURSE last Tuesday night*, and found that visually presented focus alternatives, e.g., *doctor*, were recognized faster as a word of English. The activation of alternatives in SI has, however, not been tested in this way. (For work on priming and scalar inference more generally, see Schwarz et al. (2016), who subliminally primed participants with the stronger alternative before they read the weaker one in an SI-triggering sentence, as well as de Carvalho et al. (2016), who investigated whether scalar terms prime each other in the absence of a sentential context.)

Experiment 1: Sentential priming. Capitalizing on the scalar diversity phenomenon (i.a. van Tiel et al., 2016), our testing ground for the activation of alternatives is 60 lexical scales (adjectival, verbal, adverbial and quantifier). In Exp. 1, participants (N=46) saw an SI-triggering sentence such as *The movie is good*, which was presented word-by-word. Participants then saw the scalar alternative *excellent*, and had to indicate by button press whether this word was a word of English or not. We refer to this experimental condition as the “related” condition. In the “unrelated” condition, participants were first presented with a sentence that was unrelated to the lexical scale, e.g., they saw *The movie is foreign* before making a lexical decision on *excellent*. In addition to the 60 lexical scales, there were 60 fillers items with non-words (e.g., *kleans, spraize*), which were preceded by unrelated sentences.

Predictions. If lexical scalar alternatives like *all* and *excellent* are reasoned about, and retrieved in the process of SI-calculation, then we should see facilitated reaction times in the related condition, as compared to the unrelated condition. That is, *excellent* should be recognized faster when it follows an SI-triggering sentence where it serves as a stronger alternative, than when it follows an unrelated sentence. On the contrary, if lexical alternatives do not play a role in the processing of SI, then there should be no difference in reaction times between the related and unrelated conditions.

Experiment 2: Priming with “only”. For comparison, we conducted a version of the experiment

where the prime sentences also included the focus particle *only*. That is, participants (N=43) saw sentences like *The movie is only good* before they had to make a lexical decision on *excellent*. Because the exclusion of alternatives in sentential focus is encoded in the semantics (Rooth 1992, 1985), and previous work has found that focus alternatives are indeed primed, we have a strong prediction that we should find facilitated reaction times in Exp. 2, which can then provide a baseline for Exp. 1.

Experiment 3: Lexical priming. In Exp. 3, we investigated the lexical priming of stronger alternatives, given the weaker alternative, but without any sentential context. This is to rule out the possibility that semantic priming might occur unrelated to SI processing, simply because pairs of scalar terms are semantically related. Here, participants (N=44) were presented with single words (*good* vs. *foreign*) as the prime, and responded to *excellent* afterwards —otherwise, the design of the experiment was the same as Exp. 1. If semantic priming arises due to similarities in meaning between scalar terms such as *good-excellent*, then we should see facilitated reaction times in the related condition in Exp. 3, serving as a control for SI-related priming in the sentential experiments.

Results and discussion. The figure on the right shows the results of our experiments. In the control, lexical experiment (Exp. 3), we found no effect of Condition ($p = 0.26$): targets in the related condition were not recognized significantly faster than in the unrelated condition. This shows that pairs of scalar terms are not sufficiently semantically related to result in semantic priming, and therefore any priming effect we find in sentential experiments is due to alternative retrieval, not just mere meaning similarity. In the sentential experiment (Exp. 1), we indeed found a significant effect of Condition ($p < 0.5$): targets were recognized faster following an SI-triggering sentence. This provides evidence for the retrieval and activation of alternatives in SI processing, and supports Neo-Gricean accounts of SI, in which hearers reason about particular lexical alternatives. On the other hand, such results are not predicted by theoretical accounts of SI that dispense with lexical scales, such as Post-Gricean accounts.

The experiment with *only* (Exp. 2) also revealed a significant effect of Condition ($p < 0.01$). Exp. 1 and 2 pattern alike: analyzing the two data sets together, we find no significant difference between them ($p = 0.59$). This suggests that alternatives like *excellent* are similarly activated no matter whether the sentence that is processed is *The movie is good* or *The movie is only good*. This presents a puzzle: in a separate set of experiments, we investigated the rate of inference calculation for SI-triggering sentences and sentences with *only*, and found that the latter lead to higher rates of inferences. The lack of a difference between the current Exp. 1 and 2 suggests that activation of alternatives, as measured via priming, does not track the rate of inference from the corresponding sentences.

Conclusion. In a series of semantic priming experiments, we have addressed an open question regarding the psycholinguistic processing of scalar implicature. We have found evidence that lexical alternatives (*all*, *excellent*) are retrieved and activated in the real-time processing of SI-triggering sentences. In addition to informing our understanding of the mental representations behind pragmatic reasoning, our findings also help adjudicate between theoretical accounts of SI, and are most in line with Neo-Gricean theories.

