Compositional Semantics in Children

Introduction: Acquisition of semantics requires extracting the core semantics of the propositions from their use in the real world. This process goes in the opposite direction from compositional semantics, which derives the truth-value of propositions relative to a model by the application of logical and syntactic operations. In this study we compare responses of five-year-old children and adults on a truth-value judgment task in Hebrew with a partitive quantification *'xelek me-'* (1) and negation of the predicate (2):

(1) xelek me-ha-kadurim betox ha- misgarot
Some of the balls (are) inside the frames

(2) xelek me-ha-kadurim lo betox ha- misgarot
Some of the balls (are) not inside the frames

Partitive quantification introduces a scalar implicature relative to some denotations, and negation potentially reverses the truth value of the proposition. Previous studies show conflicting findings regarding the performance of five-year-old children on these semantic operations. Some studies found that five-year-old children fail to derive scalar implicatures (Noveck 2001), though later studies suggest that they merely show effects of extra processing cost (Pouscoulous et. al. 2007). For the interpretation of negation, some studies found that five-year-old children consistently interpret negation with narrow scope (Lidz and Musolino 2002) while others show that given a felicitous model, five-year-old children can interpret negation as taking scope over the proposition (Crain et. al. 1996).

Hypothesis: We suggest that the differences found between adult's responses and children's responses are due to different types of computations: while adults use syntactically driven computation, five-year-old children use pragmatically driven computation. We argue that five-year-old children can compute scalar implicatures, similarly to adults; however, unlike adults, their interpretation of negation is dependent on the context of the utterance.

Methods: A group of 41 children (age mean 5;06, 17 boys) participated in this study, and a group of 21 adults (age mean 32;03, 8 males). The truth-value judgment task consisted of a visual display of five rectangular frames on a white computer screen, and of five different objects which were manipulated to be either inside or outside the frames (Katsos et. al. 2012). We presented participants with a visual model for each proposition, and included two linguistic cues which affect truth-value computation: partitive quantification (1) and negation of the predicate (2). Three arrangements of objects and two types of target sentences were tested, resulting in a 3x2 design for each age group (see Table 1). Response measure is an average of correct truth-value assignment over 6 items for each target type.

Findings: A mixed model analysis found significant main effects for group (adults/ five-year-old children) $F(1,60) = 3.43 p<0.05$ and polarity (positive/negative) $F(1,60) = 4.19$ $p<0.05$. Our findings show that negation reduces correct responses in children and adults compared to true positive partitive (94% vs. 70% and 98% vs. 87%, respectively). An added cost was found for both children and adults for the scalar implicature, which affects the correct responses to positive partitive sentences with an ALL arrangement relative to the PARTIAL arrangement (62% vs. 71% and 83% vs. 98%, respectively). Yet, the most interesting finding in this experiment was in the negative partitive condition where the children showed no difference between the contexts, while for the adults the NONE context yielded the lowest percent of correct assignment of truth value (78%).

Discussion: The combined effect of a negative partitive with a NONE arrangement has on adults is predictable from the added cost of negation and computing a scalar implicature. However, the lack of a cumulative effect in the five-year-old group suggests that the computation process of five-year-old children is not based on hierarchical composition. This is supported by the similar correct response rate to all negative partitive, which is stable around 70%. Thus, we suggest that children approached this type of task differently from the adults. One possible explanation is that five-year-old children take the set of objects outside the frames as the reference set. If this is indeed the case, negation is interpreted as part of the predicate, with narrow scope. This finding is consistent with previous findings suggesting that negation is interpreted in its surface position (Lidz and Musolino 2002, Lidz et. al. 2004), as well as general theories for the effect of context on the way children tackle questions (Crain et. al. 1996, 2002). To conclude, these findings show that the apparent competence of five-year-old children at complex semantic relations, like integrating negation, computing scalar implicatures, and assignment of truth-value to propositions, relies on an alternative computation which based on their knowledge of the world.

Arrangement	Polarity	Truth-value
PARTIAL (2 objects inside the frames and 3 outside)	Positive (ex 1)	True
	Negative (ex 2)	True
NONE (all 5 objects outside the frames)	Positive	False
	Negative	True (with implicature)
ALL (all 5 objects inside the frames)	Positive	True (with implicature)
	Negative	False

Table 1. Layout of conditions for visual model; the same design was presented to each group (adults and five-year-old children).

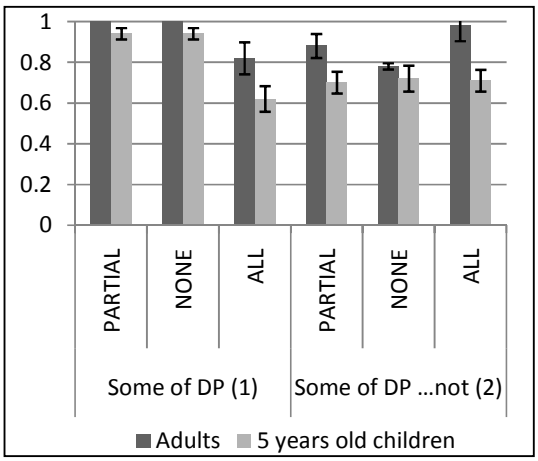

Figure 1. Mean percent of correct truth-value assignment for adults and five-year-old children; error bars denote standard error of the mean.

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