How to provide exactly one interpretation for every sentence, or what eye movements reveal about quantifier scope

Oliver Bott and Janina Radó

SFB 441 University of Tübingen

oliver.bott@uni-tuebingen.de, janina@sfs.uni-tuebingen.de

The interpretation of multiply quantified sentences has been subject to considerable debate concerning the available readings as well as theoretical considerations about the underlying representations and how they are constructed. There is a growing body of experimental work investigating these issues, but they tend to focus on only one of the two aspects. The studies that report *offline* preferences for one or the other reading do not reveal whether the preferred scope relation is the result of the first interpretation, or of reinterpretation. On the other hand, experiments looking at *online* interpretation often use insufficient disambiguation, which makes it difficult to evaluate the processing data. Moreover, when explicit disambiguation is given, the preferences on the earlier, ambiguous part of the sentence are likely to be distorted. Clearly, though, the two aspects complement each other and should be considered simultaneously.

Experiment We present the results of an ongoing experiment where we monitored subjects' eye movements both during reading instructions and while inspecting computer displays following those instructions. The computer displays consisted of three fields, each with four pictures, i.e., 12 pictures in total. In the experimental conditions all pictures were of the same category, e.g., animal. Two of them appeared in all three fields, the others appeared only once in the whole display (for Control A, only one picture appeared multiple times, and all others were of a different category).

Please include Figure 1 here

The sentence materials consisted of short instructions. In the ambiguous conditions they were of the form *Genau ein Tier auf jedem Bild/auf allen Bildern sollst du nennen!* (“Name exactly one animal in each field/in all fields!”). This construction known as inverse linking favors an inverse scope reading (see e.g. Heim and Kratzer, 1998), which is even more pronounced with 'each' than with 'all', reflecting the usual contrast between the two universal quantifiers (see e.g. Beghelli and Stowell 1997). Two types of controls were included. In type A we used definite NPs in place of the first quantifier to control for reading time differences on the universal quantifier: *Das Tier auf jedem Bild/auf allen Bildern sollst du nennen!* (“Name the animal in

each field/in all fields!"). The Type B conditions contained the same quantifiers as the ambiguous conditions but were disambiguated, to guarantee that subjects do in fact consider both readings. ∃∀: *Ein Tier, das sich auf allen Bildern befindet, sollst Du nennen!* ("Name an animal which can be found in all fields!") *vs.* ∀∃: *Von jedem Bild sollst Du irgendein Tier nennen!* ("From each field, name some animal!"). Subjects read the instruction, then inspected the corresponding display and had to produce an answer under time pressure.

Predictions In the 'each' condition, the desire of the universal quantifier to take wide scope together with scope properties of the construction should lead to relatively smooth integration of the second quantifier into the sentence, and ultimately to choosing the ∀∃ answer. Since 'all' does not want wide scope, we expect a conflict between the construction and the quantifier in the 'all' condition. This should be reflected in longer reading times on the universal quantifier and in a larger proportion of ∃∀ answers. Moreover, reading time patterns may differ depending on the chosen scope relation.

Results Preliminary data from 14 subjects showed marginally higher first-pass reading times on the universal quantifier for 'all' than for 'each' in the ambiguous conditions, but not in Control A. This effect was fully significant in the total reading times. No differences were found in later regions of the sentence.
An ∃∀ reading was defined as one where the subject looked at all three fields before providing a single answer, whereas for an ∀∃ interpretation they responded field-by-field. The ∃∀ answer was selected significantly more often with 'all' than with 'each' in the ambiguous conditions (42.7% vs. 16.2%). The ∃∀ condition of Control B only received ∃∀ answers, and the ∀∃ condition was also interpreted as unambiguous (97.5% vs. 5% ∃∀answers).

Implications for processing The results suggest that in our experiment quantifier scope relations were computed immediately. Further, the lack of later reading time effects indicate that all factors that play a role in the ultimate interpretation of the sentence were considered right away. In addition to the online processing aspects, our method of requiring an answer after an ambiguous instruction rather than supplying some sort of disambiguation allowed us to see directly what reading subjects preferred. The findings confirm our intuition of an overwhelming preference for inverse scope in the construction we used.

Implications for semantic theory First, our results are only compatible with theories that acknowledge the existence of scope-influencing factors such as distributivity. Moreover, the reading time data suggest that multiple scope readings conflict rather than co-exist, that is, that a greater balance between the readings in a doubly quantified construction makes it more difficult to arrive at a single interpretation.

References

Beghelli, F. and Stowell, T. (1997). Distributivity and negation: The syntax of *each* and *every*. In A. Szabolcsi, ed., Ways of scope taking. Kluwer, Dordrecht, pp. 71-107.

Heim, I. and Kratzer, A. (1998). Semantics in generative grammar. Blackwell, Malden.