What Would a Compositional Hearer Do? - Controlling for Prior Expectations in Scalar Timecourse Studies

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Visual-World studies on the time course of processing pragmatically enriched *some* compared to *all* have found conflicting evidence. [1] reported a considerable delay in gaze to target when the referential disambiguation was based on interpreting *som*e as 'some and not all' compared to conditions where no pragmatic enrichment was involved (interpreting 'all', 'two', and 'three'). In contrast, [2] and [3] found that target identification for utterances with pragmatic *some* was as fast as for utterances with *all*. Verbal encoding has been suggested as a plausible hypothesis to explain the differences in these results. In studies where no delay was found, only the quantificational scale <*some*, *all*> was used to identify the target. By contrast, in the studies where a significant delay was found, both quantificational and numeric scales (e.g. <two, three>) were employed. Verbal encoding hypothesis suggests that fast target i.d. where only one scale is used could be the result of labelling the potential referent with a scalar quantifier prior to the quantifier onset. In contrast, in a context where two different scales are used, verbal encoding is discouraged and the delay is interpreted as evidence for the slow implicature effect. While verbal encoding is plausible, we want to argue that even in studies with two modes of description, there is a related, uncontrolled factor, namely the prior expectation between set size and quantifier use, which makes the interpretation of previous visual world data problematic. Here we present experimental evidence for the prior expectation hypothesis. In addition, we propose that visual search for a 'residue set' is a better indicator to explore whether the pragmatically enriched meaning of *some* is available in the same timecourse as the semantic interpretation of *all*.

The prior expectation hypothesis is that people have expectations about the relative set size of the target in a display given the quantifier (*all*/*some*). We conjecture that people have an expectation that an agent with a total set of something will possess a relatively large set of objects. And it is also possible that people have an expectation that an agent with a subset of something will possess a relatively small set. We explore these prior expectations in exp.1-2. In exp.1, we asked participants to indicate which image fits better with the given statement using a slider scale with images located on two ends. In the experimental scenario (fig.1), the statement containing a quantifier, e.g. "The girl has *all* of her sister's flowers" or "The boy has *some* of his cousin's candies", was ambiguous on which agent it described. The size of sets used were the same as in [1-2]. If prior expectations between set size and quantifier use are detectable, we expect participants prefer the agent with the larger set as *all* referent, they prefer the agent with the smaller set as *some* referent. There were 4 fillers, of which two were clearly unambiguous (e.g. The boy has less oranges than lemons), and two were clearly ambiguous (e.g. the girl has red and green apples). In total, each participant (N=52) judged 6 trials. The results showed that for both quantifiers, participants preferred the agent with the larger set as the referent of the statement (both *p*s<.001). The results of *some* trials were not expected. They may due to the fact that the smaller set contained only two objects. It is unnatural to use 'some' to refer to a set of two objects. To address the concern that participants may inhibit the prior expectation in *some* trials, exp.2 replicated exp.1 with one key difference: in experimental trials, the larger set contained four objects and the smaller set contained three objects (fig.2). The big set preference for *all* trials (p<.001) found in experiment 1 replicated. However, the results indicated a reverse tend for *some* trials that participants prefer the agent with the smaller set as the *some* referent.

