Plurality inferences are scalar implicatures: Evidence from acquisition

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Summary: This study offers novel experimental evidence for a scalar implicature (SI) approach to plurality inferences (PIs) in English. We investigated comprehension of plural morphology in both children and adults. The main findings were that both groups computed PIs significantly more often in upward-entailing (UE) than in downward-entailing (DE) environments, but children computed PIs significantly less often than adults did in UE environments. The findings are consistent with previous research demonstrating children's relative insensitivity to SIs.

Plurality inferences as scalar implicatures: The plural-singular distinction is the source of a long-standing puzzle (Sauerland 2003, Spector 2007, a.o.): (1-a) appears equivalent to (1-b) and different from (1-c), suggesting that English plural morphology is associated with a meaning like 'more than one' (Lasersohn, 1995, a.o.). Under negation, however, the expected "not more than one" meaning is absent; the negated plural in (2-a) is better paraphrased as the negation of a singularity, as in (2-c).

(1) a. Emily fed giraffes.
b. Emily fed more than one giraffe.
c. Emily fed a giraffe.

(2) a. Emily didn't feed giraffes.
b. Emily didn't feed more than one.
c. Emily didn't feed a (single) giraffe.

In response to this puzzle, an SI approach to plurals has been proposed. Spector (2007), in particular, argues that the plural and singular are equivalent and are both associated with a weak semantics, with PIs arising as a higher-order type of SI (see also Magri, to appear). On the SI approach, both the singular and the plural have the meaning in (3-a) (in a model with three giraffes, Jill, Mary, and Fran). The singular is typically compared to (3-b), yielding the SI in (4-a). By contrast, the plural is directly compared to the singular enriched with its SI (4-a). Once the enriched singular is negated, the PI is generated (4-b).

(3) a. $[\![\textbf{giraffes}]\!] = [\![\textbf{giraffe}]\!] = \{j, m, f, j \oplus m, j \oplus f, f \oplus m, j \oplus m \oplus f\}$
b. $[\![\textbf{more than one giraffe}]\!] = \{j \oplus m, j \oplus f, f \oplus m, j \oplus m \oplus f\}$

(4) a. $[\![\textbf{giraffe}]\!] \wedge \neg [\![\textbf{more than one giraffe}]\!] = \{j, m, f\}$
b. $[\![\textbf{giraffes}]\!] \wedge \neg([\![\textbf{giraffe}]\!] \wedge \neg [\![\textbf{more than one giraffe}]\!]) = \{j \oplus m, j \oplus f, f \oplus m, j \oplus m \oplus f\}$

Given that SIs are typically not derived when scalar terms appear in DE contexts, the SI approach predicts the pattern of interpretation observed in (1) and (2). Moreover, the SI approach can account for an additional reading of (2-a) that excludes singularity, namely that in (5) (typically read with emphasis on the plural *-s*); this involves postulating a local SI under the scope of negation.

(5) Emily didn't feed giraffes, because she fed only one!

The acquisition of plurality inferences: If PIs are derived as a kind of SI, the pattern of children's PIs is expected to mirror their performance with other SIs. Despite considerable variation in the reported rates of children's success with SIs (Chierchia et al., 2001; Gualmini et al., 2001, 2004; Papafragou & Musolino, 2003, a.o.), one consistent finding is that children compute SIs less than adults do. Against this background, Sauerland et al. (2005) tested 3-5-year-olds' computation of PIs in polar questions such as *Does a dog have tails?*, and found that children accepted these more often than adults did. As the authors (and Pearson et al. 2011) point out however, the study had some potential limitations: first, PIs typically disappear in polar questions, and, second, the stimuli involved generic interpretations, which could have been misinterpreted by children as containing dependent plurals, e.g., *Do dogs have tails*?

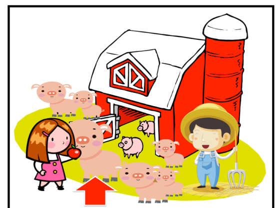
The experiment: To overcome these potential limitations, and to provide a clearer picture of the viability of the SI account, we used a Truth Value Judgment Task to assess subjects' interpretations of singular and plural sentences in both UE and DE environments.

