The Online Interpretation of Sentence Internal *Same* and Distributivity

I. The phenomena. Many languages have lexical means to compare two elements and express identity / difference / similarity between them. English uses adjectives of comparison (henceforth AOCs) like *same*, *different* and *similar* for this purpose. Often, the comparison is between an element in the current sentence and a sentence-external element mentioned previously, as in (1) below. But AOCs can also compare sentence-internally, that is, without referring to any previously introduced element, as in (2): both compared elements are introduced in the current sentence, hence the **sentence-internal** label for this reading.

1. **a.** Arnold saw <u>'Waltz with Bashir'</u>. **b.** Heloise saw *the same movie*.
2. Each student / The students / All the students saw <u>*the same movie*</u>.

This paper investigates how sentence-internal *same* is processed with three of its licensors (EACH, ALL and THE) and two orders, surface scope of licensors as in (2) above or inverse scope as in *The same student saw each movie*. Our study shows that (*i*) there is no effect of surface vs inverse order, which we take as an argument for a model-oriented view of the processing cost of inverse scope (see [5] a.o.), and (*ii*) ALL is processed faster than EACH and THE, which we take as an argument for a particular semantics of distributive licensors.

II. Experimental method. We used a self-paced reading task to test how easy it is to interpret sentence-internal *same* with 3 licensors, EACH, ALL and THE, in 2 orders, Q+AOC (quantifier precedes AOC) and AOC+Q (AOC precedes quantifier), i.e., $3 \times 2 = 6$ conditions in total. Each condition was tested 4 times, twice in sentences most likely judged as true relative to the background scenarios and twice in sentences most likely judged as false, for a total of 24 items. There were 35 fillers. A total of 29 subjects (27 undergraduate students completing the experiment for extra-credit and 2 volunteers), all native speakers of English, completed the experiment online. For each subject, we randomized the order of the 59 items+fillers subject to the condition that any 2 items were separated by at least 1 filler.

Every item/filler consisted of a scenario introducing 2 sets of entities and a relation between them, e.g., 3 movie critics Bill, Ray and Douglas for a Boston journal, 2 movies 'A pink guitar' and 'A dangerous open closet' and the 'review' relation (which critic reviewed which movie). After reading the scenario, the subjects moved on to a new screen where they read the target sentence word-by-word with the SPACE bar revealing the next word and hiding the preceding one. Here are 3 test items (varied by quantifier): *I think that each/all the/the movie critic(s) working for the journal in Boston reviewed the same movie last week.* Every sentence was followed by a yes/no comprehension question (*Am I right to think that?*); 1 subject was excluded because more than 15% of the questions were incorrectly answered.

III. Statistical modeling and resulting generalizations. 3 outlier subjects with mean log reading times (RTs) more than 2 sd.s from the grand mean are removed. The influence of word length and word position in the sentence was factored out (following [8] a.o.) by running a linear mixed-effects regression, with fixed effects for word length in characters, word position in the sentence (cubic-spline interpolated with 2 knots demarcating the beginning and end of sentences) and their interaction and with subject random effects (intercept and word length and position slopes). We used the log RT residuals for all subsequent analyses.

We then investigated the critical regions of each item and the following 2 words with a series of mixed-effects models. Each item has 2 critical regions: the quantifier word *each* / *all* / *the* and the word *same*. In all models, we consider subject and item random effects and spillover variables (log RTs for the 3 regions preceding the critical region) in addition to the fixed effects we were interested in, namely (i) QUANT: factor with 3 levels, ALL (reference level), EACH and THE; (ii) ORD: factor with 2 levels, Q+AOC (reference level) and AOC+Q.

