

The cost of being cooperative: Details of the effort in processing scalar implicature

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INTRODUCTION

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 (Levinson 2000) hearers compute such SIs quickly, costlessly, and automatically. In contrast, according to the Relevance Theory view (Sperber and Wilson 1995), all inferences are costly and only computed if contextually sufficiently relevant.

Several experiments 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”) precedes the pragmatic interpretation (“not all”), with conflicting results (Huang and Snedeker 2008; Grodner, Klein, Carbary, and Tanenhaus 2008). We analyzed eye-movement patterns within a scene to gain further insights into the cognitive processes underlying SI computation.

MATERIALS AND METHODS

- Visual-world eye-tracking with picture verification task
- 20 targets / 40 fillers in 2x2 design (Picture and Quantifier):
 - Pictures contained all exactly alike objects [**Picture=All**], or objects that differed only in color [**Picture=Some**].
 - Recorded sentences were identical, except in quantifier: [**Quant=Some**] and [**Quant=All**] conditions. (See example stimuli.)
- Participants (n=24) pressed a button to indicate whether a sentence was a “good description” of the picture.

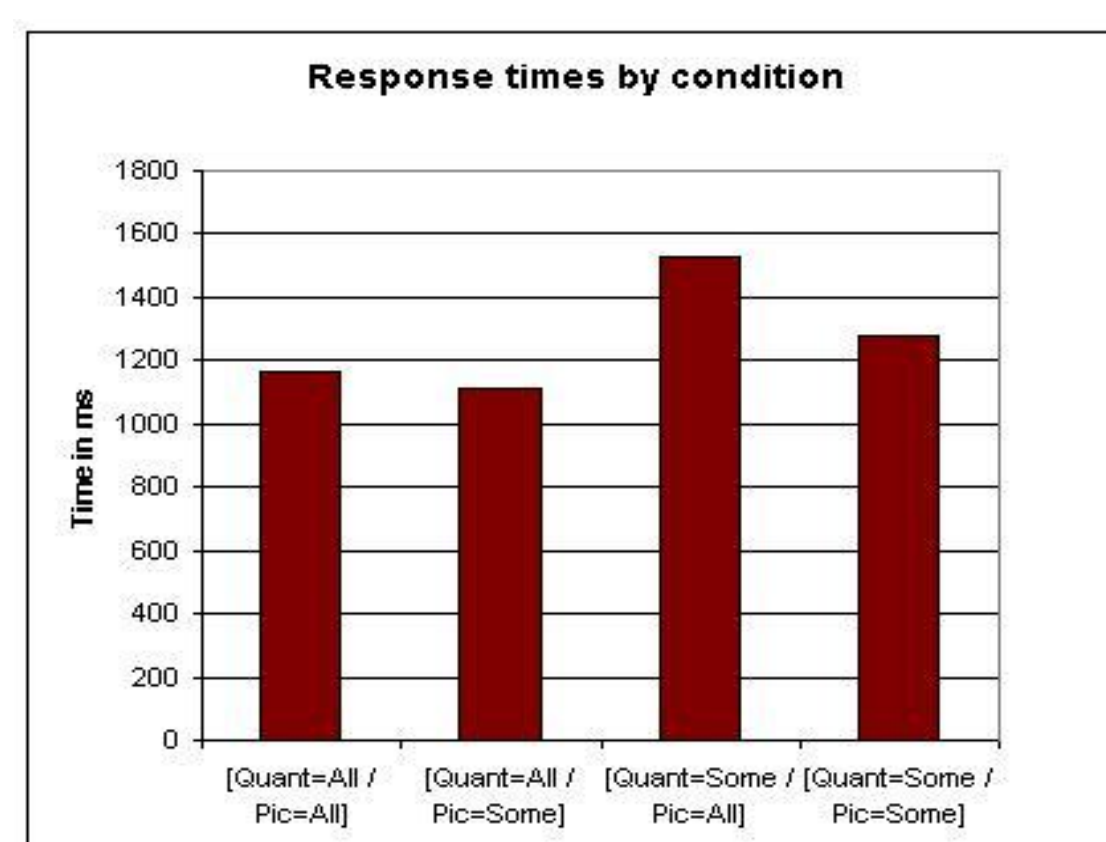
RESULTS

Fixation Durations

Average fixation durations were significantly ($p < .05$) longer in [**Quant=Some**] conditions (478 ms) than [**Quant=All**] conditions (417 ms).

