

# Testing theories of temporal inferences: Evidence from child language

Frances Kane<sup>1</sup>, Alexandre Cremers<sup>2</sup>, Lyn Tieu<sup>3</sup>, Lynda Kennedy<sup>3</sup>, Yasutada Sudo<sup>4</sup>, Raffaella Folli<sup>1</sup> & Jacopo Romoli<sup>1</sup>

[1] Ulster University, [2] University of Amsterdam, [3] Macquarie University, [4] UCL

## > Background: Temporal inferences

- Sentences involving past tense verbs like (1) tend to give rise to the inference that the corresponding present tense sentence (2) is false, while (2) doesn't suggest that (1) is false.

- (1) My dogs were in the basket.       $\rightsquigarrow$  My dogs aren't in the basket  
 (2) My dogs are in the basket.       $\not\rightsquigarrow$  My dogs weren't in the basket

## > A scalar implicature approach (Thomas 2012)

- Thomas (2012) argues that the temporal inference of (1) arises as a scalar implicature through competition with the alternative in (2) (see also Musan 1995, Magri 2009).
- The absence of the inference in (2) is because (1) is not an alternative to (2).
- Thomas appeals to Katzir's (2007) **structural theory of alternatives** and assumes that the past tense sentence structurally contains its present tense counterpart.
- Specifically, (2) has an LF like (3-a), where the T head only contains a pointer to the time of utterance N. On the other hand, (1) involves additional covert temporal and aspectual operators, as in (3-b).

- (3) a.  $[[T N] [my\ dogs\ are\ in\ the\ basket]]$   
 b.  $[[T ONCE [ PAST N] [ my\ dogs\ are\ in\ the\ basket ]]$

- Under Katzir's (2007) theory, this structural asymmetry ensures that the present tense sentence is an alternative of the past tense one, but not necessarily vice versa.
- This in turn correctly predicts that (1) has the negation of (2) as an inference, while (2) does not give rise to the negation of (1) as an inference.

## > The Restricted Alternatives Hypothesis (RAH) (Tieu et al. 2016)

- A robust finding from developmental research is that without strong contextual support or special experimental manipulations, 4–6-year-old children typically 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-like behaviour is that children have trouble accessing certain alternatives during scalar implicature computation, namely those alternatives that are derived via lexical replacement (cf. Tieu et al.'s 2016 **Restricted Alternatives Hypothesis**, Barner et al. 2011, Singh et al. 2016, Tieu et al. 2017).
- This approach posits that alternatives that are contained within the uttered sentence, rather than being derived via lexical replacement, are not problematic for children.
- Indeed children have been reported to perform better when the alternatives are explicitly included in the assertion, e.g. free choice inferences (Gualmini et al. 2001, Barner et al. 2011, Tieu et al. 2016, Singh et al. 2016, Tieu et al. 2017).

## > Prediction

- The structural assumption of Thomas' (2012) implicature approach, in combination with Tieu et al.'s (2016) RAH, leads straightforwardly to the following prediction (P) for the acquisition of temporal inferences:

**(P): In contrast to scalar implicatures, which require lexical replacement, children will be more adult-like on temporal inferences.**

## > Our study

- We conducted an experiment testing the prediction (P) by comparing the performance of 4–6-year-old children and adults on temporal inferences like (1), scalar implicatures like (4), and the inferences of adverbial modifiers under negation like (5).

- (1) My dogs were in the basket.       $\rightsquigarrow$  My dogs aren't in the basket  
 (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

- 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.
- The inference *My dogs jumped* in (5) is generally considered to involve an alternative that is contained in the uttered sentence, e.g., *My dogs didn't jump* for (5) (cf. Simons 2001). It therefore provides a baseline for an inference children are predicted to be able to compute, according to the RAH.
- 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 novel task that involved matching a sentence to a group of animals in a video presentation.
- Participants listened to a puppet's 'clues', 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. An example of each 'Group' type is outlined below for the **Temporal Inference (TI)**, **Scalar Implicature (SI)**, and **Adverbial Modification (AM)** conditions.