The main generalizations are as follows (the paper provides more details about modeling etc.). First, the quantifier word and the following 2 words are read more slowly in the Q+AOC (surface scope!) order and there is no effect of QUANT when we examine the AOC+Q subset of the data (it does not make sense to examine the Q+AOC subset because the subjects have not seen both the quantifier and the AOC *same* in those cases). Second, the word *same* and the following 2 words are read more slowly in the AOC+Q order; again, there is no effect of QUANT when we examine the Q+AOC subset (it does not make sense to examine the AOC+Q subset in this case for the same reason as above). Finally, when we sum over the entire sentence, we find that ORD is not significant and remains non-significant even if we split the data by quantifier type; but the effect of QUANT is significant, in particular, sentences with ALL are significantly faster than EACH and THE. When we split the data into 2 subsets based on order, we see that QUANT is only significant in the AOC+Q (inverse scope) order.

IV. Interpretation of results. We did not find any slowdown effect on sentences or quantifiers+following words in the AOC+Q, i.e., inverse scope, order. This is surprising because (*i*) it is assumed that quantifiers must scope over AOCs to license their sentence-internal readings ([2], a.o.) and (*ii*) previous studies of indefinite+quantifier sentences found slower reading times in inverse scope readings ([1], [9]). Our results indicate either that an NP licensor does not need to scope over *same* to license its sentence-internal reading or that inverse scope is not costly in our case. It has been suggested that sentence-internal AOCs can be licensed by cumulative readings ([3], [7]) but crucially, this possibility is only available with non-distributive quantifiers—and we found no effect of order even when restricting ourselves only to sentences with EACH. Since in this case cumulative readings are not a likely option, we conclude that inverse scope, crucial for licensing sentence-internal *same* in the AOC+Q order, does not have any processing cost. This cannot be due to the fact that we use AOCs because other AOCs like *different* do not obviate slowdown in inverse scope readings ([1]).

We take our results to show that taking inverse scope is not costly. What is costly is the reinterpretation of the discourse model, necessary when a quantifier takes inverse scope over indefinites, e.g., *A boy climbed every tree*, or over the AOC *different*, e.g., *A different boy climbed every tree*: in both cases, we must backtrack and allow for multiple boys in the discourse model when we reach the universal quantifier and decide to give it wide/inverse scope. But this is not necessary for *same* in *The same boy climbed every tree.*

Second, we found that sentences with *all* are read faster than EACH and THE. Following [4], we assume that there are (at least) two kinds of distributors licensing sentence-internal readings, using the **dist** and **dist-WHOLE** operators. In (2) above, *each* contributes **dist**, which requires us to consider every pair of students and compare what movies they saw (multiple comparisons). In contrast, *all* contributes **dist-WHOLE**, which requires us to compare all the students and movies at the same time (one comparison). Given that **dist** requires a more complicated interpretive operation than **dist-WHOLE**, we explain the slowdown on *each*. Finally, we assume that *the* can make use of **dist-WHOLE** just like *all*, but it is likely that definites are read more slowly in the AOC+Q order because definites are worse inverse-scope takers than *all*-quantifiers ([6]).

References: [1] Anderson, C. (2004) The structure and real-time comprehension of quantifier scope ambiguity. Phd Diss., Northwestern U. [2] Barker, C. (2007). Parasitic Scope. *Ling. & Phil.* 30, 407-444. [3] Beck, S. (2000). The Semantics of Different. *Ling. & Phil.* 23, 101-139. [4] Brasoveanu, A. (2011). Sentence-internal *Different* as Quantifier-internal Anaphora. *Ling. & Phil.* 34, 93-168. [5] Fodor, J. D. (1982). The mental representation of quantifiers. *Processes, Beliefs, and Questions*. Dordrecht, 129–164. [6] Ioup, G. (1975). Some universals for quantifier scope. *Syntax & Semantics* 4, 37-58. [7] Moltmann, F. (1992). Reciprocals and Same/Different. *Ling. & Phil.* 15, 411–462. [8] Trueswell, J.C. et al (1994). Semantic Influences on Parsing. *Journal of Mem. & Lang.* 33, 285-318. [9] Tunstall, S. (1998). The interpretation of quantifiers: Semantics and processing. Phd Diss., UMass.