The cost of being cooperative: Details of the effort in processing scalar implicature
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A long-standing open question concerns the cost or effort involved in processing scalar implicatures (SIs). When we hear "Some of the boxes are red", we go beyond the literal meaning of "some" and infer that *not all* of the boxes are red. According to the Default view [1] hearers compute these kinds of SIs (generalized conversational implicatures) quickly, costlessly, and automatically. In contrast, according to the Relevance Theory view [2], all inferences are costly and only computed if contextually sufficiently relevant.

Several experiments (e.g.[3],[4],[5]) have demonstrated effortful processing associated with scalar inference. Recent eye-tracking work has focused on the Relevance Theory prediction that the literal interpretation of "some" ("possibly all") is computed before the pragmatic interpretation ("not all"), with conflicting results ([6],[7]). Existing work ([8],[9]) shows that eye-movements are closely time-locked to interpretations that listeners consider as language unfolds. In this present work, we analyze eye-movement patterns within a scene to gain further insights into the cognitive processes that take place during SI processing.

We used a picture-verification task with visual-world eye-tracking. Target trials involved pictures of two types: [Picture=All], where all objects were exactly alike (ex.1) or [Picture=Some], which showed the same objects in the same configuration, but some were one color and some another color (ex.2). Participants (n=24, all native English speakers) viewed these scenes while listening to sentences that were identical except for Quantifier (ex.3), [Quant=Some] and [Quant=All] conditions. The 20 target items, randomized in a Latin Square design across four lists, consisted of highly frequent nouns and colors ("apple" / "red"), while 40 filler items used terms of varying frequency ("hang-glider" or "bell" / "magenta" or "blue").   Participants pressed a button (YES/NO) to indicate whether a sentence was a "good description" of the picture.

If the Relevance view is correct (SIs carry a cost when deemed relevant), then we expected greatest response time/indications of processing when the process of judging the picture would most likely evoke the scalar implicature ([Quant=Some/Picture=All] condition) and equal results in other conditions. Under the Default view (SIs are costless), we expected no such difference between conditions. By recording both eye-movements and RTs, we can analyze two different indicators of processing activity.

RESULTS: [Quant=All/Picture=All] and [Quant=Some/Picture=Some] conditions resulted in nearly 100% "good description" responses; the [Quant=All/Picture=Some] condition triggered 1% "good description" responses, as expected. Strikingly, the [Quant=Some/Picture=All] condition resulted in 56% "good description" responses, though nearly all participants expressed awareness of the implicature.

Average RTs in both [Quant=Some] conditions were significantly longer than in the [Quant=All] conditions with the same picture (p<.05). Moreover, RTs in the [Quant=Some] condition were significantly influenced by Picture conflict (longer in [Quant=Some/Picture=All] than [Quant=Some/Picture=Some], p's<.05).

Analysis of fixation durations (post-Quantifier-onset) revealed only an effect of Quantifier: average fixation durations were significantly longer in [Quant=Some] conditions regardless of visual scene (p<.05), which we interpret as signaling more processing than in the [Quant=All] conditions.

Eye-movement latencies also revealed early sensitivity to "some". When the picture depicted two color groups of objects ([Picture=Some]), participants were faster to look at the "other" group (defined relative to where they were looking at quantifier onset) in the [Quant=Some] condition than the [Quant=All] condition (p<.05).

In conclusion, comprehenders seem to show early sensitivity to the "not all" meaning of "some" (as shown by latency data). Situations where scalar inferences appear relevant result in longer RTs and fixation durations, indicative of increased processing. This result seems to be at odds with the Default claim that implicatures are costless.

ex.1. ex.2.

ex.3. "This is a picture of apples. {Some/All} of them are red."
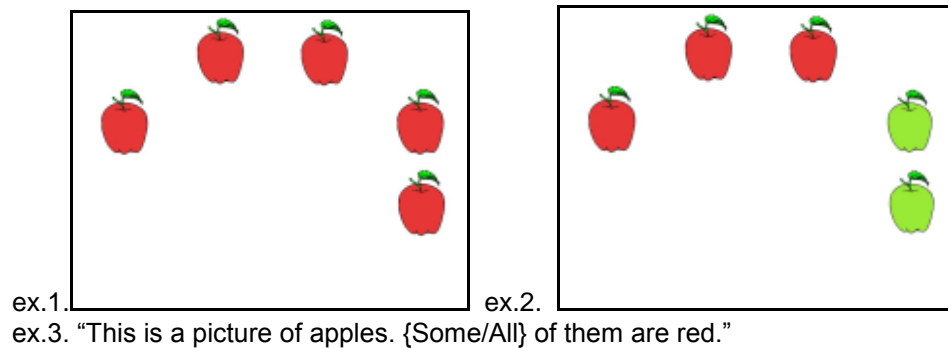
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