Testing theories of temporal inferences: Evidence from child language

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Background: Sentences involving past tense verbs like (1) tend to give rise to the inference that the corresponding present tense sentence (2) is false. By contrast, (2) doesn't suggest in any way that (1) is false.

(1) My dogs were on the carpet. $\rightsquigarrow$ *My dogs aren't on the carpet*

(2) My dogs are on the carpet. $\not\rightsquigarrow$ *My dogs weren't on the carpet*

Following Musan (1995) and Magri (2009, 2011), Thomas (2012) derives the inference shown in (1) as a scalar implicature arising from negating the competitor in (2); in other words a past tense sentence triggers the implicature that its present tense alternative is false. In addition, Thomas proposes that the absence of the inference in (2) is due to the latter not having (1) as a competitor. Under this analysis, the asymmetry between (1) and (2) is explained by reference to Katzir's (2007) structural theory of alternatives. More specifically, it is assumed that episodic present tense sentences like (2) have an LF like (3b), where in the T head there is only a pointer to the time of utterance N. On the other hand, the past tense counterpart in (1) would involve additional covert temporal and aspectual operators, as in (3a).

(3) a. [[$_T$ ONCE [PAST N] [my dogs are on the carpet]] b. [[$_T$ N] [my dogs are on the carpet]]

Crucially, under this proposal, the past tense sentence structurally contains its present tense counterpart. In Katzir's (2007) theory, this asymmetric structural complexity ensures that the present tense sentence is an alternative of the past tense one, but not vice versa. The structural assumption of Thomas (2012) leads straightforwardly to a clear developmental prediction. A robust finding from language acquisition research is that without extra facilitation, 4–6-year-old children compute fewer scalar implicatures than adults (Chierchia et al. 2001, Noveck 2001, Papafragou & Musolino 2003, Guasti et al. 2005, Barner et al. 2011, among many others). One recent explanation for this non-adult behaviour is that children have trouble accessing certain alternatives during scalar implicature computation, namely those alternatives that are to be derived via lexical replacement (cf. Tieu et al.'s *Restricted Alternatives Hypothesis* and discussion in Barner et al. 2011 and Singh et al. 2016). A further prediction of this hypothesis is that alternatives that are contained within the uttered sentence should not be problematic for children. This is supported by experimental evidence that children perform better on scalar inferences when the necessary alternatives are explictly included in the assertion, for example in free choice disjunction (Gualmini et al. 2001, Barner et al. 2011, Tieu et al. 2016, Singh et al. 2016).

Present study: Assuming the above developmental lexical access hypothesis for scalar inferences and Thomas's (2012) theory of temporal inferences, we derive the prediction (P):

P: Children will compute more temporal inferences than classical scalar implicatures.

We report on an experiment testing the prediction (P). Our experiment compared the performance of 4–6-year-old children and adults on temporal inferences like (1), scalar implicatures like (4), and adverbial modifiers like (5). The scalar implicature of (4) is assumed to require lexical replacement (*some* vs. *all*), providing a baseline of an inference which children typically struggle with. Turning to (5), the inference *My dogs jumped* is generally considered to be due to an alternative which is contained in the uttered sentence, e.g., *My dogs didn't jump* for (5). It provides a baseline for an inference children are predicted to be able to compute.

(4) Some of my dogs jumped on the bed. $\rightsquigarrow$ *Not all of my dogs jumped on the bed*

(5) My dogs didn't jump high. $\rightsquigarrow$ *My dogs jumped*

Given this double comparison, the prediction (P) sets up the expectation that children's performance on temporal inferences and sentences with adverbial modifiers like (5) will be more adult-like than their performance on sentences involving *some* like (4).

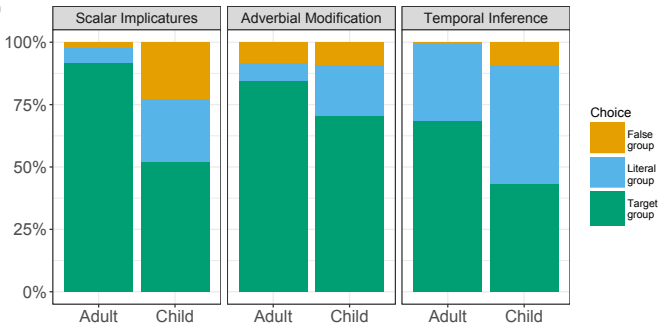
Experiment: *Methods*: We tested the prediction (P) using the following task: participants heard a puppet uttering a "clue" such as (1), (4), or (5) and were asked to guess which one of three groups of pictured characters, e.g., dogs (Target Group, Literal Group, False Group) belonged to the puppet. The materials were designed so that each set of dogs would make the sentence or its implicature true or false (see Table 1). An anonymized online version of the experiment can be found at `http://spellout.net/ibexexps/AnonymizedExps/SuB`.

	Target Group	**Literal Group**	**False Group**
Literal meaning	True	True	False
Inference	True	False	False
Temporal inference (1)	in basket, then move	in basket throughout	never in basket
Scalar implicature (4)	some on the bed, some not	all on the bed	none on the bed
Adverbial modification (5)	jumped low	didn't jump	jumped high

Figure 1: Experimental conditions

Each participant received 4 repetitions of each target type, 2 control items that contained 1 Target Group and 2 distinct False Groups, 2 present tense controls, and 3 fillers. To ensure that participants would distinguish between past and present tense, the animals remained animated until a response was provided.

Results & Discussion: 40 English-speaking adults and 17 children (4;02–5;10, M=5;00) participated in the experiment. The percentages of each of the group selections are provided in the graph. The adults overall systematically favoured the target group across conditions, although more literal choices were observed for the temporal targets. The children performed well on controls (91% accuracy); on targets, they chose the Target group less often than adults in the scalar implicature condition (mixed-effects logit model: $z = 3.0, p = .002$) but not in the adverbial modification ($z = 1.0, p = .30$) or temporal conditions ($z = 1.2, p = .25$). Child testing is ongoing, and we aim to test 40 children in total.



Conclusion: The present study evaluates the developmental predictions of a recent account of temporal inferences by Thomas (2012), and in addition provides novel data on children's ability to compute implicatures arising from adverbial modification in negative sentences. To this end, we developed a new selection task, the results of which replicate the robust finding that 5-year-old children derive fewer implicatures from *some* than adults, and reveal that children perform more like adults on temporal inferences and inferences arising from adverbial modifiers. This pattern of results is predicted by Thomas' (2012) theory of temporal inferences and the developmental lexical access hypothesis for scalar inferences.