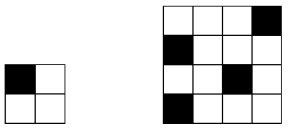
Processing implicatures: a comparison between direct and indirect SIs

Background. Previous results suggest that deriving the scalar inference (SI) associated with 'some' can be cognitively demanding: in comparison to their literal interpretation, the enriched interpretation of 'some'-sentences requires additional processing time (a.o., Bott and Noveck 2004, Bott et al. 2012, B&N effect henceforth) and extra memory resources (a.o., De Neys and Schaeken 2007, Marty and Chemla 2013, D&S effect henceforth). Investigating the extent to which these findings for 'some' generalize to other scalar terms, van Tiel et al. (2019) compared the cognitive processing of various scalar words differing in their scalarity, i.e. whether they impose a lower or upper bound on their dimension. They found that the original B&N and D&S effects extend to the SIs of other positively scalar words like 'or' or 'might', but not to those of negatively scalar terms like 'scarce' or 'low'. The authors explain these findings by arguing that the derivation of the former, but not the latter, introduces negative information into the meaning of the sentence, and that it is the costly processing of such negative information that is responsible for the observed delay and memory effects. We will refer to this line of explanation as the *scalarity hypothesis* (SH).

Present study. SH predicts that SIs are cognitively costly insofar as they add a negative proposition into the meaning of the sentence. We tested this prediction by comparing the processing signature of negative, direct SIs arising from positively scalar terms (e.g., inferring *not all* from 'some') to that of positive, indirect SIs (ISIs) arising from their negated stronger scale-mate (e.g., inferring *some* from 'not all'). Building upon van Tiel et al.'s material and method, we constructed three tasks that manipulated the cognitive load on participant's memory during sentence comprehension: one classical sentence-picture verification task (NO LOAD), and two dual-tasks in which participants had to perform that verification task while trying to remember either a simple visual pattern (LOW LOAD) or a more complex one (HIGH LOAD; see Fig. 1). The verification task tested three scales: <some, all>, <or, and> and <possible, certain>. For each scale, we constructed one positive sentence with the weaker term (POS-WEAK) and one negative sentence with the stronger one (NEG-STRONG). Each sentence was paired with three types of pictures depicting a situation in which it was unambiguously true ('True' control), unambiguously false ('False' control), or in which its truth-value depended on whether the relevant SI was computed ('Target'; see Fig. 2). Crossing sentence and picture types gave rise to 18 conditions (3 scales$\times$2 sentence types$\times$3 picture types), each of which was instantiated 3 times by varying the content of the pictures. 150 native speakers of English participated in the study (50 subjects per task).

Main results. The proportions of 'true' responses in all three tasks are provided in Fig. 3, and the mean response times in the NO LOAD task are provided in Fig. 4. First, in the Target conditions, people provided less pragmatic answers for both POS-WEAK and NEG-STRONG sentences under cognitive load (D&N effects across-the-board). Thus, increasing memory load decreased the rates of pragmatic answers regardless of the polarity of the corresponding SI. Second, in comparison to all relevant baselines, people were slower to answer pragmatically to POS-WEAK sentences (B&N effects), but not to NEG-STRONG sentences. Thus, there is no evidence that indirect SIs come at an extra processing time, unlike direct SIs. Third, people were faster to answer pragmatically than logically to NEG-STRONG sentences (reverse B&N effect; absent from POS-WEAK sentences).

Discussion. Our dual task results challenge the idea that the polarity of SIs is the only or main factor for the D&S effect. To explain our findings, we could suppose that memory load directly impairs the activation of pragmatically enriched interpretations (Marty and Chemla 2013). If so, then there is more to the cost of an SI than its polarity. Alternatively, memory load could draw on resources needed to decide among competing interpretations, making in effect people more tolerant to under-informative statements. If so, then the D&S effect may be orthogonal to the core cognitive cost of SIs, and so SH could still be valuable to explain other processing effects found with other measures/paradigms. For now, our response time results confirm those from van Tiel et al. (2019) and align well with SH: unlike direct SIs, we found no evidence for delay for ISIs. Finally, the finding that ISIs exhibit reverse B&N effects extends previous observations from Cremers and Chemla (2014, Exp.1) and Romoli and Schwarz (2015), and requires further examination. We will suggest that those effects relate to the felicity conditions of NEG-STRONG sentences, which made them harder to fully accept than simply reject in our Target conditions.



(a) low load (b) high load

Figure 1: Examples of low-load and high-load matrices that participants had to memorise.

Some of the apples are red.	True	Target	False
Not all of the apples are red.	True	False	Target

Figure 2: Example of sentence-picture displays for the scale <some, all> together with the resulting experimental conditions.

