Listeners encode multiple meanings when generating scalar inferences

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During spoken-language comprehension, each sentence's interpretation is built on a moment-to-moment basis. However, little is known about when the interpretation itself is encoded in memory. For example, in scalar inferences, listeners overwhelmingly prefer the pragmatic meaning of "*some*", but initially consider its semantic meaning.[i] Is the semantic meaning included in the final interpretation of the sentence? Or is it replaced by the pragmatic inference? One possibility is that the system waits until after pragmatic analysis to encode an interpretation into memory. Consistent with traditional models of sentence processing, this would result in a single interpretation of each sentence.[ii] Alternatively, the processing system may interpret and encode all interpretations under consideration, before pragmatic analysis and regardless of whether they fit with the context.

The current study uses two tasks to investigate whether the semantic meaning of "some" is encoded in memory prior to a scalar inference. First, during the word-learning task,[iii] participants (n = 40) heard instructions like "*Click on the girl that has some of the blickets*" while their eye-movements were recorded to a display (Fig. 1) featuring a subset of objects (girl with 2-out-of-4 items), and a total-set of objects (girl with 3-out-of-3 items). Thus, both sets are consistent with the semantics of "*some*" but only the subset is consistent with the implicature. Filler trials featured the quantifiers "*two*", "*three*", and "*all"*. The target is the subset character in "*some/two*" trials and the total-set character in "*all/three*" trials. Second, during the recall task, participants saw objects that were previously associated with the subset and total-set (Fig. 2), and were instructed to *"Click on the blicket*." Importantly, to examine participants' memory for the semantic meaning of "some" during the recall task, we calculated the proportion of matches between responses on the word-learning and recall tasks. A response was coded as a match if the same object is selected in both word learning and recall. We only analyzed the matches for accurate word-learning trials because we want to probe memory for interpretations made via pragmatic inference. If the semantic meaning is overridden by pragmatic inference, recall for the subset object should be as high for "some" as "two/three/all". Alternatively, if the semantic meaning is encoded in memory prior to the inference, it may interfere with recall and lead to fewer matches for "some" trials than "two/three/all" trials.

During the word-learning task, we analyzed proportion of looks to the target character (target over competitor looks) following quantifier onset. Figure 3 illustrates that Target looks were generally lower for quantifiers compared to number words. This is likely because the exact semantics of number words isolates the domain of quantification to the basic level, and generates a clear expectation that the up-coming novel word will distinguish the objects. The quantifier terms refer to relationships between individuals within a set, so listeners might entertain the possibility that the novel word is a superordinate category that refers to both object kinds. Critically, comparisons to chance indicate that looks converged on the target following "all" (200ms), "two" (100ms), and "three" (100ms). In contrast, a preference for the target in the "some" condition emerged at 700ms. This confirms that semantic analysis precedes pragmatic inference.[v] Moreover, participants selected the subset on 85% of trials, indicating that the pragmatic inference was made (Fig. 4). Figure 5 shows that recall of the novel object labels was significantly greater for trials that did not feature a pragmatic inference ("*two"*: 75%, "*all*": 74%, "*three*": 77%) than trials that did ("*some*": 59%). There was a significant main effect of scale

type ($p < 0.05$) and strength (lesser or greater) ($p < 0.05$), as well as a significant interaction between scale type and strength ($p < 0.05$). Although traditional models of sentence processing assume that comprehension results in a single and accurate representation of what was said, these findings suggest that listeners encode the semantic meaning of "some" in memory prior to making the scalar inference. This results in an interpretation that features multiple meanings.

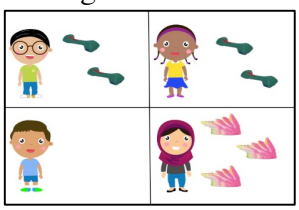

Figure 1. *Sample display from the word-learning task.*

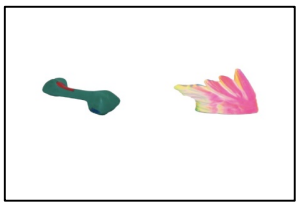

Figure 2. *Sample display from the recall task.*

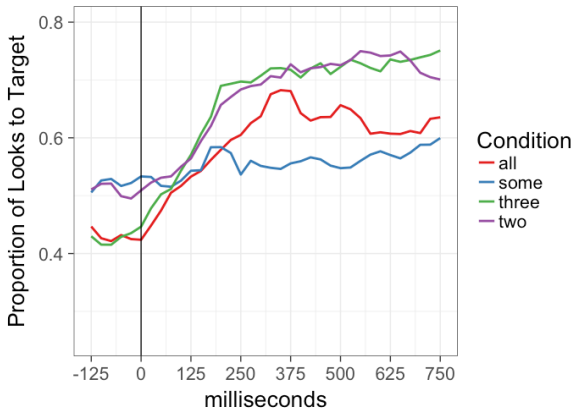

Figure 3. Proportion of looks to the target referent following the onset of the quantifier.

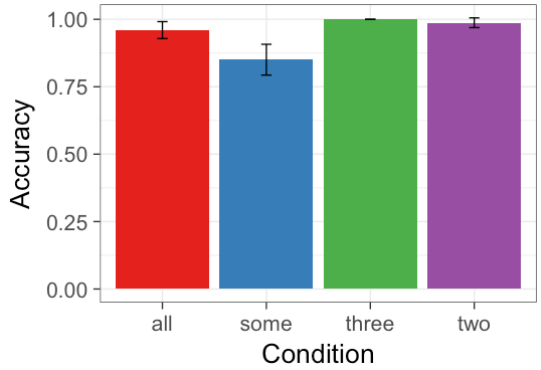

Figure 4. Word learning accuracy by condition.

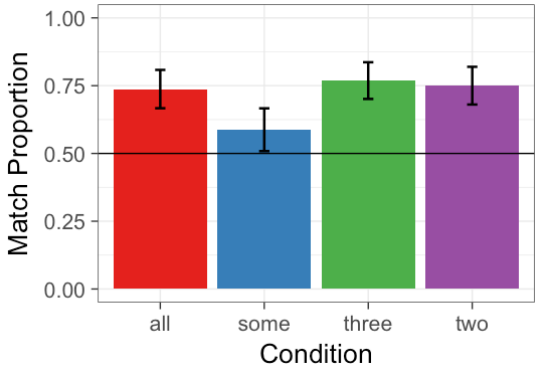

Figure 5. Percent word-learning and recall matches by condition.

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[i] Bott, L., & Noveck, I. A. (2004). Some utterances are underinformative: The onset and time course of scalar inferences. Journal of memory and language,51(3), 437-457.

[ii] MacDonald, M. C., Pearlmutter, N. J., & Seidenberg, M. S. (1994). The lexical nature of syntactic ambiguity resolution. Psychological review, 101(4), 676.

[iii] Huang, Y.T., & Arnold, A. (2016). Word learning in linguistic context: Processing and memory effects. Cognition.

[v] Huang, Y. T., & Snedeker, J. (2009). Online interpretation of scalar quantifiers: Insight into the semantics–pragmatics interface. *Cognitive psychology*, *58*(3), 376-415.