

Using a Novel Experimental Paradigm to Investigate the Processing of Scalar Implicatures

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Generating Scalar Implicatures by Default?

Scalar implicatures arise in pieces of discourse like the following [2].

(1)A: Was the exam easy?

B: Some of the students failed.

Implicature: Not all of the students failed.

It is an open issue whether implicatures are generated automatically, by default [5] or as part of a slow, context-driven process [7]. Recent studies have mostly provided evidence for the Context-Driven approach in reaction-time [6], reading-time [1], and eye-tracking studies [4]. However, one eye-tracking study [4] provides support for the Default approach.

In this study, we examine some of the factors potentially involved in the observed delays.

1. Are there difference in implicature eliciting potential between simple *some* and the partitive construction *some of the*? If so, intonation of the implicature trigger will matter to the speed of interpretation.
2. In order to draw inferences about whether or not implicatures are computed by default, what is the *appropriate reference speed*? In particular, comparison to the speed of interpretation of small exact number may be problematic, since sets of objects whose cardinality falls within the subitizing range may be better labeled by their correct exact number rather than by *some*, and subitizing happens very rapidly. If exact number is preferred in the subitizing range, interpretation of *some* may be slower. Similarly, are there baseline differences between interpretations of *some* and *all*?

The Gumball Paradigm

Method

Participants 22 members of the University of Rochester community, paid for participation.

