The Production-Comprehension Asymmetry Puzzle in the Acquisition of Scalar Implicatures

Introduction

A particular linguistic phenomenon, originally discussed by the philosopher Paul Grice (1975, 1989), is the focus of attention of formal semanticists (e.g., Chierchia, 2017) and cognitive and developmental psychologists (Noveck, 2001, 2018) alike: Scalar Implicature (SI) generation. Consider sentence (1). Despite the fact that the semantic meaning of *some* is simply lower-bounded (i.e., AT LEAST SOME), the most natural interpretation of (1) is (2). In (2), *some* is enriched with the negation of its stronger alternative *all* and, thus, receives also an upper bound.

(1) Sally gave Anne some of her dolls.

(2) Sally gave Anne some but not all of her dolls.

Interestingly, children have been found in a variety of comprehension tasks to struggle with SI generation (e.g., the inference from (1) to (2)). In other words, unlike adults, until at least the age of 5 or 6 (Foppolo et al., 2020), when hearing *some*, they tend not to derive the meaning SOME BUT NOT ALL (henceforth, simply, 'upper-bounded meaning' of *some*). Strikingly, some studies focusing on children's production further complicate the picture: in the corpus study of Eiteljoerge et al. (2018), analysis of the spontaneous production of 5 English children appears to suggest that, in their own speech, children use *some* with the upper-bounded meaning already from the age of 2;03. This finding is in line with elicitation studies that show that preschoolers can produce *some* with its upper-bounded meaning correctly, even when they still struggle in comprehension tasks with implicature generation (Foppolo & Guasti, 2005). Taken together, these results point to a production-comprehension asymmetry: the adult-like production of *some* (including the SOME BUT NOT ALL meaning) develops perhaps 3 years before the adult-like comprehension of *some*.

Constraints on Scalar Elements and the Emergence of *Some*-Implicatures

In this work, we show how children's difficulties in comprehension as well as children's unexpected success in production can be accounted for adopting the framework of Bidirectional Optimality Theory (Bi-OT). Bi-OT (Blutner, 1998, 2000; Hendriks et al., 2010) sees linguistic phenomena as emerging from the interaction between hierarchically-organized constraints. We argue that two constraints regulate SI generation. The first and most important one is a faithfulness constraint which we call FaithAll and which promotes maximal transparency between forms and meanings. The second constraint is based on Grice's first Maxim of Quantity ("Make your contribution as informative (strong) as possible", Matsumoto, 1995). We call this constraint Strength: "Use the strongest element on the Horn scale". In the case of the Horn scale <*some*, *all*>, this constraint prompts speakers to always prefer *all* (in the absence of conflicting constraints).

Given this two constraints and adopting Bi-OT, we can formalize the comprehension and the production of scalar elements as two separate processes (unidirectional optimization processes). The production process consists in a mapping between an input (i.e., the meaning the speaker wants to communicate) and an output (the optimal form), which is selected on the basis of the interacting constraints. Conversely, in comprehension, the input is a form and the output is a meaning. Importantly, the interaction between the constraints we formalized brings about different results in production and in comprehension. We can summarize the outcome of these processes as follows: in production, when speakers intend to select the upper-bounded meaning (SOME BUT NOT ALL) they have no choice but to choose the form *some* (using *all* would violate FaithAll). However, in comprehension *some* is simply ambiguous because it admits two meanings (one upper-bounded and one lower-bounded: none of the two violates FaithAll nor Strength). In order to disambiguate *some* (and select the upper-bounded meaning), a process of bidirectional optimization is necessary. In this type of process, the optimal output is a form-meaning pair. In other words, in bidirectional optimization, hearers consider also speakers' perspective: in the case at hand, they reason that there is only one situation in which the speaker can choose the form *some* in production, namely, to refer to the its upper-bounded meaning. Therefore, it is only when hearers carry out the bidirectional optimization process that scalar elements like *some* are interpreted in an adult-like way and the *some*-implicature can emerge.

A series of empirically-testable predictions (concerning also the role of individuals' cognitive abilities) arise from this approach. Notably, children's pattern of behavior (adult-like production but non-adult-like comprehension) can easily be explained in this framework if we assume that children can only optimize unidirectionally: unidirectional optimization suffices in production, but brings about an ambiguity in comprehension; this ambiguity can only be resolved by children when they learn to optimize bidirectionally (see Hendriks & Spenader, 2006, for similar claims).

Our proposal demonstrates the significance of formal tools such as the Bi-OT framework for our understanding of experimental data: viewing Bi-OT as cognitively plausible mechanism of online sentence processing allows us to account for the puzzling asymmetry between preschoolers' delayed comprehension and their adult-like production of scalar terms.

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