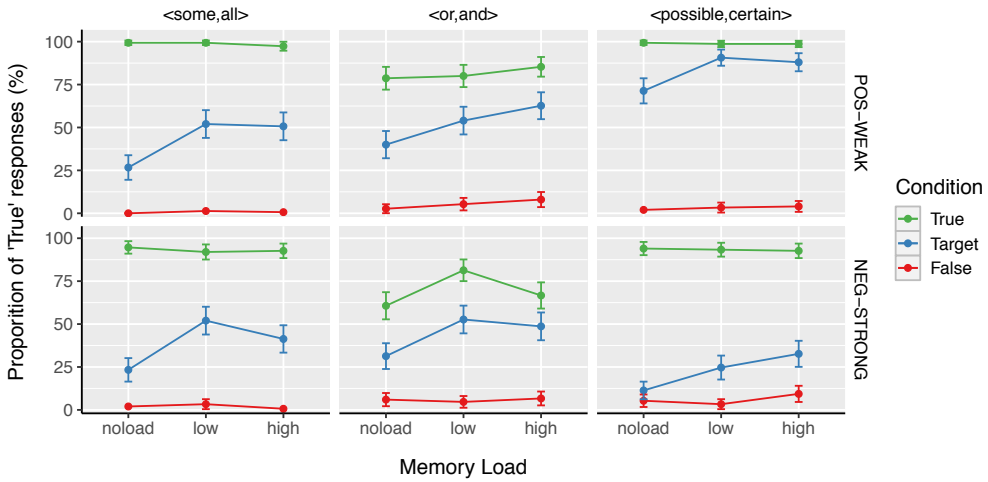


Figure 3: Proportion of 'true' responses for each pair of scalar terms by sentence type as a function of memory load and condition. Error bars represent 95% confidence intervals.

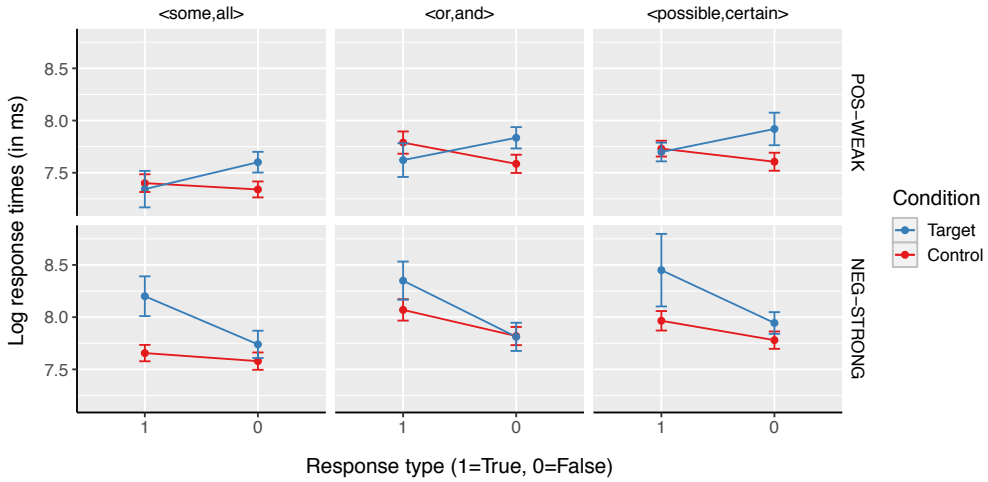


Figure 4: Mean Log response times in the NO LOAD task for each pair of scalar terms by sentence type as a function of response type and condition. Error bars represent 95% confidence intervals.

Selected references

Bott, L. and Noveck, I.: 2004, *Some utterances are underinformative* • Bott, L., Bailey, T. M. and Grodner, D.: 2012, *Distinguishing speed from accuracy in scalar implicatures* • Cremers, A. and Chemla, E.: 2014, *Direct and indirect scalar implicatures share the same processing signature* • De Neys, W. and Schaeken, W.: 2007, *When people are more logical under cognitive load: Dual task impact on scalar implicature* • Marty, P. P. and Chemla, E.: 2013, *Scalar implicatures: working memory and a comparison with 'only'* • Romoli, J. and Schwarz, F.: 2015, *An experimental comparison between presuppositions and indirect scalar implicatures* • van Tiel, B., Marty, P., Pankratz, E. and Sun, C.: 2019, *Scalar inferences and cognitive load* • van Tiel, B., Pankratz, E. and Sun, C.: 2019, *Scales and scalarity: Processing scalar inferences*.