Materials & Procedure: Subjects watched short stories on a laptop computer. Following each story, a puppet was asked a question about the story, and the subject's task was to judge the puppet's answers. We adopted a 2x2x2 design with three factors: group (adults vs. children), number (singular vs. plural - between subjects), and monotonicity (UE vs. DE - within subjects). 28 English-speaking children (4;01-5;09, Mean

= 4;11) and 43 adults participated. There were six test stories and eight controls. Three of the test stories were associated with a positive (plural or singular) sentence, and three with a negative (plural or singular) sentence. In a typical story, a main character executed an action on only one of a set of objects (see (i)-(ii)). For example, at a farm with a large group of pigs, Emily ultimately feeds only one (salient) pig. If participants in the plural condition computed the PI in the UE condition, they were expected to reject the sentence *Emily fed pigs*; in the DE condition, participants were expected to reject the sentence *Emily didn't feed pigs* (although they might accept it if they accessed a meaning like (5)). Both plural and singular test conditions also included two positive and two negative control items designed to elicit opposite target responses, e.g., positive plural sentences in contexts that satisfied the PI, and negative plural sentences in contexts that did not satisfy the PI. All participants also received four negation controls (e.g., *Sally didn't eat the apple*). Only participants who passed at least 6 of 8 controls were included in the analysis.

Results & Discussion: There were three main findings. First, in the plural condition children and adults computed PIs significantly more often in the UE than in the DE condition (Fig. 1). A two-way ANOVA on responses in the plural condition revealed a main effect of monotonicity ($F(1,68)=21.36$, $p<.001$) and of group ($F(1,68)=19.04$, $p<.001$), but no interaction. Second, a two-way ANOVA on the UE condition revealed a main effect of number ($F(1,67) = 197.79$, $p<.001$) and of group ($F(1,67)=24.89$, $p<.001$), as well as a significant interaction ($F(1,67)=24.44$, $p<.001$); both children and adults were significantly more accepting in the singular than in the plural condition (Fig. 2). Third, a two-way ANOVA on the DE condition revealed a main effect of number ($F(1,67) = 22.12$, $p<.001$), no effect of group, and no interactions (Fig. 3). The results indicate that children were adult-like in the singular condition, as well as the plural DE condition. In the plural UE condition, however (where PIs are expected), children differed significantly from adults. While adults computed PIs 92% of the time, children only did so 40% of the time. This finding is consistent with previous findings that children typically compute SIs less than adults do. Follow-up justifications were elicited from the adult-like children who rejected the positive plural statements. These justifications were consistent with the PI being computed. Finally, note that some proportion of adults (42%) and children (19%) in the plural DE condition appeared to access the interpretation in (5), made available by locally computing the PI in the scope of negation.

(i)

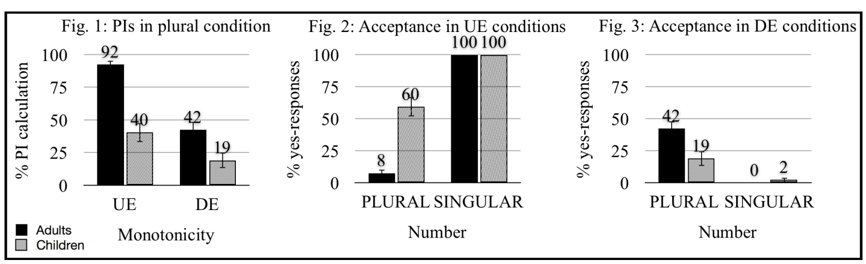


Plural test sentence: Emily fed pigs (target: NO)

(ii)

Plural test sentence: Emily didn't feed giraffes (target: NO)

Conclusion: All in all, these findings strongly support an SI-approach to PIs. The observed differences in behavior between children and adults are typical of previous SI findings. Moreover, the present study overcame some possible limitations of the previous study by Sauerland et al. 2005. Because we examined both UE and DE contexts, there is no clear way in which our stimuli could have been misinterpreted as involving dependent plurals.



Selected References • **Sauerland et al 2005**. The plural is semantically unmarked. • **Spector 2007**. Aspects of the pragmatics of plural morphology. • **Pearson et al 2011**. Even more evidence for the emptiness of plurality.