Investigating the use of alternatives in incremental processing

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Theories of implicature and focus both make use of alternatives when computing the interpretation of a given utterance [1-2]. For instance, quantity Implicature (*QI*) is derived by negating an alternative utterance that the speaker might have said, and focus particles like *only*/*also* are interpreted as an exhaustivity operator/presupposition trigger, with respect to sets of alternatives. While alternatives play a crucial role in these theories, to date little is known about how hearers use alternatives in real time. Here we investigate whether hearers draw their visual attention to the depicted alternative when interpreting *QI* and *only*.

In a visual-world study in German, participants first listened to a dialogue in which the question of what Mia has done is salient (see p.3). This dialogue restricts the set of alternatives to actions, the results of which are depicted in the visual display (fig.1). We tracked participants' eye movements while they listened to the subsequent two-sentence discourse (Table 1). The target sentence was preceded by either (1a) or (1b). (1a) is likely to give rise to the *QI* that Mia did not cut the cake, which is derived by reasoning about the alternative utterance such as *Mia peeled the banana and cut the cake*. Whereas (1b) carries an exhaustive assertion triggered by *only*, which asserts that apart from 'peeled the banana', no other alternatives to the VP leads to a true assertion. The interpretations of (1a) and (1b) are equivalent and spelled out in the following target sentence. Because of German word order, in the target sentence, the noun *die Torte* precedes the target action *nicht geschnitten*. We predict that, before the onset of the target action (i.e. *nicht*), if participants rapidly compute *QI* and the meaning of *only*, then their attention should be directed to the competitor (cut cake), which is the representation of the alternative state, before being switched to the target (uncut cake), which is the representation of the implied/asserted state. In order to have a baseline against which to determine whether the representation of the alternative state draws participants' attention, we included a condition containing *also* as in (1c). Unlike the *QI* and *only* conditions, the competitor (uncut cake) in the *also* condition is irrelevant to either at-issue or non-at-issue content of the target sentence. Thus, we predict that, before the target action onset, there are more looks to the competitor in *QI* and *only* conditions than in the *also* condition. In addition, there is no reason to predict any difference between *QI* and *only* conditions. Filler items were constructed to counterbalance the polarity of the target sentence and to minimize the effect of discourse relations like 'contrast' and 'parallel' (Table 2).

Eye movement analyses were conducted on two critical time windows: "Sie hat" and "die Torte" (fig.2). Results (n=24) showed that in *only* and *also* conditions participants anticipated the target by the offset of 'die Torte' (p=.01; p=.02). Whereas in the *QI* condition, they only started to anticipate the target after the onset of 'geschnitten' (p<.01). As for visual bias to the depicted alternative, we found a greater bias to the competitor in the *QI* condition compared to the *also* condition in both windows (p=.02; p=.04). In addition, the *QI* condition showed a steeper linear increase during the 'Sie hat' window (p <. 001). Between the *only* and *also* conditions, the overall bias to the competitor was not different, nevertheless, the effect on the linear component suggested a faster changing bias towards the competitor in the *only* condition in 'Sie hat' window (p=.053). In addition, one unexpected finding is that there were more looks to the competitor in *QI* than in *only* for both windows (ps<.01). Taken together, these results suggest that listeners make use of alternatives in real-time when interpreting *QI* and *only*. The difference between *QI* and *only* is not predicted by formal theories, however, our results are in line with previous results on comparison between scalar implicature and *only* [3-4]. For example, [3] suggests a greater cost for QI might be due to more attention to context. Likewise, in our *QI* condition, the competitor could be viewed as the representation of the context under discussion.

A follow-up study is in progress to address the issue of slow target identification in the *QI* condition and the unnatural use of *also*. The materials and procedure are similar to the current study with one key difference: we remove the 2nd/target sentence and track participants' eye movement till 1s after the offset of the 1st sentence.

Condition	1st sentence	2nd /Target sentence	Target	Competitor
QI	(1a) Mia hat die Banane geschält. Mia has the banana peeled.	Sie hat die Torte nicht geschnitten. She has the cake not cut.	(c)	(d)
Only	(1b) Mia hat nur die Banane geschält. Mia has only the banana peeled.			
Also	(1c) Mia hat auch die Banane geschält. Mia has also the banana peeled.	Sie hat die Torte geschnitten. She has the cake cut.	(d)	(c)

Table 1. Examples of experimental sentences.

