Implicatures in (non-) monotonic environments

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A key function of implicature is to improve the efficiency of communication (Levinson, 2000, Ch. 1). If implicature can be *reliably* communicated, then a speaker can produce less linguistic material while obtaining the same degree of communicative success as with more complex literal descriptions. For most previous experimental studies, the main question about embedded implicatures (see Sauerland, 2012; Geurts and van Tiel, 2013 for an overview) was the question about their *existence*. Even small percentages of subjects drawing contested readings could be taken as evidence for this *existence* (Chemla and Spector, 2011; Potts et al., 2016). To show that implicatures can be *reliably* communicated, in turn, it has to be demonstrated that almost all subjects infer them in certain contexts. There is now overwhelming experimental evidence that embedded implicatures in upward entailing (UE) contexts can be reliably communicated. For example, the sentence *All of the girls found some of their marbles* (A-E) can reliably convey that *all of the girls found some but not all*. To achieve reliability, the experimental context must satisfy strong Gricean conditions (Gotzner and Benz, 2018; Benz et al., 2018; Benz and Gotzner, 2020). It is still unclear whether implicatures embedded under non–monotonic operators like *only* and *exactly* are reliably communicated, and if they are, how to account for them.

In neo–Gricean theories (Levinson, 1983; Horn, 1989), scalar implicatures are only triggered in *upward entailing* (UE) contexts, i.e. in contexts A(.) in which A(*all*) implies A(*some*). In contrast, if a context A(.) is *downward entailing* (DE), i.e. if A(*some*) implies A(*all*), then the assumption was that implicatures do not occur (e.g. under negation). If a context is neither an UE context, nor a DE context, it is called *non–monotonic* (NM). As in NM contexts A(*all*) is not stronger than A(*some*), no implicatures are expected. Hence, it is surprising that previous experimental work found even stronger evidence for the existence of implicature of *some* embedded under the non-monotonic quantifier *exactly one* than for their existence in embededded UE contexts (Chemla and Spector, 2011; Potts et al., 2016; van Tiel et al., 2018; Gotzner and Romoli, 2017; Franke and Bergen, 2020).

We present an experiment that compares the NM contexts created by *only Kate*, *only one person*, *exactly one person*, and *exactly two*, see (1). The case of *exactly two* has not been tested previously. Our results go beyond previous studies by showing that all of these non–monotonic operators *reliably* trigger the inferences in (a), in addition to the one in (b). We then address the theoretical challenge presented by our data and present a proposal that meets it. We follow analyses that decompose non–monotonic operators into (i) a positive UE and (ii) a negative (DE) component. This decomposition is motivated, for example, by the observation that non–monotonic *only* may license NPI's, which suggests some DE flavour (e.g., Horn, 1996; Von Fintel, 1999).

(1) Only Kate / only/exactly n of the girls found some of their marbles.
   a. $\rightsquigarrow$ Kate / n found some but not all of their marbles.
   b. $\Rightarrow$ None of the other girls found any marbles.

Methods: We implemented a variant of the *interactive best response paradigm* (Benz and Gotzner, 2020), in which four participants take turns in (1) a production task and (2) a comprehension task. Our programmed system randomly paired two participants for a given production-interpretation trial. In the production task, participants had to describe a picture with up to five sentences. We allowed for several response options including *all*,

Interpretation	Only Kate	Only 1	Exactly 1	Exactly 2	Kate
n sbna, rest none	97%	93%	89%	96%	79%
n sbna, rest all or none	3%	7%	11%	4%	21%

Options filling '___ (of the girls) found **some** of their marbles'. (e.g. Kate; sbna: *some but not all*)

some, *none*, *some but not all*, *only*, *exactly n*, numerals as well as common names. In the comprehension task, participants were asked to choose a set of rewards, depending on the utterance they received from the producer. The reward system was defined such that one girl gets (a) a gold medal if she finds all 4 of her marbles, (b) a silver medal if she finds 1 to 3 of her marbles, and (c) a bronze medal if she finds none of her marbles (as a consolation prize). Comprehenders had to choose the number of gold, silver and bronze medals, which reflected their underlying interpretation of a given utterance. On some trials, we used a confederate (played by the system), which produced critical utterances of interest.
Results: In Table 1, we present the interpretation data for the critical sentences. The first column lists all interpretations that were chosen with a probability > 0. The data show that all critical sentences had a dominant interpretation (line 1) corresponding to the inferences in (1a) and (1b) above, and, hence, indicate the presence of the embedded implicature of *some*, in addition to the inference that no other girl found any marbles. This later inference was derived to a lower extent for the sentence *Kate found some of her marbles*. We compared the rates of the dominant interpretation with the corresponding rates of sentences where *only Kate*, *only 1* and *exactly n* embed the universal quantifier *all* (as a control condition). In each case, the difference was significant ($p < 0.05$).

Theoretical challenge: The condition *exactly two* is of particular theoretical interest. Chemla and Spector (2011) derived the implicature from *Exactly 1 found some* to *1 found sbna and the others found none* by globally negating the non–stronger alternative *exactly 1 found all*. This explanation does not generalize to *exactly n* with $n > 1$ ("exactly 1 some $\wedge \neg$ exactly 1 all $\Rightarrow$ none all", whereas "exactly 2 some $\wedge \neg$ exactly 2 all" is consistent with some all). Hence, the explanation by Chemla and Spector (2011) would leave it open whether there is a girl that found all marbles. The implicature does also not follow by locally embedding the scalar implicature, as this would make *exactly n found some* equivalent to *exactly n found sbna*, which is weaker than the attested reading.

Proposal: We found that participants readily strengthen *some* to *some but not all* when the quantifier is embedded under *only* and *exactly 1* and *exactly 2*. We propose an analysis that decomposes non-monotonic quantifiers into two components: one positive UE component and a negative DE component (negated alternatives) (Alxatib, 2014; Bar-Lev, 2018; see Marty and Elliott, 2019 for related cases and see Denić and Sudo, 2020 for a decomposed analysis of *exactly* to account for donkey anaphora). In the UE component *Kate found some of her marbles*, the standard sbna implicature is derived. In the DE component, the literal *some* is negated (i.e., alternatives of the form *Mary found some of her marbles*). The same analysis can be given to the quantifier *exactly*, which has previously been analysed as a focus-sensitive expression (Sauerland, 2013; Marty and Elliott, 2019). The decomposed analysis explains why the embedded implicature of *some* was derived to a similar extent with *only*, *exactly one* and *exactly two* (in the UE component). Since the negative component of *only* and *exactly one* is a DE environment, *some* does not trigger an implicature here. Implicatures in DE environments usually lead to weakening, which is why they are dispreferred (e.g., Chierchia, 2013). Crucially, though, in the case of *only* and *exactly*, the overall meaning of the entire utterance gets strengthened. This explains why the implicature occurs more often in non-monotonic than usual

DE contexts. Our findings also shed light on the 'asymmetry wars', where they favour an asymmetric analysis of *only* (e.g. Horn, 1969, 1996 vs. Atlas, 1991, 1993).

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