Embedded implicature: What can be left unsaid?

Anton Benz & Nicole Gotzner, ZAS, Berlin.[1]

There has been a sharp debate about implicature of complex sentences, a variety of theoretical approaches have been developed [e.g. 1, 2, 3, 4, 5], and conflicting experimental evidence has been produced [e.g. 6, 7]. The relevant complex sentences are sentences in which an implicature trigger like '*some*' is embedded under a quantifier, which may itself be an implicature trigger. For example, the sentence (A-E) '*Each girl found some of her marbles*' potentially gives rise to the inference that each girl found some but not all of her marbles. In the course of this debate, a view took hold according to which sentence meaning is highly ambiguous, and different implicatures are just different readings that language speakers may entertain [in particular 1, 5]. In this talk, we are guided by the standard neo–Gricean view [8] that considers implicature a part of communicated meaning. Therefore, our main research question is: What can be reliably communicated by sentences containing embedded or unembedded '*some*'? In the following, we operationalise this research question and develop a new interactive experimental paradigm that tests both the production and interpretation of embedded '*some*'. We started out with the following basic idea: A speaker who wants to communicate a certain proposition can express all he wants to express literally, or he may take advantage of implicature, and leave certain aspects unsaid. This will lead to a shortening of utterances. Hence, our main research question can be reformulated as follows: To what extend can a description be shortened without jeopardizing communicative success? The shortest descriptions will then reveal all the implicatures that can be communicated reliably. To turn this idea into a testable theory, we formulated two cognitive principles that guide the elimination of linguistic material related to embedded '*some*': (ENA-Elim) the simplification of '*some but not all*' to '*some*', and (N-X-Elim) the elimination of '*none found X*'. For example, together they allow the simplification of literal '*Some found all, some some but not all, and none none*' (E–A : E–ENA : N–N) to '*some all and some some*' (E–A : E–E).[2] Our assumption was that utterance simplifications based on (ENA-Elim) and (N-X-Elim) communicate the intended message as reliably as the corresponding literal description, and all further simplification leads to unreliable communication.

With utterances composed of sentences of the form (X–Y) '*X of the girls found Y of the marbles*' with X and Y chosen from quantifier phrases '*none*', '*some*', '*any*', '*some but not all*', '*some and possibly all*', and '*all*', seven different worlds can be semantically distinguished depending on whether there are some who found none (E–N), some who found some but not all (E–ENA), or some who found all (E–A). As a next step towards a testable hypothesis, we defined a critical production strategy for the seven possible worlds, shown in (1) below, by application of the two elimination rules to a literal production strategy also shown in (1).

The main test hypotheses were: (I) The critical strategy is as successful at communicating the state of the world as the corresponding literal strategy; (II) any further reduction of utterance length makes the utterance significantly less reliable than the corresponding literal description. Further, the model predicts utterances of differential length for different possible worlds. In the following, we present an experimental study that tests the efficiency of this strategy for all seven worlds. Specifically, we tested whether the strategy is successful, and how it compares to strategies pursued by naive participants, in particular whether they produce shorter utterances, and if so, whether these utterances are still successful. The experiments indicate that the critical strategy is among the shortest strategies with almost maximal communicative success.

[1]This work was supported by the Bundesministerium für Bildung und Forschung (BMBF) (Grant Nr. 01UG1411), and the Deutsche Forschungsgemeinschaft (DFG) (Grant Nr. BE 4348/4-1).

[2]E–A : E–ENA : N–N –(N-X-Elim)→ E–A : E–ENA –(ENA-Elim)→ E–A : E–E.

Interactive Best Response Paradigm. Previous experiments on embedded implicature using picture verification tasks and acceptability judgements have obtained a substantial proportion of literally interpreting subjects [e.g. 6, 7]. This renders their experimental designs inappropriate for our task. Since our goal is to test the communicative success of utterances involving embedded *some*, we developed an interactive task involving both the production and interpretation of sentences in a collaborative scenario.

Methods: Participants in our experiment were presented with a scenario involving six girls who each own a set of four special edition marbles (based on 9). While the girls are playing the marbles get lost and they have to find them again. During the experiment, participants took two different roles. (1) The speaker had to describe a picture representing how many marbles each girl found. (2) The hearer received a message from the speaker and had to buy sweets to reward the girls. The speaker was allowed to produce up to five sentences by typing in one the following words into a sentence frame: *all, some, none, some but not all, some and possibly all* and *any* (in German). The speaker could produce a description consisting of a conjunction of up to five sentences of the form X–Y. Subsequently, the hearer received the sentences the speaker produced and had to choose the appropriate sweets as rewards. The reward system was defined such that a girls gets...