Exp./ Filler	*Condition*	*Number of items*	*Example*
Exp.	Only	6	Mia hat nur die Banane geschaelt. Sie hat die Torte nicht geschnitten.
	QI	6	Mia hat die Banane geschaelt. Sie hat die Torte nicht geschnitten.
	Also	6	Mia hat auch die Banane geschaelt. Sie hat die Torte geschnitten.
Filler	Only	6	Mia hat nur die Torte nicht geschnitten. Sie hat die Banane geschaelt.
	QI	6	Mia hat die Banane nicht geschaelt. Sie hat die Torte geschnitten.
	Also	6	Mia hat auch die Banane nicht geschaelt. Sie hat die Torte nicht geschnitten.
	Ignorance	6	Mia hat die Banane nicht geschaelt. Ich weiß nicht, ob sie das andere erledigt hat.
	Ignorance	6	Mia hat die Torte geschnitten. Ich weiß nicht, ob er das andere erledigt hat.
	Total	48	

Table 2. Experiment design.

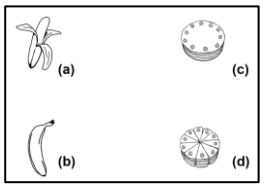

Fig. 1 Visual display. The display contained four possible states of affairs: (a) peeled banana, (b) unpeeled banana, (c) uncut cake, and (d) cut cake. For experimental trials, *Alts* = {peeled banana, cut cake}. (Actual displays did not contain labels.)

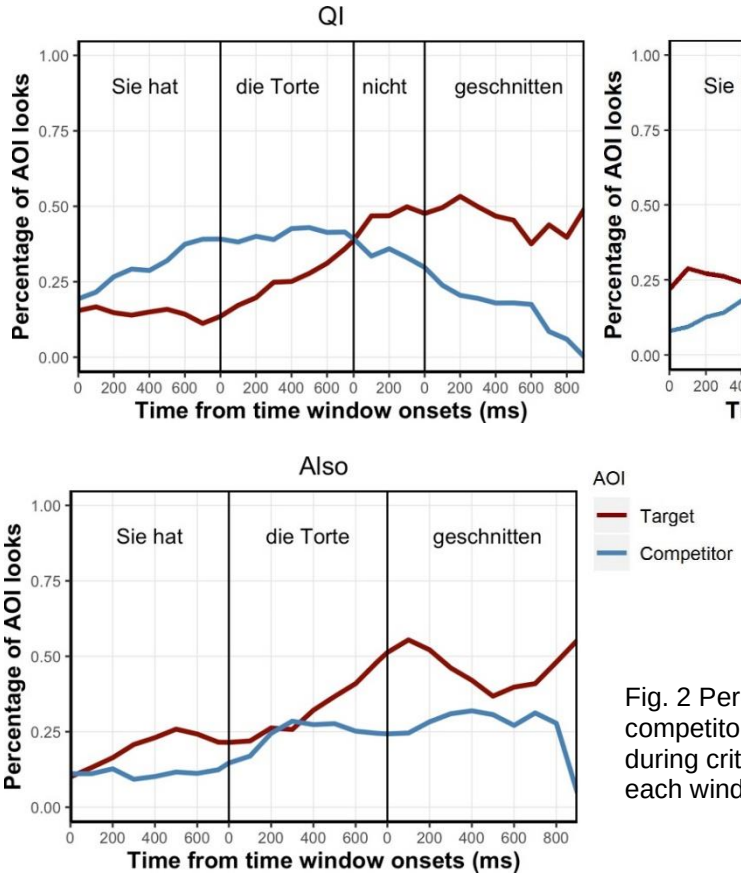

Fig. 2 Percentage of looks to target and competitor for the *QI, only* and *also* conditions during critical windows. The average offset of each window is marked with the vertical line.

[1] Geurts, B. (2010). Quantity implicatures. [2] M. Rooth. (1992). *Natural Lang Sem*, 1(1), 75-116. [3] Bott, L., Bailey, T., & Grodner, D. (2011). *J Mem Lang* 66, 123–142. [4] Marty, P., & Chemla, E. (2013). Frontiers in Psychology, 4, 1–12.

Example context:

Speaker A:	Mia	wollte	vor	dem	Abendbrot	zwei	Dinge	erledigen.
	Mia	wanted	before	the	dinner	two	things	do.
Speaker B:	Wie	weit	ist	sie	gekommen?			
	How	far	is	she	come?			