Scales and scalarity: processing scalar inferences

Bob van Tiel, Elizabeth Pankratz, Chao Sun / Leibniz-ZAS Berlin, Humboldt Universität Berlin

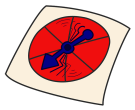
Scalar words, such as "some", may be interpreted with an upper bound, i.e., as excluding "all". A number of studies have provided evidence suggesting that the computation of such *scalar inferences* (SIs) is cognitively costly, which has been interpreted as confirming relevance theory (Sperber & Wilson, 1986). However, these studies have, for the most part, confined their attention to just two scalar words, namely "some" and "or". Apparently, the tacit assumption has been that ⟨some, all⟩ and ⟨or, and⟩ are representative of a much larger family of scales. In this paper, we investigate whether this uniformity assumption is justified by attempting to replicate the results of three studies with a wider array of scalar words.

Our experiments tested seven scales. For each scale, we constructed three sentences with the weaker scalar word, and for each sentence, we created three types of pictures: one in which the sentence was unambiguously true ("true" control), one in which it was unambiguously false, ("false" control), and one in which the sentence was literally true but false if the SI was derived (target). Example sentences and target pictures are shown below.

The apple or pepper is red

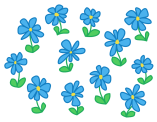
Some socks are pink

The arrow might land on red



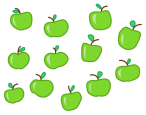
The battery is low

Red flowers are scarce



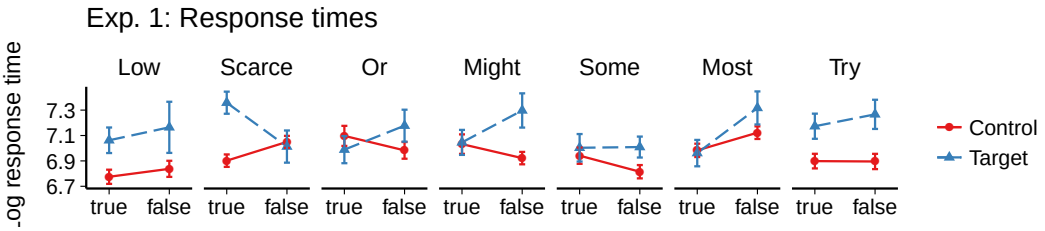
He tried to tie his tie

Most apples are green



Exps. 1 and 2 sought to replicate Bott and Noveck's (2004) finding that the SI of "some" slows down verification times. In Exp. 1, 50 participants were thus presented with sentences and pictures, and had to indicate whether they felt the sentence correctly described the picture. Exp. 2, which tested 250 participants, was the same as Exp. 1, except that participants were trained whether to respond literally (i.e., "true") or pragmatically (i.e., "false") to target items, rather than allowing them to give their intuitive judgements.

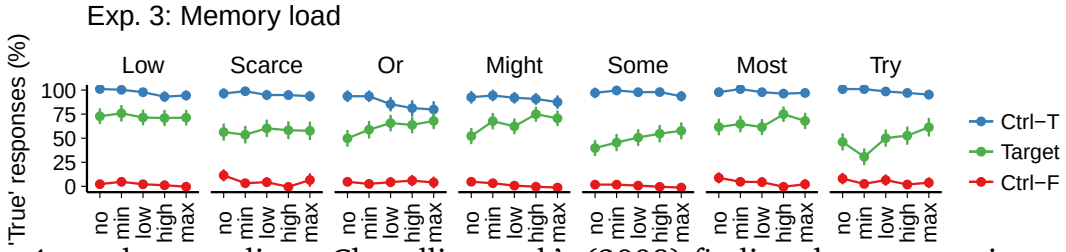
The figure shows mean response times in Exp. 1, which were confirmed in Exp. 2. We analysed these by constructing mixed models predicting response times based on condition (target or control), response ("true" or "false"), and their interaction. In the case of "some", there was a significant interaction in the expected direction between condition and response, in line with Bott and Noveck's results. "Or", "might", and "most" patterned with "some". No effect was found for "low" and "try", and the reverse interaction was found for "scarce".



Exp. 3 sought to replicate De Neys and Schaeken's (2007) finding that participants are less likely to respond pragmatically to "some" when they have to memorise complex grid

patterns than simple ones. Thus, Exp. 3 was the same as Exp. 1, except that participants' working memory was burdened to various degrees during the experiment. In the no-load condition, participants did not have to memorise anything. In the minimal, low, high, and maximal load conditions, participants had to memorise increasingly complex grid patterns. 50 participants were tested in each memory load condition.

The figure shows responses in Exp. 3. We analysed these by constructing mixed models predicting responses in the target condition based on memory load as an ordinal factor. In line with De Neys and Schaeken's results, the frequency of pragmatic responses for "some" decreased linearly with working memory load. "Or", "might", "most", and "try" patterned with "some" in this respect. No effects of memory load were found for "low" and "scarce".



Exp. 4 sought to replicate Chevallier et al.'s (2008) finding that pragmatic responses for "or" are more frequent when participants have more processing resources available. Thus, 150 participants were tested in three conditions: in the fast condition, the picture was briefly presented and was then replaced by the sentence, in the normal condition, the picture remained on screen when the sentence was presented, and in the slow condition, participants had to wait for three seconds before responding.

We analysed the results by constructing mixed models predicting responses in the target condition (literal or pragmatic) based on processing time (fast, normal, or slow) as an ordinal factor. However, we failed to replicate Chevallier et al.'s results for "or": there was no effect of processing time on responses for "or", nor for any of the other scalar words.

Overall, then, we find that the SIs of "or", "might", "some", "most", and, in Exp. 3, "try" are associated with a processing cost, as opposed to "low" and "scarce". We explain these findings in terms of the notion of *scalarity* (Horn, 1989). "Or", "might", "some", "most", and "try" are positively scalar because they denote a lower bound on their dimension; "low" and "scarce" are negatively scalar because they denote an upper bound. Correspondingly, the scalar inferences of positively scalar words are negative, i.e., upper-bounding, unlike those of negatively scalar words. There is a large body of evidence showing that the processing of negative information is costly. Hence, we argue that the SIs of positively scalar words are cognitively costly because they introduce negative information into the meaning of the sentence, rather than because of any processing cost that is intrinsic to scalar inferencing.

Thus, the processing of scalar words is heterogenous, and the presence or absence of a processing cost should be understood in terms of low-level constraints on the process of sentence verification. Hence, the processing cost for the SIs of "some" and "or" should not be construed as evidence for relevance theory. Instead, our results suggest that the literal and pragmatic interpretations of scalar words may be processed in parallel.

References: **[1]** Bott, L. & Noveck, I. (2004). *J Mem Lang*, *51*. **[2]** Chevallier, C., Noveck, I., Nazir, T., Bott, L., Lanzetti, V., & Sperber, D. (2008). *Q J Exp Psych*, *61*. **[3]** Clark, H. & Chase, W. (1972). *Cog Psych*, *3*. **[4]** De Neys, W. & Schaeken, W. (2007). *Exp Psych*, *54*. **[5]** Horn, L. (1989). *A natural history of negation*. **[6]** Sperber, D. & Wilson, D. (1986). *Relevance: communication and cognition*.