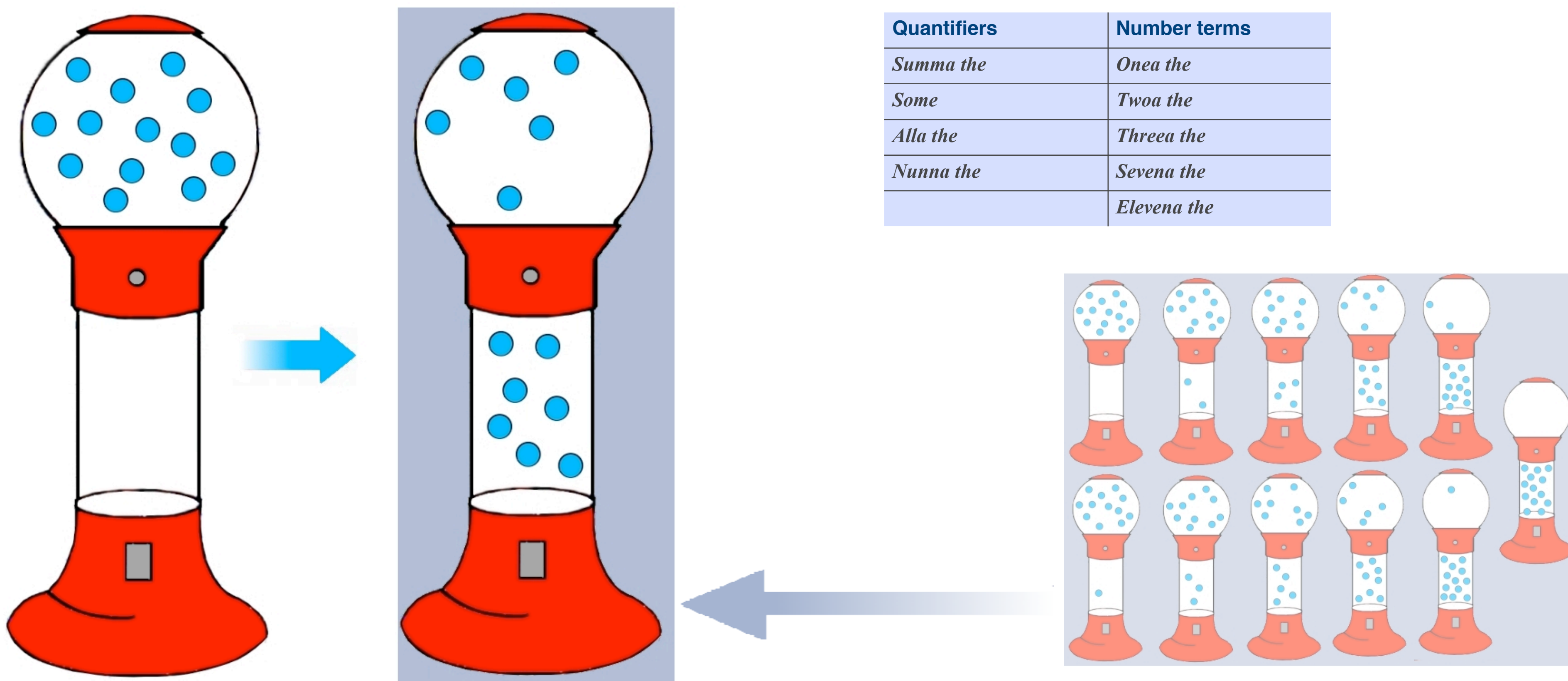
Procedure and Materials

- On each trial, participants saw a gumball machine with a full upper chamber (13 gumballs) and an empty lower chamber.
- A *KA-CHING* was followed by a new display with a certain number of gumballs moved to the lower chamber.
- Participants heard a statement of the form: *You got « QUANTIFIER/NUMBER TERM » gumballs.*
- Participants responded as quickly as possible whether they agree or disagree by pressing the *YES* or *NO* button

Paradigm

Conditions

Quantifiers	Number terms
<i>Summa the</i>	<i>Onea the</i>
<i>Some</i>	<i>Twoa the</i>
<i>Alla the</i>	<i>Threea the</i>
<i>Nunna the</i>	<i>Sevena the</i>