Response Times

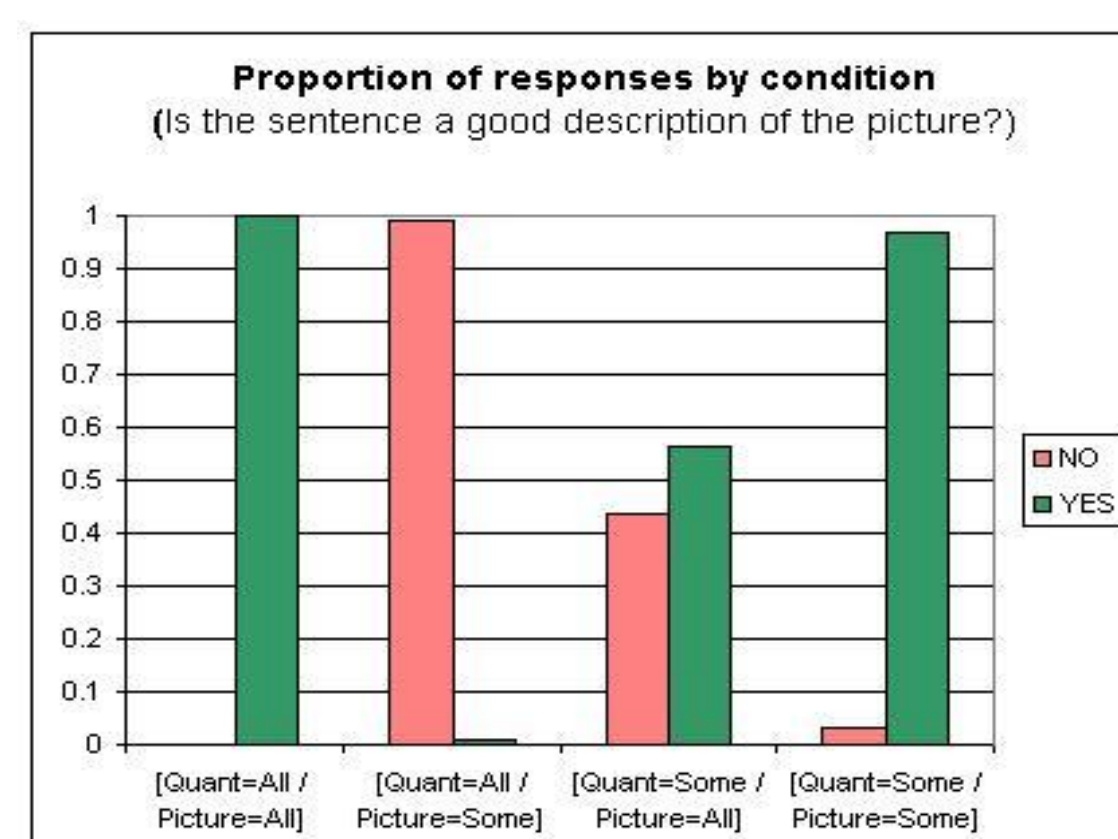
Average RTs in both [**Quant=Some**] conditions were significantly longer than in the [**Quant=All**] conditions with the same picture ($p < .05$).



Average RTs in the [**Quant=Some**] condition were significantly influenced by Picture conflict (longer in [**Quant=Some/Picture=All**] than [**Quant=Some/Picture=Some**], $p < .05$).

Picture Verification Responses

- [**Quant=All/Picture=All**] and [**Quant=Some/Picture=Some**] conditions resulted in nearly 100% “good description” responses.
- [**Quant=All/Picture=Some**] triggered 1% “good description” responses, as expected.
- [**Quant=Some/Picture=All**] resulted in 56% “good description” responses.



Participants were internally consistent, and nearly all expressed awareness of the implicature (either through their responses or during debriefing).

