

Romanian 5-year-olds derive global but not local implicatures with quantifiers embedded under epistemic adverbs: Evidence from a shadow-playing paradigm

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The current paper draws light on the acquisition of the semantics and pragmatics of quantifiers embedded under epistemic adverbs in Romanian by means of a novel *shadow play paradigm* tested on Romanian 5-year-olds and adults. It provides experimental evidence that 5-year-old children derive fewer global implicatures than adults, but that local implicatures triggered are equally infrequent in both groups. The present study is the first one testing quantifiers embedded under epistemic modal operators. **Background:** There has been much debate in the literature concerning whether/how adult speakers derive local implicatures in embedded contexts, such as (1).

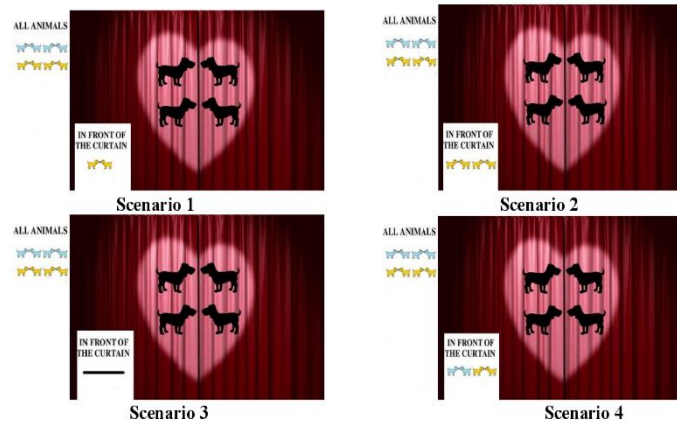
(1) Every pig carried some of his rocks. (a) **Semantic interpretation:** Every pig carried some and possibly all of his rocks. // (b) **Global implicature:** Not every pig carried all of his rocks.// (c) **Local implicature:** Every pig carried some but not all of his rocks.

The grammatical approach predicts local implicatures as in 1-(c) by resorting to an exhaustification operator, integrating them into compositional semantics (Chierchia 2004, Fox 2007, Chierchia et al. 2012). In contrast, traditional neo-Gricean approaches only predict global implicatures as in 1-(b) (Sauerland 2004, Geurts 2010). Game-theoretic approaches model implicatures (both global and local ones) via recursive reasoning between the speaker and hearer (Franke 2009, Benz 2012, Potts et al. 2016). Except for Geurts & Pouscoulous (2009), who looked at *some* embedded under various items (*all, think, has to, want*), previous adult experimental studies have mainly focused on quantifiers embedded under other quantifiers (e.g., *<every, some>* Chemla & Spector 2011, Bill 2017, *<each, some>* Gotzner & Benz, 2018). Moreover, only one previous study by Bill (2017) has tested local implicatures in children. He found that both adults and children accessed a semantic and an implicature reading (global or local) to an almost equal degree for sentences like (1). Interestingly, though the type of implicature derived differed among children and adults: Adults derived global implicatures (and almost no local implicatures) while children derived local implicatures (but no global implicatures). Bill took these results to support an initial grammatical approach to implicatures in acquisition, in combination with the view that children struggle accessing alternatives from the lexicon (Alternative access hypothesis: e.g., Barner et al., 2011). To derive implicatures, children may either require alternatives to be presented in the discourse (e.g., Barner et al., 2011; Gotzner et al., 2020), as part of the same sentence (Restricted alternatives hypothesis: Singh et al., 2013; Tieu et al., 2015; Bill, 2017) or be relevant to the Question under Discussion (Skordos & Papafragou, 2016). Bill (2017) argued that children in his study were able to derive local implicatures because of access to both scale mates (*<every, some>*) in the same sentence. **The current experiment:** The experiment we designed tests the mastery of the semantics and pragmatics of the quantifiers *unii* ('some') and *toți* ('all') when embedded under the epistemic adverbs *sigur* ('certainly'), *poate* ('possibly') by adults and 5-year-olds. It aims to see whether adults and children derive local or global implicatures for quantifiers embedded under epistemics (e.g., 'It is certain that some dogs are blue'). This provides a novel test case to access the role of alternatives in implicature. In order to prevent subjects from being too cautious, but, at the same time, keeping the object of inquiry inaccessible so as to justify the use of modal adverbs, we used a novel *shadow play* paradigm where animals hide behind a curtain. Instead of just speculating upon the presence of an unseen animal in a box, subjects can now see the shadow of the animal(s), and, moreover, they heard the specific sound it produces (e.g., a woof-woof). **Participants:** 32 Romanian adults and 30 5-year-olds (14M and 16F, Age range: 5-5;11, Mean age: 5;8). **Methodology & Materials:** The experiment (implemented in PennController) employs

