

An online investigation into how Gricean pragmatic reasoning affects incremental utterance interpretation

Much recent research reveals that Gricean reasoning can have an early effect on incremental discourse interpretation. However, as Sedivy (2003) notes, the early nature of these effects is difficult to square with the apparent complexity of the reasoning that lies behind them. For example, if quantity implicatures were derived online via Gricean inference, the hearer would need to evaluate what the speaker's words say against some contextually specified level of informativeness in order to exclude more informative alternatives. Thus, it is tempting to assume that in common cases of Gricean reasoning, like lexically triggered quantity implicatures (where saying 'some' excludes *all*, see Breheny et al., 2006) or adjectival modification ('the *plastic* glass', see Sedivy et al., 1999), the reasoning is somehow routinised (Levinson, 2000) or grammaticalised (Chierchia, 2004).

Here we present two visual world studies that examine non-lexically triggered, 'ad hoc' quantity implicatures, where for example, sentence [1b] elicits the implicature that the zookeeper fed *nothing else* to the zebra. The implicature arises in contexts where informativeness is fixed by an implicit question, *the zookeeper fed what to the zebra*. The aims of these studies were to establish (1) whether ad hoc quantity implicatures can be integrated early into incremental utterance processing and (2) whether in these contexts, hearers *are* evaluating what is said against the contextually specified level of speaker-informativeness.

We used a visual world paradigm to measure the time-course of discourse-mediated eye movements towards target referents in a visual display. Thus, participants were aurally presented with sentences like those shown below alongside a picture depicting three scenarios: the zookeeper feeding (i) a carrot to the elephant, (ii) an apple *and* a carrot to the zebra, and (iii) a banana to the gorilla.

[1a] The zookeeper fed a carrot to the elephant.

[1b] The zookeeper fed an apple to the zebra.

[1c] The zookeeper fed a banana to the gorilla.

We calculated for each object noun ('carrot', 'apple' or 'banana'), and for each 20ms time-interval from the onset of the object noun, the relative proportions of eye-movements across trials towards each of the target referents (elephant, zebra or gorilla). Results from Experiment 1 showed early predictive looks towards the appropriate target referent following [1c], emerging from the offset of 'banana'. In contrast, such prediction was delayed following [1a], as participants waited for disambiguating information from the speaker. Finally, for [1b] we found a persistent

visual bias towards the unmentioned carrot that had the effect of delaying participants' predictions about the target referent as they expected a reference to the carrot also.

In Experiment 2, auditory sentences were modified (see below) to provide a fully informative speaker context and a longer delay between reference to object and target for inferences to be made. Under these conditions, the delayed effects reported previously were removed as participants successfully predicted the appropriate target referent in all conditions *before* the onset of the target nominal.

[2a] The zookeeper fed a carrot to the hungry elephant.

[2b] The zookeeper fed an apple and a carrot to the hungry zebra.

[2c] The zookeeper fed a banana to the hungry gorilla.

The result for [2a] demonstrates that ad hoc quantity implicatures can rapidly be generated online during discourse processing. Importantly, a comparison of [1b] and [2b] suggests that participants are evaluating the utterance against expected levels of informativeness in these contexts. Thus we conclude that Gricean reasoning does take place on line and can directly affect incremental interpretation.

We rule out the alternative possible explanation of these effects as being due to participants assigning an underlying structure to these sentences along the lines of [3] (where *Exh* is an exhaustivity operator as defined in Chierchia et al (2008) and elsewhere) since the interference effect for [1b] begins at the offset of the object noun ('apple'). If this effect were due to [3b], then we should expect similarly early looks to the elephant in [1a], given [3a].

[3a] [*Exh* [The zookeeper fed [a carrot]_F to the elephant]]

[3b] [*Exh* [The zookeeper fed [an apple]_F to the zebra]]

Breheny, R., N. Katsos, & J. Williams. (2006). Are generalised scalar implicatures generated by default? *Cognition*, 100: 434-463.

Chierchia, G. (2004). Scalar implicatures, polarity phenomena and the syntax/pragmatics interface. In A. Belletti (Ed.), *Structures and beyond*, 39-103. OUP.

Chierchia, G., D. Fox & B. Spector (2008) The grammatical view of scalar implicatures and the relation between semantics and pragmatics. (ms)

Levinson, S. (2000). *Presumptive Meanings*. Cambridge, MA: MIT Press.

Sedivy, J. (2003). Pragmatic versus Form-based Accounts of Referential Contrast: Effects of Informativity Expectations, *J. of Psycholinguistic Res.*, 32, 3-23.

Sedivy, J.C., Tanenhaus, M.K., Chambers, C.G., & Carlson, G.N. (1999). Achieving incremental semantic interpretation through contextual representation. *Cognition*, 71, 109-147.