DISCUSSION

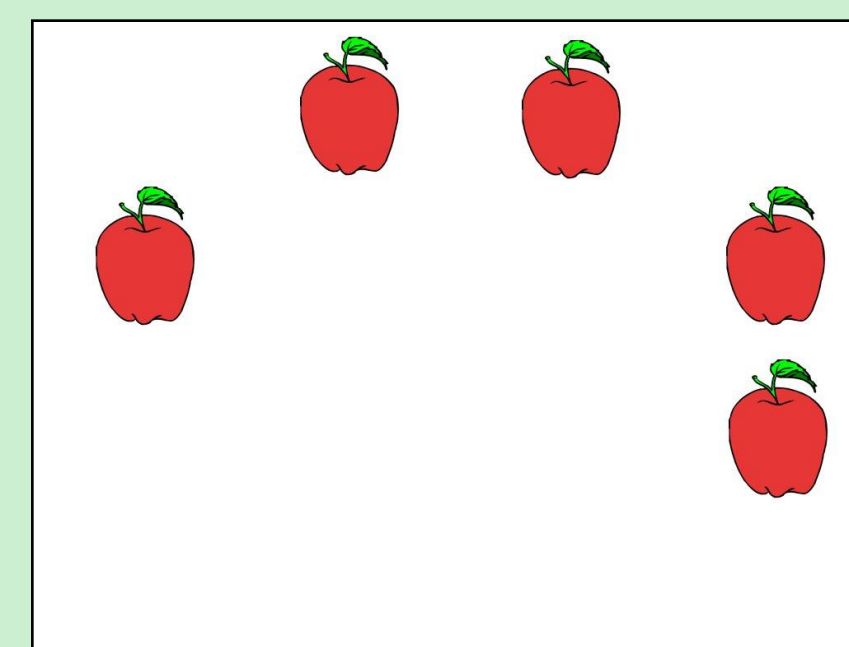
Although RTs were longest for the [**Quantifier=Some/Picture=All**] condition, other eye-movement differences were only affected by Quantifier. We take longer average fixation durations to be indicative of increased overall processing, and these were found for both [**Quantifier=Some**] conditions, indicating that participants were computing a scalar inference whenever they heard “some”. Because we found that participants were aware of the implicature, this seems to be true even if they answered according to the literal interpretation of “some” (“possibly all”).

PREDICTIONS

If SIs are effortful, we expect longer RTs and greater eye-movement indications of processing when the implicature is available ([**Quantifier=Some**] conditions), especially when the implicature is in conflict with the picture ([**Quantifier=Some / Picture=All**] condition). If there is no effort required for SIs, RTs and eye-movement patterns should be the same in all conditions.

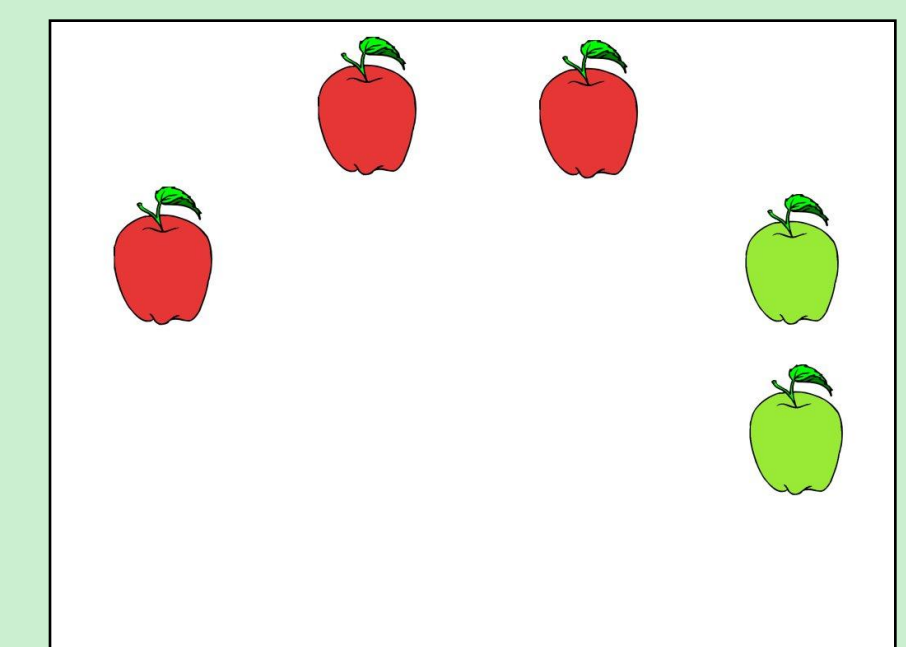
EXAMPLE STIMULI

[**Quantifier=All / Picture=All**]