Exp.3-4 are visual world studies, as in [1-2] set up to examine whether or not prior expectations between set size and quantifier use affects the quantificational NP processing. In addition, we measure anticipatory looks to the residue set – an alternative indicator of implicature processing that is not affected by low-level expectations. In exp.3, each trial started with fig.3 (a) or fig.3 (b). After an audio description of the object types, a new display appeared (fig.4). After 2.5 seconds, participants heard an instruction of the form "Click on the girl with [Det] of the [modifier] [shape]". [Det] was one of *some*, *all*, *two*, *three*, [modifier] was one of *dotted*, *stripy*, *checked* and [shape] was one of *circles*, *squares*, *triangles*. In the experimental displays, there were always two agents that have *all* of one kind of object and the other two have *some* but not *all*. The residue remained in the centre. This design allowed us to examine the anticipatory looks to the residue set which reflect the verification process of the quantificational NP. In number conditions, participants can anticipate the referent without checking the residue set. For quantifiers, if *some* is unenriched, anticipating the referent does not require checking the residue set; to establish whether it is an agent with *all*, or an agent with *some* but not *all*, it is necessary to check the residue set. Therefore, we expect a lower bias to the residue set for numbers than *all*. We also expect that, to the extent that *some* is enriched in the same timecourse as *all*, there should be also lower looks to the residue set in numbers than *some*. Additionally, we manipulated the target set size for *all* and *some* through changing the objects in the residue set. Thus, fig.4 (a) can be used on a big-set *all* or small-set *some* trial, fig.4 (b) can be used on a big-set *some* or small-set *all* trial. These manipulations allowed us to examine the predications for prior expectations. Given exp.1's results, we expect the target bias is greater in big *all* and big *some* compared to small *all* and small *some*.

Fig.5 shows the timecourse of looks to the residue set (elog) by determiner across the determiner ('[det] of the') and modifier time regions. In line with a fast-pragmatic hypothesis, looks to the residue set decreased faster in numbers than both *all* and *some* in both windows (*p*s<.01). Critically, in the second time window, there were less looks to the residue set in *numbers* than *all* and *some* (*all*: b=-0.59, SE=0.16, p=.001; *some*: b=-0.51, SE=0.16, p=.003). Fig.6 shows looking pattern in *all* and *some* conditions by big and small target sets. In the determiner window (fig.6(a)), the higher target bias for big *all* and big *some* compared to small *all* and small *some* could reflect prior expectations between set size and quantifier use (*all*: b=1.18, SE=0.29, p<.001; *some*: b=0.74, SE=0.25, p=.005). However, an initial big set bias (see [1-2]) before the quantifier onset confounded with the predicted gaze patterns. In the modifier window (fig.6(b)), the higher bias in big *all* condition continued (b=1.72, SE=0.34, p<.001). We suspect that the severe delay in bias formation in small *all* condition may due to an anti-presupposition effect, as it is infelicitous to use *all* to refer a set with only two members. No difference between big *some* and small *some* was found in this window. When both target sets were combined, there was no processing difference between *some* and *all* in both windows (*p*s >0.1), and target bias was greater in numbers than both quantifiers (*p*s <.03). Thus our design, which controls for prior expectations, eliminates the difference between *some* and *all*, even in the presence of number items.

To control for the initial big set bias and anti-presupposition effect, in exp.4, we increased the target set sizes so that the large sets contained four objects and the small sets contained three. Predications for looks to the residue set remain the same. On the basis of exp.2's results, we expect the target bias is greater in big *all* and small *some* compared to small *all* and big *some* respectively. As shown in fig.7, exp.4 replicated the findings of exp.3 that looks to the residue set were significantly less for *numbers* than for both *all* and *some*,

even when we increased the target set size. Visual inspection of fig.8(a) suggested we successfully controlled for the initial big set bias. In fig.8(a), there was no significant difference among conditions. Whereas in fig.8(b), we found the greater target bias in big *all* and small *some*. These results were consistent with the prediction for prior expectations.

We conclude that gaze data in previous visual world studies reflects prior expectations about the relative set size given a quantifier expression. We suggest that visual search for a residue set is a more effective measure as it is relatively unaffected by the expectation bias. Even so, when verbal encoding strategy and prior expectation bias are controlled, the timecourse of decisions based on pragmatic *some* is not really different to that for *all*.