	<i>Elevena the</i>



Results

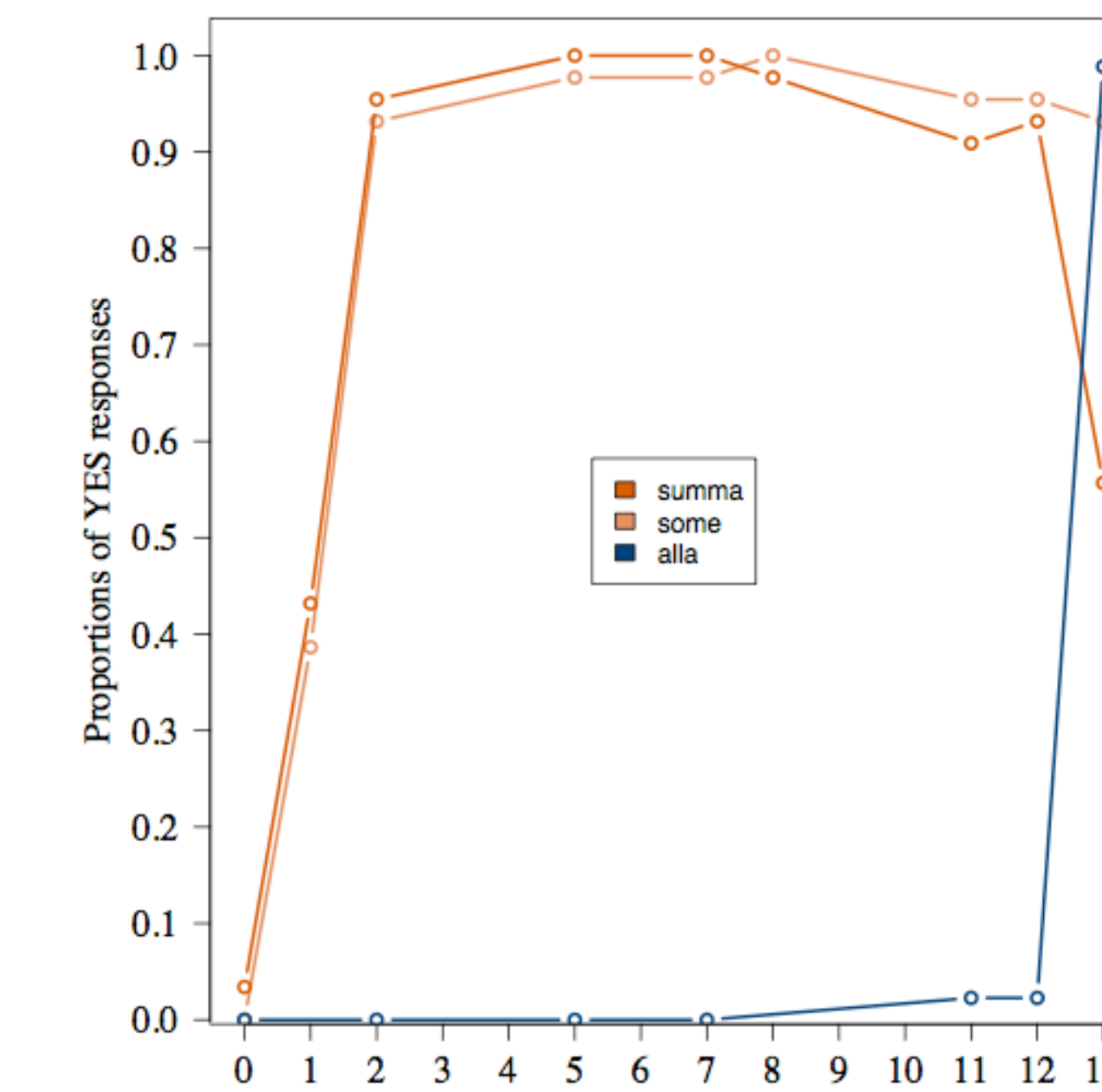
Judgments. When receiving all gumballs, 99% of participants respond YES to *alla*, 93% to *some*, and 56% to *summa*. *Alla* and *some* are significantly more likely to receive a YES response than *summa* ($t=6.3$, $p<.0001$, $t=7.9$, $p<.0001$). This suggests that *summa* nearly always gives rise to implicatures, while *some* does so to a much lesser degree. In addition, there were significantly less YES responses to 0 and 1 gumballs for both *some* and *summa* than for more than two gumballs. The effect was marginally significant for 2 gumballs. This suggests that for small set sizes *some/summa* is somewhat unnatural.

