When pragmatics helps syntax: an eye tracking study on scope ambiguity resolution in 4- to 5-year-old children.

Sentences like (1) with two scope-taking operators, subject-position *alle* ('all') and *nicht* ('not'), give rise to two readings.

(1) Alle Piraten sind nicht auf das Schiff zurückgekehrt.
All of the pirates did not go back to the ship.

Under the surface-scope reading of (1), no pirates went back to the ship, whereas under the inverse-scope reading, not all the pirates did. Previous studies report that children, unlike adults, display a strong surface-scope preference [1], although they may adopt an inverse-scope interpretation if semantically primed [2] or pragmatically facilitated [3,4]. Under one hypothesis [2,3], this pattern is due to children's lack of processing resources, preventing them from revising their initial parse (assumedly corresponding to surface-scope). Under alternative hypotheses, uncontrolled prosody may influence children's choices [5,6] and elicit incongruent results [7]. Finally, children can derive indirect scalar implicatures ('not all' -> 'some') [8], which could facilitate access to inverse-scope readings.

To explore these issues and investigate children's accessing and preference of the two readings, we designed an experiment combining a semantic decision task between two scenarios with eye movement recording. We recorded the experimental sentences with a neutral intonation, controlling for prosody.

45 German-speaking children (aged 46.9-71.9 months, mean=61.6) and 50 adult controls were told 16 stories about pirates, acted out by two groups of toy-actors. Each group depicted a) a FALSE scenario where all the pirates went back to the ship, b) a NONE scenario where no pirates did, or c) a SOME scenario where only some pirates did (Picture 1). Critically, the SOME scenario is only compatible with the inverse-scope reading, while the NONE scenario is compatible with both interpretations. The task was to reward the group of toy-actors that best followed the instructions (the test sentence). The experimental design involves the combination of these scenarios: the NONE-FALSE condition shows whether participants access any of the two interpretations whereas the SOME-FALSE condition shows whether they access the inverse-scope reading. The NONE-SOME condition shows which scenario they prefer and how quickly this choice is made with respect to the access conditions. Eye movements may inform us on the exact timing of access.

We found that children provided significantly more correct responses in the SOME-FALSE vs. NONE-FALSE condition (Table 1) and displayed a slight preference for SOME in the NONE-SOME condition. In contrast, eye movement analysis of participants with good comprehension of both configurations shows a lower latency in shifting of looks towards the correct scenario in the NONE-FALSE condition (Table 2). This suggests that although the surface-scope interpretation can be accessed faster, the inverse-scope reading boosts children's overall accuracy. Furthermore, children who chose SOME in the NONE-SOME condition showed a looking preference for that scenario two seconds earlier than those who chose NONE (Picture 2).

These results speak against the processing-based hypothesis and suggest that pragmatic inferences may play a role in facilitating children's access to inverse-scope readings. In conclusion, we found that German-speaking children and adults access both scopal interpretations readily even in the absence of prosodic cues.