- chocolate if she finds all 4 of her marbles
- candy if she finds fewer than 4 of her marbles
- a gummy bear when she finds none of her 4 marbles (as a consolation prize).

Seven possible worlds were represented by seven items in total. The system randomly paired two participants for a given production-interpretation trial and each participant took a certain role three times. In total, 53 native German participants took part in the experiment. Participants took the experiment in groups of varying sizes: there were groups with 4 players, with 2 players, and groups with 3 players in addition to the experimenter, who played the critical strategy.

Results: We analyzed participants' success rate (expected utility) as a function of whether the hearer selected the appropriate sweets depending on the picture the speaker saw. Overall, the average participant had a high success rate of 89% (average length 2.09 compared to 1.71 (critical) and 2.5 (literal)), showing that participants understood the task. A t-test showed that the critical strategy was significantly better than the average participant strategy and it was also significantly shorter in terms of sentence length (p-values $<.001$). Interestingly, when participants produced exact/literal descriptions such as *Each girl found some but not all of her marbles* the communicative success was not better compared to utterances where the short form was used (1).

(1)

world	critical	% success	literal	% success
□	N–Any	97%	N–Any	97%
■	A–E	93%	A–ENA	92%
■	A–A	98%	A–A	98%
◨	E–E : E–N	95%	E–E : E–N : N–A	88%
◨	E–A : E–N	98%	E–A : E–N : N–ENA	93%
◨	E–A : E–E	93%	E–A : E–ENA : N–N	82%
◨	E–A : E–E : E–N	100%	E–A : E–ENA : E–N	93%

Reducing utterance length further can result in three utterances: E–E (39%■, 22%◨, 34%◨, 4%■), E–A (12%■, 69%◨, 19%■), and E–N (68%◨, 5%◨, 13%◨, 9%□, 5%■). For all of them the success rate was significantly lower than for the utterances of the critical strategy. The data, therefore, confirmed both main hypotheses: The critical strategy is as successful as the corresponding literal strategy, and shortening it further significantly reduces communicative success. The results, thereby, support the thesis that the two proposed elimination principles (ENA-Elim and N-X-Elim) characterise what can be left unsaid.

[1] Chierchia, G., Fox, D., and Spector, B. (2012) Scalar Implicature as a Grammatical Phenomenon. In Maienborn, C., von Heusinger, K., and Portner, P., (eds.), *Semantics: An International Handbook of Natural Language Meaning*, Vol. 3, pp. 2297–2331 De Gruyter Mouton Berlin.

[2] Sauerland, U. (2004) Scalar implicatures in complex sentences. *Linguistics and Philosophy*, **27**, 367–391.

[3] Franke, M. Signal to Act: Game Theory in Pragmatics PhD thesis Universiteit van Amsterdam (2009) ILLC Dissertation Series DS-2009-11.

[4] Benz, A. (2012) Implicatures of Complex Sentences in Error Models. In Schalley, A., (ed.), *Practical theories and empirical practice*, pp. 273–306 John Benjamins Amsterdam.

[5] Potts, C., Lassiter, D., Levy, R., and Frank, M. C. (2016) Embedded implicatures as pragmatic inferences under compositional lexical uncertainty. *Journal of Semantics,* **33**, 755–802.
[6] Geurts, B. and Pouscoulous, N. (July, 2009) Embedded Implicatures?!?. *Semantics and Pragmatics,* **2**(4), 1–34.
[7] Chemla, E. and Spector, B. (2011) Experimental evidence for embedded scalar implicatures. *Journal of Semantics,* **28**(3), 359–400.
[8] Levinson, S. C. (1983) Pragmatics, Cambridge University Press, Cambridge.
[9] Degen, J. and Goodman, N. D. (2014) Lost your marbles? The puzzle of dependent measures in experimental pragmatics. In Bello, P., Guarini, M., McShane, M., and Scassellati, B., (eds.), *Proceedings of the 36th Annual Conference of the Cognitive Science Society*, pp. 397–402.