a shadow play paradigm where subjects have to reward a baby dragon depending on whether his statements are the best description of the situation (see also Bleotu et al., 2021). Subjects are told there is a wizard who likes to play a shadow game with a baby dragon. In this game, various animals go and hide behind the curtain but some of them come in front of the curtain later on. Participants are told that they are supposed to reward the baby dragon with a big apple if what he says is the best description of the situation and with a small apple otherwise (Katsos & Bishop 2011). In the game, there are various groups of animals: a control/ training group of two bunnies, and 4 testing groups of 4 pairs (8 animals): dogs, frogs, cats, cows. Importantly, the animals only hide in pairs. In the main part, after a short training using true and false affirmative sentences with no modal adverbs, the actual testing begins, employing four scenarios per group.

The pictures (see Figure 1) show an image with the main silhouettes, a small image with the animals in front of the curtain, and a small image with all the animals in the game. The small image on the left (ALL ANIMALS) is always present for subjects to easily access the initial situation and in order to prevent processing difficulties because of memory load (Crain & Thornton 1998). In *Scenario 1*, where two animals come back in front of the curtain (in this case, 2 yellow dogs), tests participants' understanding of alternatives, their ability to reason that the situation has two possible outcomes: either the silhouettes belong to 4 blue dogs or they belong to 2 blue dogs and 2 yellow dogs. *Scenario 2* tests whether subjects are able to reason that the silhouettes can only belong to the blue dogs, given the fact that there are four yellow dogs in front of the curtain now. *Scenario 3*, where there are no animals in front, tests whether subjects understand that several alternatives are possible: the silhouettes belong to 4 blue/ 4 yellow dogs, or 2 blue and 2 yellow dogs. *Scenario 4* tests whether subjects can infer from the presence of 2 blue dogs and 2 yellow dogs in front of the curtain that the silhouettes can only belong to 2 blue dogs and 2 yellow dogs. While *Scenario 1* and *Scenario 2* are indeterminate (multiple alternatives) scenarios, where participants derive ignorance implicatures (Fox 2007, Sauerland 2004, Spector 2003), inferring that the baby dragon uttered weaker statements because of lack of evidence for the stronger alternatives, Scenarios 3 and 4 are determinate (single-outcome) scenarios, where participants can infer that the baby dragon uttered weaker statements because he believed the stronger alternative was false. The 4 Scenarios are presented two at a time in order to enable certain inferences: Scenario 1 (8 Ss) & Scenario 2 (5 Ss), and Scenario 3 (2 Ss) & Scenario 4 (2 Ss). There are 17 instances of sentences (9 critical, 8 controls) per animal group presented in a randomized manner (containing the quantifiers *unii* ('some') and *toji* ('all') embedded under the epistemics *poate* ('possible') or *sigur* ('certain') the epistemics *poate* ('possible'). The challenge was to create situations allowing one to distinguish among semantic interpretations/local implicature answers/global implicature answers (through a different reward for one interpretation in comparison to the other interpretations). For instance, in Scenario 1, when hearing (2), participants would reward the baby dragon with a big apple in case of a semantic/global interpretation, but with a small apple in case of a local implicature. Thus, we

Figure 1. Example images used for each Scenario for a group of animals



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could tease apart the local implicature reading from the other interpretations (semantic reading or global implicature).