Word count: 498

SOME-FALSE condition *SOME-NONE condition* *NONE-FALSE condition*

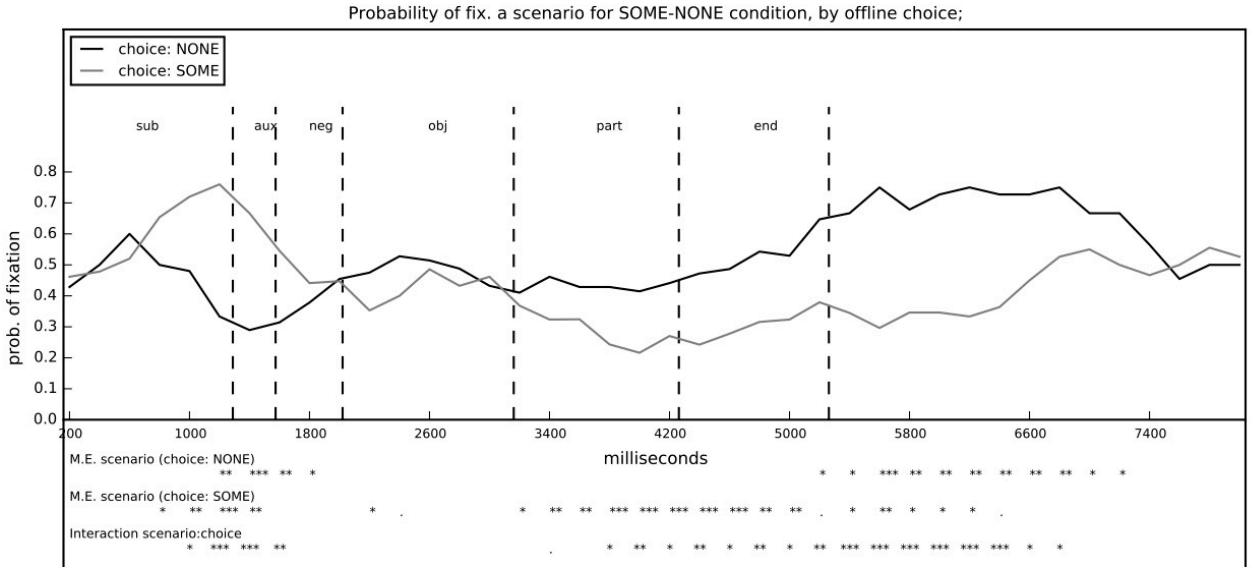
Picture 1. Examples of experimental scenarios for each condition.

	Access conditions			*Ambiguous condition*
	NONE-FALSE	**SOME-FALSE**	GLMM	**NONE-SOME**
participants	accuracy	accuracy	on acc.	preference for NONE
adults (n=50)	84.70%	88.20%	p>.1	57.70%
all children (n=45)	65.30%	79.10%	p=.000	43.70%
good comp. (n=28)	91.60%	92.70%	p>.1	51.20%

Table 1. Offline choices for the experimental conditions in each group of participants.

	avg offset	**shift latency**				
participants	of 'nicht'	**to NONE**	**to SOME**	**beta**	**t value**	**p. value**
adults						
good comp. (n=45)	2020 ms	581 ms	727 ms	-88.6152	-0.9613	0.3402
children						
good comp. (n=28)	2020 ms	586 ms	934 ms	-335.1813	-2.4895	0.0195

Table 2. Latency analysis computed from the offset of 'nicht' + 200 ms. LMM statistics are reported.



Picture 2. Probability of fixating the NONE (1) vs. SOME (0) scenario for the NONE-SOME condition in children good comprehenders (N=28) by offline choice (NONE = black; SOME = gray). GLMM significance levels are reported.

References. [1] Musolino, J., S. Crain & R. Thornton. 2000. Navigating negative quantificational space. *Linguistics* 38, 1-32. [2] Musolino, J. & J. Lidz. 2006. Why children aren't universally successful with quantification. *Linguistics* 44:4, 817-852. [3] Viau, J., J. Lidz & J. Musolino. 2010. Priming of abstract logical representations in 4-year-olds. *Language Acquisition* 17:1, 26-50. [4] Gualmini, A., S. Hulsey, V. Hacquard & D. Fox. 2008. The question-answer requirement for scope assignment. *Natural Language Semantics* 16:3, 205-237. [5] Büring, D. 1997. The great scope inversion conspiracy. *Linguistics and Philosophy* 20:2, 175-194. [6] Syrett, K., G. Simon & K. Nisula. 2014. Prosodic disambiguation of scopally ambiguous quantificational sentences in a discourse context. *Journal of Linguistics* 50, 453-493.[7] Conroy, A., Lidz, J. & J. Musolino. 2009. The Fleeting Isomorphism Effect. *Language Acquisition* 16:2, 106-117. [8] Bill, C., Romoli, J., Schwarz, F. & S. Crain. To appear. Scalar Implicatures vs. Presuppositions - The view from Acquisition. In TOPOI special issue "*Presuppositions: Philosophy, Linguistics, and Psychology*".