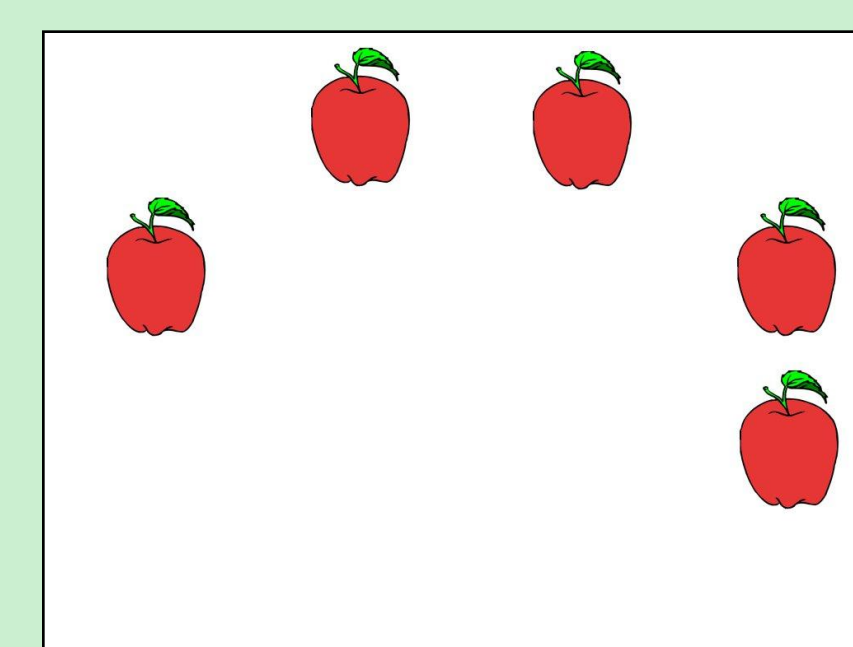
“This is a picture of apples.
All of them are red.”

[**Quantifier=All / Picture=Some**]



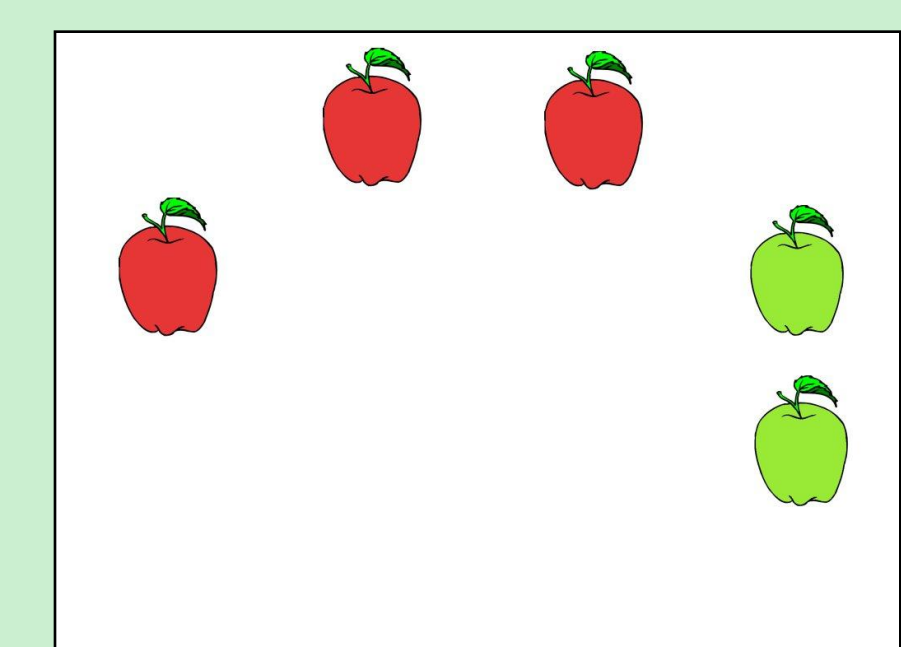
“This is a picture of apples.
All of them are red.”

[**Quantifier=Some / Picture=All**]



“This is a picture of apples.
Some of them are red.”