Reaction times.

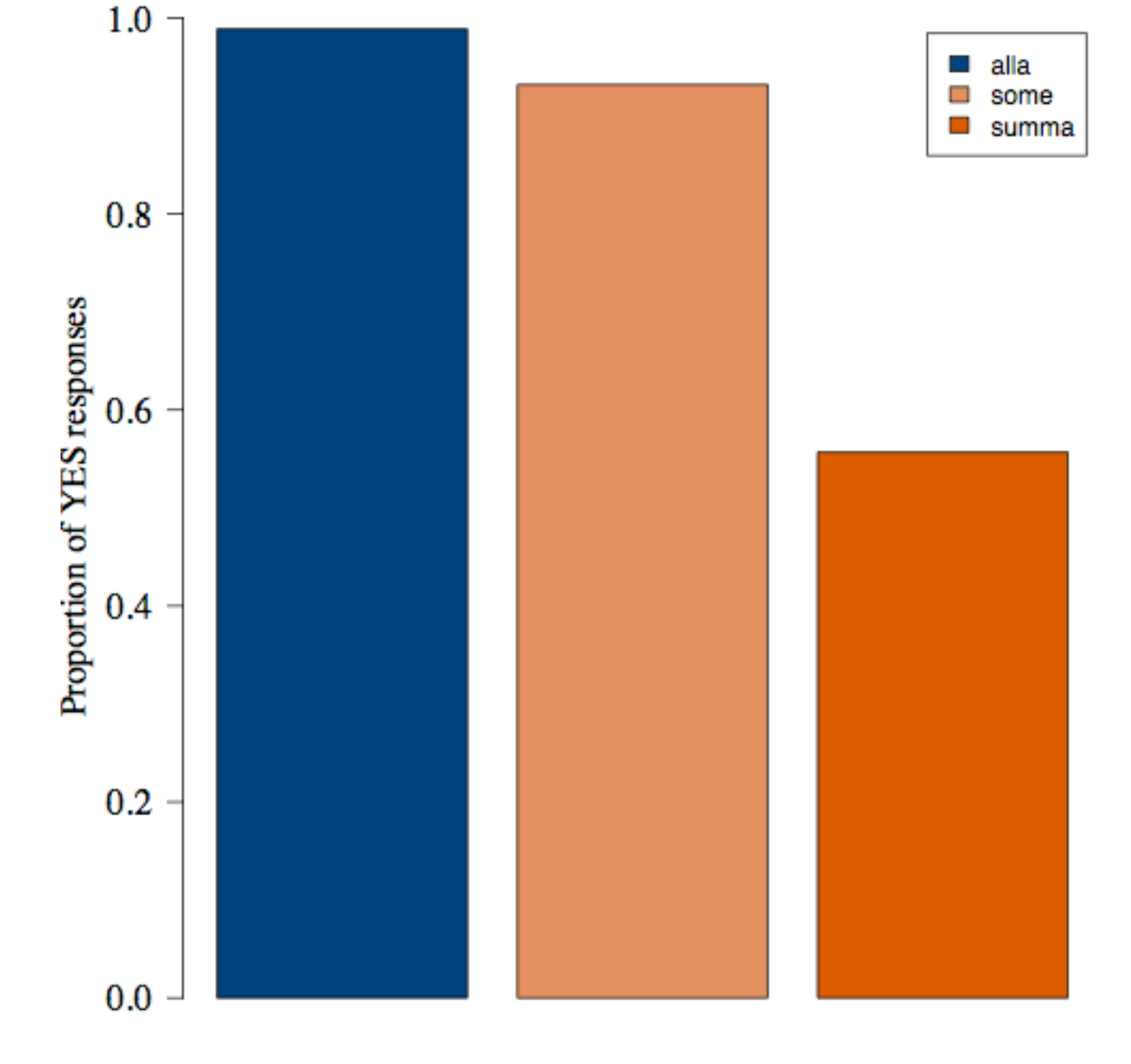
- In line with previous findings, we find that pragmatic responses - NO responses to *summa* at the upper bound - are slower compared to both YES responses to *alla* at the upper bound ($t=7.1$, $p<.0001$) and to number terms in the subitizing range ($t=9.7$, $p<.0001$).
- Pragmatic (NO) and logical (YES) response times to *summa* were not significantly different ($t=-0.772$, $p=0.44$). Thus we have no evidence that pragmatic *summa* is delayed relative to logical *summa*.
- There was no difference in reaction time for logical responses to both *some* and *summa* ($t=0.5$, $p=0.64$).
- Unsurprisingly, exact number is interpreted more rapidly within the subitizing range than outside of it ($t=19.7$, $p<.0001$). Reaction times for *alla* and exact number within the subitizing range are not significantly different ($t=1.3$, $p=0.2$).
- YES responses to both *some* and *summa* are slower at the upper bound than in the middle and high range (*some*: $t=3.74$, $p<.001$, *summa*: $t=6.063$, $p<.0001$). This suggests intrusion of the upper bound on the logical interpretation of *some/summa*.
- In addition, there is a trend for NO responses to both *some* and *summa* to be faster at the upper bound than at 12 gumballs (*some*: $t=2.2$, $p<.07$, *summa*: $t=1.5$, $p=0.15$). Again, this is support for fast computation of the upper bound.
- Processing of YES responses to *alla* is faster than *some* or *summa* in all ranges (low: 0-3, mid: 5-8, high: 10 - 12). See table. NO responses could not be compared due to data sparseness.
- YES responses for *summa* and *some* are slower than for exact number in the subitizing range (*some*: $t=7.3$, $p<.0001$, *summa*: $t=5.9$, $p<.0001$). This may lead to delays for *some* and *summa* when participants see displays with small sets of items.

	<i>alla</i> faster than <i>some</i>	<i>alla</i> faster than <i>summa</i>
Low range	$t=3.8$, $p<.001$	$t=4.3$, $p<.0001$
Mid range	$t=2.6$, $p<.05$	$t=1.9$, $p<.07$
High range	$t=2.594$, $p<.05$	$t=2.9$, $p<.01$