### Participants

- 40 English-speaking adults recruited through Amazon Mechanical Turk and 40 English-speaking children recruited from preschools in Belfast (4;02–5;11, M=5;04) participated in the experiment.

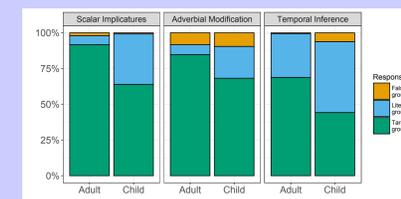
### Materials

- The materials were designed so that each set of characters, e.g., dogs, would make the sentence or its implicature true or false (see Table below).
- Each participant received 19 trials in total: 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 allow participants to distinguish between past and present tense, the animals remained animated until a response was provided.

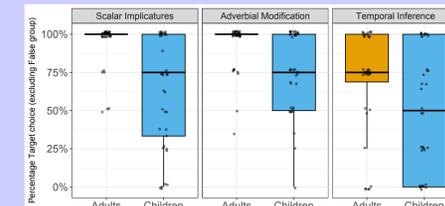


	Target Group	Literal Group	False Group
Literal meaning	True	True	False
Inference	True	False	False
TI (1)	in basket, then move	in basket throughout	never in basket
SI (4)	some on the bed, some not	all on the bed	none on the bed
AM (5)	jumped low	didn't jump	jumped high

## > Results



Percentages of each of the group selections for children and adults



Percent Target group selection against Literal group selection for individual participants

- Overall, adults systematically favoured the target group across all conditions, although more literal choices were observed for the temporal targets.
- The children performed well on controls (94% accuracy); on the temporal targets, they chose the Target group less often than adults ([Child vs. Adult]:  $z = -2.4, p = .02$ ).
- There was no interaction between Group and Target Type for the adverbial and temporal targets ([Child vs. Adult]  $\times$  [AM vs. TI]:  $z = -0.1, p = .92$ ), but the scalar implicature targets did show an increased difference between children and adults ([Child vs. Adult]  $\times$  [SI vs. TI]:  $z = -2.2, p = .02$ ).

## > Discussion

- In our paradigm, children computed more scalar implicatures than has typically been reported in truth-value judgment task studies. Children nevertheless computed fewer scalar implicatures than adults, in line with previous results in the literature.
- Children's performance on adverbial modifiers was more adult-like than their performance on scalar implicatures. This finding is in line with the RAH.
- In line with prediction (P), whilst both groups computed fewer temporal inferences than scalar implicatures overall, children were as adult-like on such inferences as on those of negated adverbial modifiers.
- Our results therefore support both the RAH and Thomas' theory of temporal inferences.

## > Conclusion

- We introduced a novel paradigm to investigate scalar and related inferences, and presented novel data on children's and adults' comprehension of inferences arising from adverbial modifiers and temporal inferences.
- Our findings are in line with proposed theories of these inferences, as well as with the RAH: children's performance was more adult-like for adverbial modifiers and temporal inferences than for classical scalar implicatures.
- The observed variability among different inferences in children and adults is also in line with previous results (van Tiel et al. 2016, Gotzner et al. 2017)

**Selected References:** Barner et al. (2011) Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference. *Cognition*, 118. Guasti et al. (2005) Why children and adults sometimes (but not always) compute implicatures. *Language and Cognitive Processes*, 20. Katzir (2007) *Structurally-defined alternatives*. *L&P*, 30. Magri (2009) *A Theory of Individual-Level Predicates Based on Blind Mandatory Implicatures*. Musan (1995) *On the Temporal Interpretation of Noun Phrases*. Tieu et al. (2016) Children's knowledge of free choice inferences and scalar implicatures. *Journal of Semantics*, 33. Thomas (2012) *Temporal Implicatures*.

**Acknowledgements:** We gratefully acknowledge Guillaume Thomas for helpful discussion and suggestions. This work was financially supported by the British Academy (small grant SG-153-238).