[**Quantifier=Some / Picture=Some**]

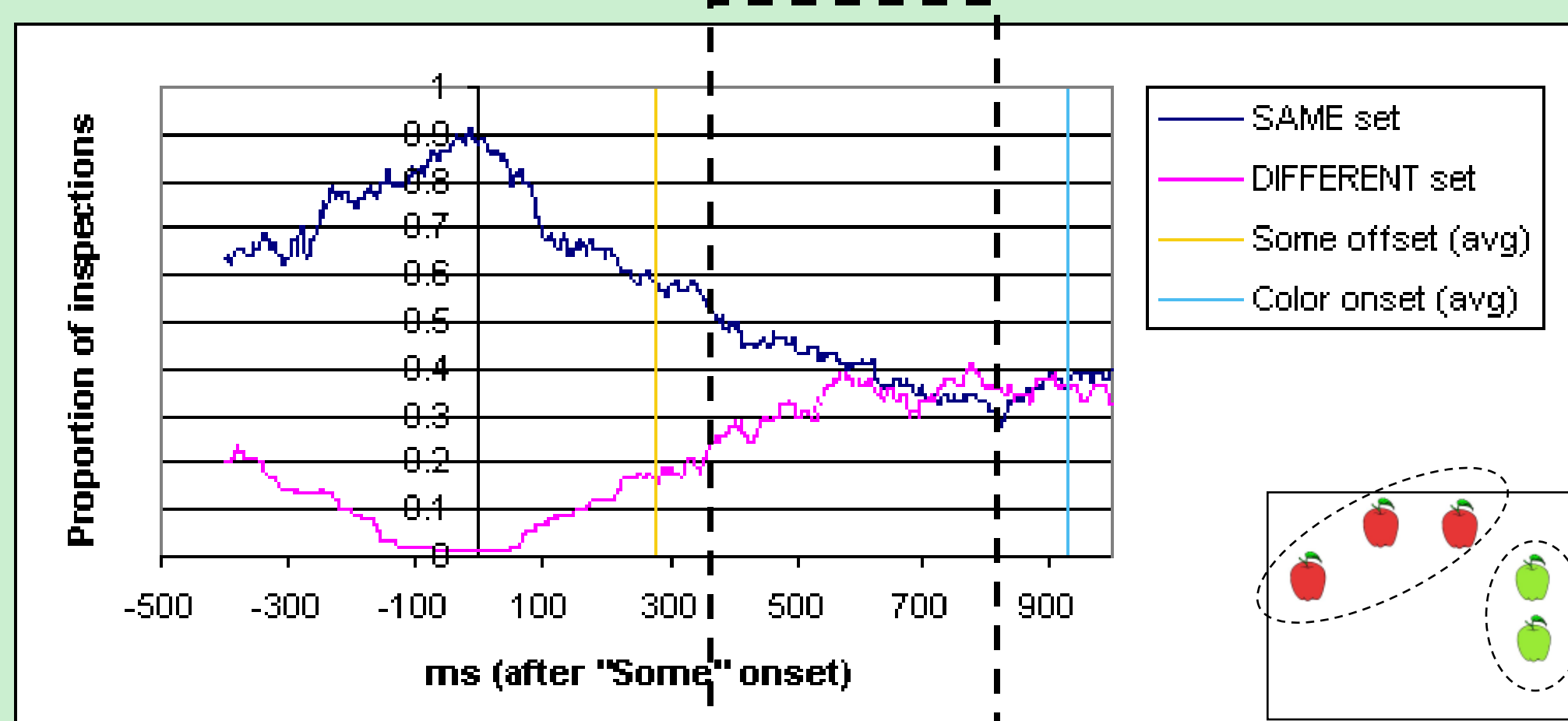


“This is a picture of apples.
Some of them are red.”