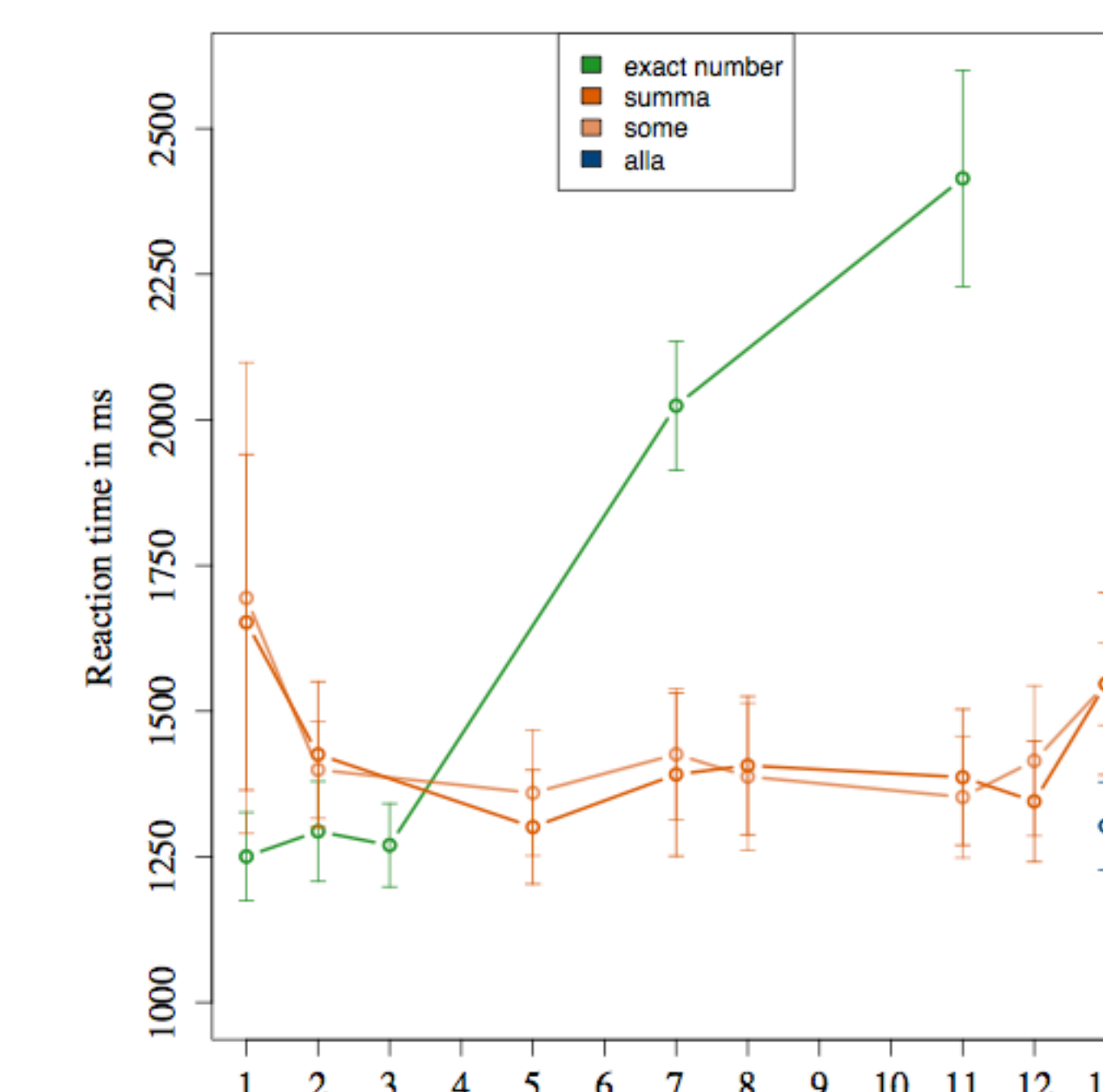
Proportions of YES responses to *summa*, *some*, *alla*



