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The Relevance of Polarity for the Online Interpretation of Scalar Terms

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The interpretation of scalar terms (like, e.g., some vs. all; the numerals) has been at the center of much theoretical debate. Recently, this debate has focused on whether Scalar Implicature (SI) computation is grammatically or post grammatically driven (cf., e.g., Russell, 2006 vs. Chierchia, Fox and Spector, 2008 and references therein). In the present work, we address these issues through experimental means arguing, specifically, for two theses:

Thesis 1: *The interpretation of both numerals and determiners like some/all are systematically affected by the polarity (Downward monotone or DE vs. Upward monotone or UE) of the local context in which they are embedded.*

Thesis 2: *Numerals and Determiners differ in how the ‘exact’ interpretation comes about: for numerals such interpretation is much faster.*

Thesis 1, if true, provides evidence against the thesis that scalar items are lexically ambiguous (for no lexical ambiguity is polarity sensitive in such a way) and in favor of the view that the ‘exact’ vs. the ‘at least’ interpretation of both types of scalar items is an implicature. Thesis 2, if true, shows that the way in which the ‘exact’ interpretation comes about for numerals vs. determiners is partly similar and partly different. This can be construed as an argument against the thesis that these elements are ‘underspecified’ in similar ways (cf., e.g., Musolino, 2003).

Background. The ‘exact’ interpretation of some/two is salient in (1a), the ‘at least’ one in (1b).

- (1) a. A boy has two/ some of the paperclips. Point to him
b. If a boy has two/some of the paper clips, then point to him

Intuitively, (1a) seems to be talking about a boy who has either some though not all or exactly two paperclips. Per contra, (1b) seems to be about boys who have some and possibly all or at least two of the paper clips. The scalar terms occur in an UE context in (1a) and in a DE context in (1b). Under the assumption that the basic interpretation of the relevant sentences is the ‘at least’ one and that the exact interpretation arises as an implicature (in the terms of Chierchia, Fox and Spector, 2008, an exhaustification over salient scalar alternatives; cf. also van Rooy and Schulz, 2004), the difference between (1a) vs (1b) would be accounted for in terms of the idea that implicatures are factored in in such a way as to maximize informativeness (for embedding an implicature in a UE context leads to strengthening, while embedding it in a DE context leads to weakening). Here is how we assume all this comes about. The lexical meaning of “some” (a generalized quantifier) is its canonical ‘at least’ interpretation given in (2). Numerals, per contra, are adjectival (of either type $\langle e, t \rangle$, as argued for by Landman, 2000 or of type $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$ as argued for by Ionin and Matushansky, 2006); so at the lexical level, they have an ‘exact’ interpretation: their ‘at least’ interpretation arises via a process of sentence-level existential closure, as schematically illustrated in (3):

(2) i. some = $\lambda Q \exists x [P(x) \wedge Q(x)]$; ii. some boys came = $\exists x [\text{boys}(x) \wedge \text{came}(x)]$

(3) i. $n(x) = x$ is a group of (exactly) n atoms; ii. three boys came = $\exists x [\text{boys}(x) \wedge 3(x) \wedge \text{came}(x)]$

SIs are then added to the sentences (2ii) and (3ii) in parallel ways (via, say, the addition of an ‘exhaustivity’ operator over the relevant alternatives, introduced in such a way as to locally maximize strength – Chierchia et al., 2008).

Experimental Background. Panizza, Chierchia and Clifton (under review) recorded the eye movements of subjects silently reading sentences such as the following:

- (4) If John parked two cars in the garage, he will park a third car in the courtyard.
(5) If John parked two cars in the garage, he will park a motorcycle in the courtyard.
(6) If John parked two cars in the garage, he won’t park a third car in the courtyard.
(7) John parked two cars in the garage and he will park a third car in the courtyard.
(8) John parked two cars in the garage and he will park a motorcycle in the courtyard.
(9) John parked two cars in the garage and he won’t park a third car in the courtyard.