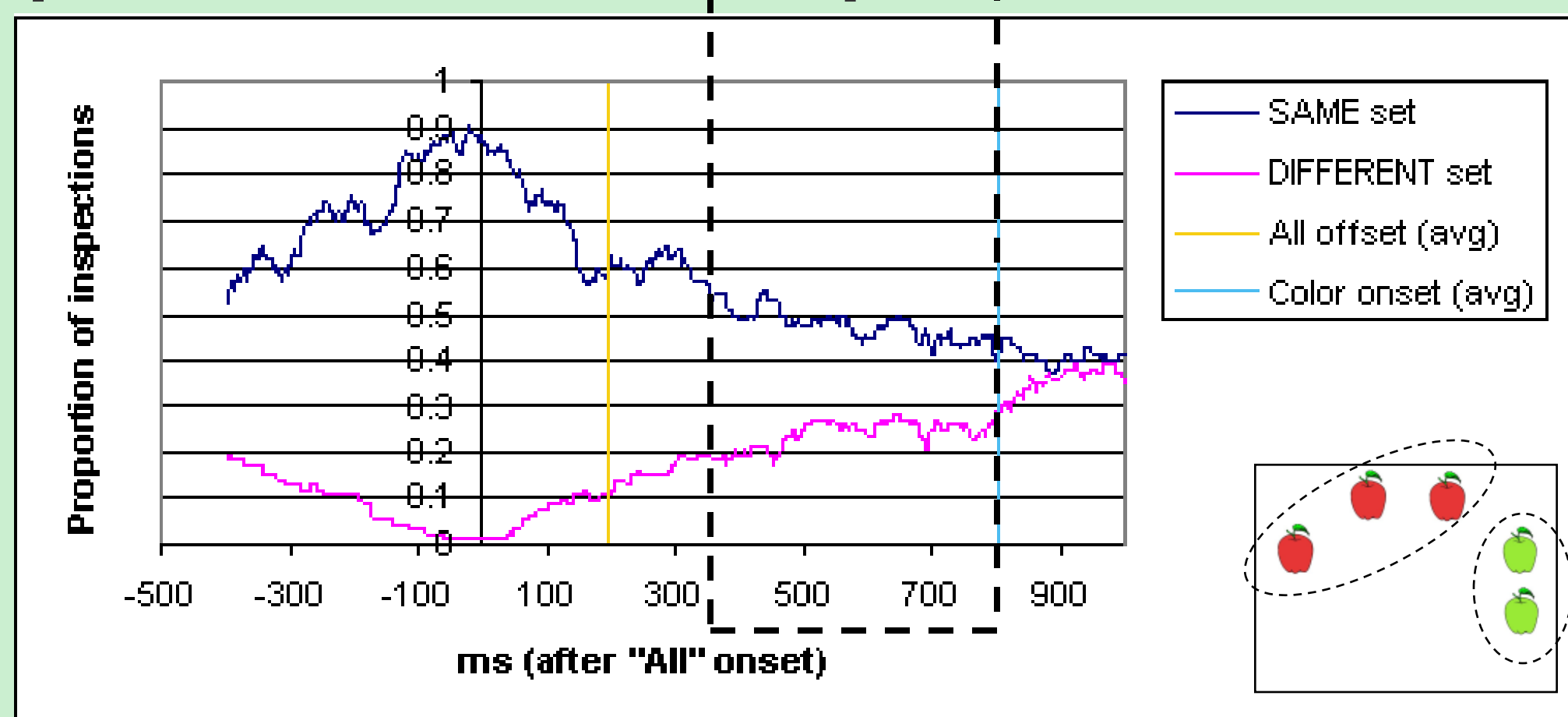
Latency to switch between color groups

Eye-movement latencies 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 fixation at quantifier onset) in [**Quant=Some**] than in [**Quant=All**] ($p < .05$), even though they had not yet heard the color name. Participants appear to become aware of “all” very soon after hearing “some” and look to the objects that conflict with this interpretation. This cannot be merely an effect of picture verification, because the scenes are identical ([**Picture=Some**]) and the participant would presumably do the verification in a similar fashion for both.

[**Quantifier=Some / Picture=Some**]



[**Quantifier=All / Picture=Some**]



- **Switch fixations:**
 - Proportion of inspections on set of items (target/non-target) that was inspected pre-quantifier.
 - 0ms is the point of the quantifier onset.
- For trials where participants were looking at the target group at quantifier onset, looks to the target group thereafter are counted as “SAME”, and looks to the non-target group are “DIFFERENT”.
- If the participants were looking at the non-target group at quantifier onset, looks to non-target group thereafter are included in “SAME”, and looks to the target group are “DIFFERENT”.

CONCLUSIONS

Comprehenders seem to show early sensitivity to the “not all” meaning of “some” (as shown by latency data).

[**Quant=Some**] conditions resulted in longer RTs and longer fixation durations.

Although our results do not fit directly with Relevance Theory predictions, we found that situations where scalar inferences are possible resulted in longer RTs and fixation durations, a result which seems to be at odds with the Default claim that implicatures are costless.