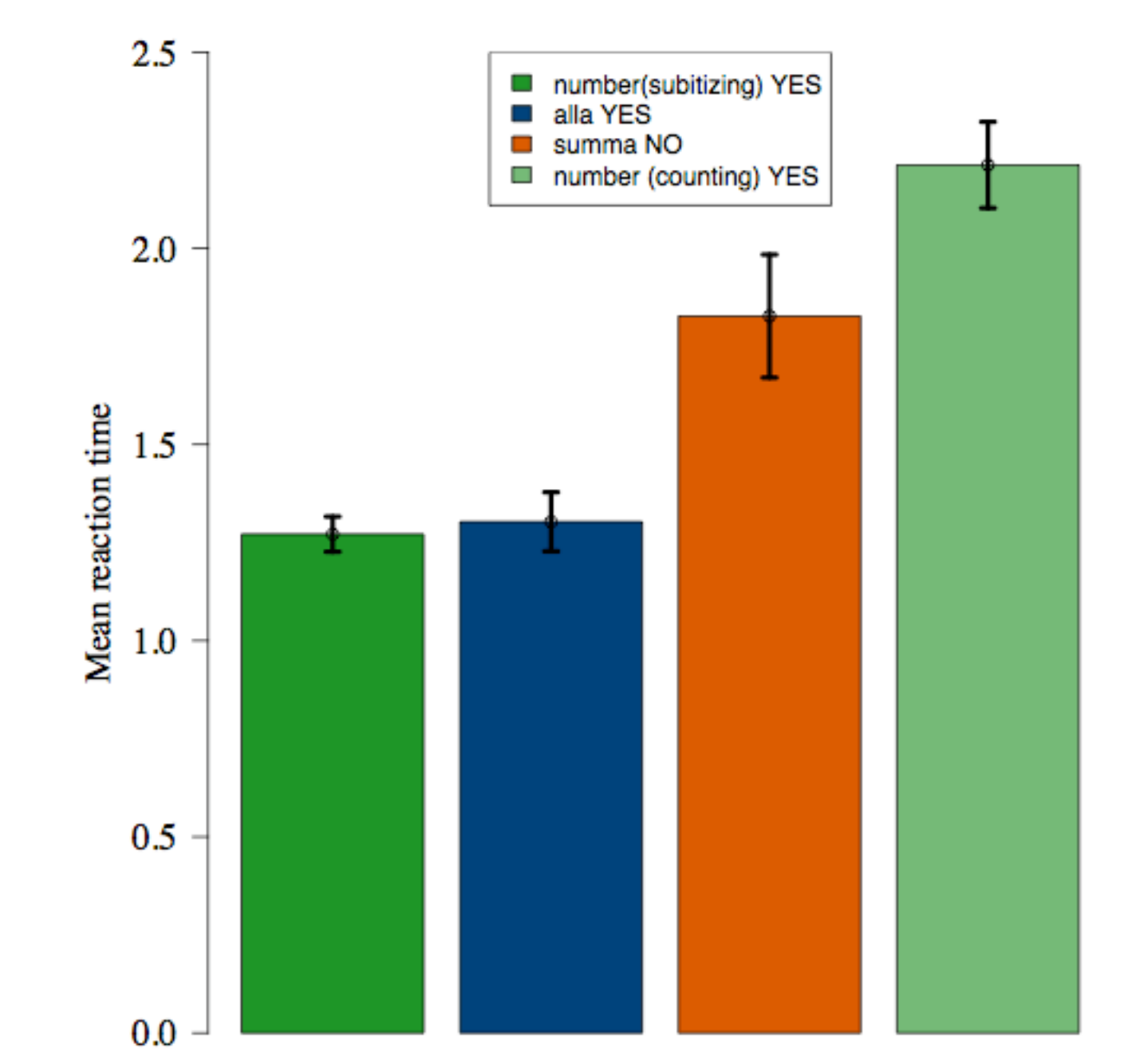
Proportions of YES responses for upper bound



Reaction times for YES responses to number, *alla*, and *summa*



Reaction times for YES responses to number and *alla* and NO responses to *summa* for upper bound



Discussion and Future Work

- Comparison of response times for *some* and *summa* to *alla* and exact number has some complexities:
 - Both *some* and *summa* are harder to process than exact number in subitizing range. Small sets may be more naturally labeled by exact number than by *some*. A question for future work is whether the same pattern will hold for small set sizes.
 - YES responses to *some* and *summa* are never as fast as to *alla*. However, *alla* is processed as fast as exact number. This cannot be explained by logical *some/summa* being computed prior to pragmatic *some/summa*. Rather, there seem to be baseline differences in computation speed. How best to compare the speed of implicature processing to the processing of literal meaning remains an open question. However, our data shows that the picture of scalar implicature processing painted to date may be overly simplistic.
 - At the upper bound, YES response times for *some/summa* become slower, while NO responses tend to become faster. This suggests that either the pragmatic interpretation is not delayed relative to the logical interpretation, or both are processed in parallel.
- Future work:
 - Using this paradigm in an eye-tracking setting will allow us to obtain more accurate measures of speed of interpretation.
 - How does uncertainty about the upper bound influence speed of interpretation?
 - How does the relevance of the upper bound influence both judgments (more pragmatic responses?) and reaction times (faster processing if upper bound relevant to the task?).

References

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