(2) It is certain that some dogs are blue (Scenario 1): (a) **Semantic**: It is certain that some and possibly all dogs are blue // (b) **Global**: Semantic + It is not certain that all dogs are blue// (c) **Local**: Semantic + It is certain that some but not all dogs are blue// (Semantic/Global = big apple, Local= small apple)

Results: Figure 2 presents the rate of different interpretation in children and adults in Scenarios 1 and 2. We analyzed these results with logit mixed effects models involving contrast coding and the full random effects structure. The model revealed main effects of group ($p < .001$), inference type ($p < .001$) and a group by interpretation interaction for global implicatures ($p < .01$) but not local ones ($p = .38$). Thus, children derived local implicatures to a similar degree like adults but fewer global ones. Scenarios 3 and 4 allowed us to further distinguish between two types of global implicatures. When faced with an utterance like ‘It is possible that some Xs are Y’, both adults and children derived more global implicatures of the type global implicatures of the type ‘It is not certain that some Xs are Y’ (*not-certain-some*) than global implicatures of the type ‘It is not possible that all Xs are Y’ (*not-possible-all*) (main effect of global implicature type but no interaction). Figure 3 presents the rate of the two types of global implicatures across groups.

Fig. 2: Interpretation by group (Scenarios 1, 2)

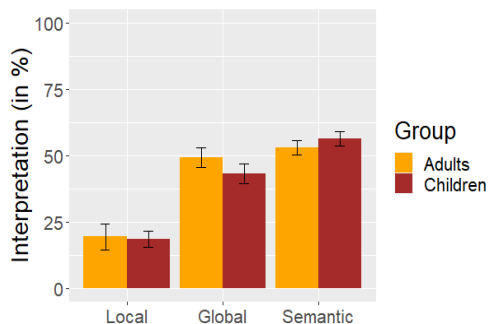
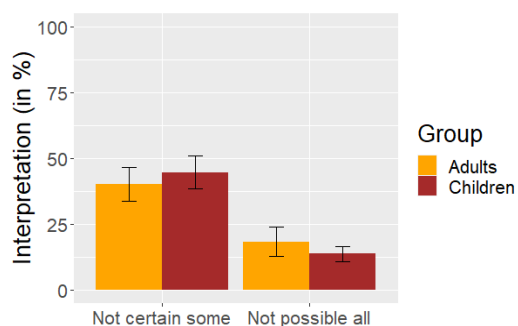


Fig. 3: Types of global implicatures (Scenarios 3, 4)



Discussion: Our main finding is that children derive fewer global implicatures than adults but that local implicatures under epistemics are equally infrequent in both groups. Our results differ from Bill (2017), who found that children derived local but no global implicatures. However, while both scale mates were present in the same asserted sentence in Bill (2017)’s experiments (*<every, some>*), we presented sentences with alternatives belonging to different Horn scales (e.g., *certain* and *some*). Our results thus provide evidence for the Restricted alternatives hypothesis, according to which children require scale mates to be presented in the same sentence. In fact, the alternative relevant to the local implicature was presented in the discourse/over the course of the experiment and yet we saw low rates of local implicatures in children and adults. An additional explanation for the different results could also be that Bill (2017)’s study used partitive *some of*, whereas ours used non-partitive *unii* ‘some’, and it is known that fewer implicatures are derived without the partitive (Degen 2015). Our second finding that both children and adults derived more global *not-certain-some* than *not-possible-all* implicatures further indicates that the epistemic state (*possible/certain* contrast) was more relevant than the *some/all* contrast. Hence, our novel test cases add to literature on the role of the Question under Discussion in implicature (see for example, Zondervan, 2010; Skordos & Papafragou, 2016). Overall, our study highlights that different scalar items may pose different challenges to children depending on their scale mate status and relevance to the QuD, and this leads to different rates of (global/local) implicatures.