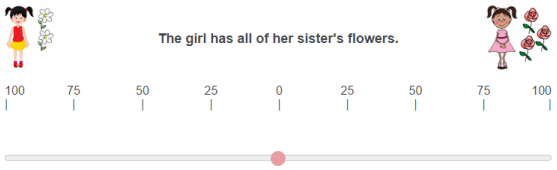

Fig.1 exp.1 Sample item

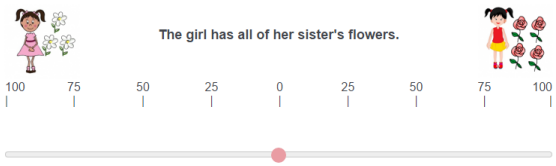

Fig.2 exp.2 Sample item

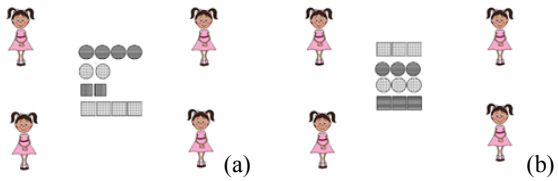

Fig.3 Initial displays

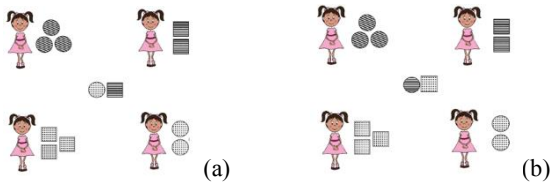

Fig.4 Experimental displays

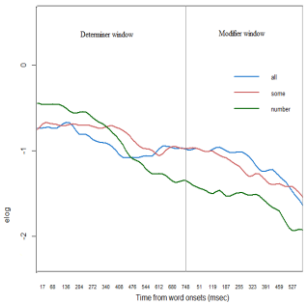

Fig.5 Looks to the residue set in

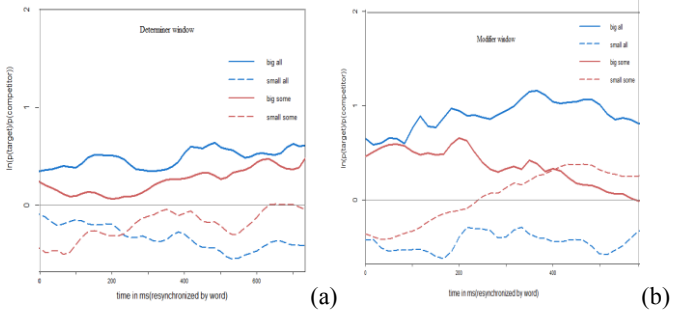

Fig.6 Log ratio in *all* and *some* conditions by big and small target sets in exp.3

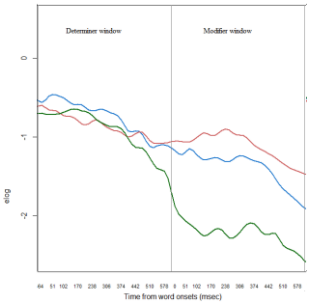

Fig.7 Looks to the residue set in

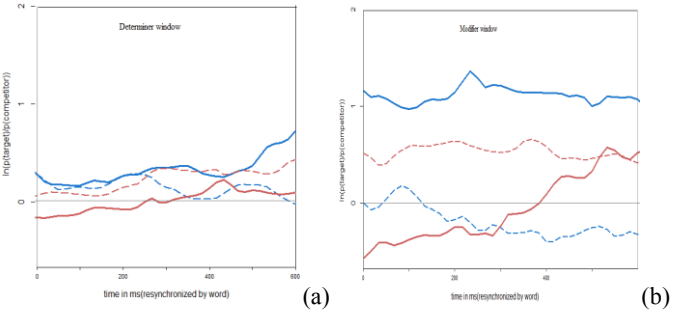

Fig.8 Log ratio in *all* and *some* conditions by big and small target sets in exp.4

Reference:[1] Huang, Y. T., & Snedeker, J. (2009). Online interpretation of scalar quantifiers: insight into the semantics-pragmatics interface. Cognitive Psychology, 58(3), 376–415. [2] Grodner, D. J., Klein, N. M., Carbary, K. M., & Tanenhaus, M. K. (2010). “Some,” and possibly all, scalar inferences are not delayed: Evidence for immediate pragmatic enrichment. Cognition, 116(1), 42–55. [3] Breheny, R., Ferguson, H. J., & Katsos, N. (2012). Investigating the timecourse of accessing conversational implicatures during incremental sentence interpretation. Language and Cognitive Processes, 28(4), 443–467.