In the sentences (4-6) the numeral was embedded in a DE context, whereas in the sentences (7-9) it was embedded in a UE one. The sentences (4) and (7) contain a positive continuation; the sentences (5) and (8) contain a neutral continuation; the sentences (6) and (9) contain a negative continuation. Notice that only the positive continuation forces the ‘exact’ reading of the numeral in

the DE context. They found that the numeral in the first clause was more difficult to read in the first-pass reading times in the UE conditions (7-9). This is so, presumably, because SI processing takes place more often in such contexts. Furthermore, there were significant interactions in the second-pass reading times on the same region depending on continuation type. Numerals were re-read more often when embedded in a DE context in the positive continuation condition ((4)>(7)), as expected, whereas in the other two conditions the opposite pattern emerged ((5)<(8) and (6)<(9)).

Experiment. This experiment employs the visual-word paradigm. 64 participants were told a fictional story in which four characters (2 boys and 2 girls) were dealing with two kinds of objects (e.g. “paperclips” and “paperweights”). The participants were seated in front of a computer screen and their eye movements were recorded by an eye-tracker. The screen was divided in four quadrants so that in each quadrant there was one of the four characters next to the objects he/she was dealing with. Then the voice of another character (a cook who was looking for a helper) uttered a sentence of the form in (1a) and (1b). After hearing the sentence the participants had to pick one of the characters, or tell the cook that he was wrong (if the sentence was like (1a)) or that there was none (if the sentence was like (1b)). In each scenario one of the characters was the target (e.g. a boy), the other character of the same gender was the competitor (e.g. the other boy) and the other two were the distractors (e.g. the two girls). The experimental design was built in such a way that each quantifier (“two” and “some”) was tested in two different conditions: go and no-go. In the go conditions the target was always well described by the sentence uttered by the cook, regardless of whether the participants strengthened the meaning of “some”/“two”. For instance, if the target was a boy with two paperclips, the competitor (the other boy) had three paperweights and one of the distractors (a girl) had two paperclips whereas the other girl had nothing (or one paperweight if the sentence contained a numeral). In the no-go conditions the scenario displayed a situation that was true in case the participants employed the weaker meaning of “some”/“two”, but false if they strengthened it via SI. For example, if the target was a boy with three paperclips, the competitor had nothing (or one paperclip if the sentence contained a numeral) and the distractors had two paperweights each. Here is what we expected: first, as suggested by a previous study (Huang & Snedeker, 2007) the convergence on the target should be faster for the numerals than for “some”. Our conjecture is that this is so because of the exact semantics of the numerals at the lexical level. We also expected, along the lines of what Panizza et al. (under review) previously found, to find a sign of the different computations in the DE vs. UE contexts. The off-line results show that in the no-go condition participants accepted more often the target when they heard a sentence in the DE context (acceptance rate, UE vs. DE: 74% vs. 93% with “some” and 11% vs. 40% with “two”). This shows that they were more likely to compute the SI (and then reject the target) in the UE conditions. The eye-movement pattern in the go conditions showed an early disambiguation of numerals, which occurred before the onset of the disambiguating NP (e.g. “paperclips”), versus a late disambiguation of “some”, which occurred after the onset of the NP. Finally, in the go conditions for “some” participants were slower to converge on the target in the UE context. This can be taken as evidence in favor of the tendency of the parser to add SIs in a UE context. In the go conditions for “two”, instead, they converged early and remained steady on the target in the UE context, whereas in the DE context they started focusing on the target, but immediately after they went back looking at the distractor. This is a sign that they considered the ‘at least’ interpretation only in the DE contexts and after that they considered the ‘exact’ reading. These results confirm that in different ways “some” and the numerals are sensitive to the entailing property of their local context. Moreover, this behavior, besides theses 1 and 2, shows that complex logical properties are accessed on line by the processor.

References: Huang, Y. & Snedeker, J. (in press). On-line Interpretation of Scalar Quantifiers: Insight into the Semantic-Pragmatics Interface. *Cognitive Psychology*. Panizza, D., Chierchia, G. & Clifton, C. (under review). On the Role of Entailing Properties and Scalar Implicatures in the Processing of Numerals. Chierchia, G., Spector, B. & Fox, D. (2008) “The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics” as to appear in *Handbook of Semantics*, Eds. Paul Portner, Claudia Maienborn & Klaus von Heusinger.