Cognition 153 (2016) 6–18

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Original Articles

Children's derivation of scalar implicatures: Alternatives and relevance

Dimitrios Skordos [a,*], Anna Papafragou [b]

[a] Department of Linguistics and Cognitive Science, University of Delaware, 125 E. Main Street, Newark, DE 19716, USA
[b] Department of Psychological and Brain Sciences, University of Delaware, 108 Wolf Hall, Newark, DE 19716, USA

ARTICLE INFO

Article history:
Received 30 June 2014
Revised 6 April 2016
Accepted 10 April 2016

Keywords:
Scalar implicature
Relevant alternatives
Pragmatic inference
Pragmatic development

ABSTRACT

Utterances such as "Megan ate some of the cupcakes" are often interpreted as "Megan ate *some* but *not all* of the cupcakes". Such an interpretation is thought to arise from a pragmatic inference called *scalar implicature* (SI). Preschoolers typically fail to spontaneously generate SIs without the assistance of training or context that make the stronger alternative salient. However, the exact role of alternatives in generating SIs remains contested. Specifically, it is not clear whether children have difficulty with spontaneously generating possible informationally stronger scalemates, or with considering how alternatives might be relevant. We present three studies with English-speaking 5-year-olds and adults designed to address these questions. We show that (a) the accessibility of the stronger alternative is important for children's SI generation (Experiment 1); (b) the explicit presence of the stronger alternative leads children to generate SIs only when the stronger scalar term can easily be seen as relevant (Experiment 2); and (c) in contexts that establish relevant alternatives, the explicit presence of the stronger alternative is not necessary (Experiment 3). We conclude that children's considerations of lexical alternatives during SI-computation include an important role for conversational relevance. We also show that this more nuanced approach to the role of lexical alternatives in pragmatic inference unifies previously unconnected findings about children's early pragmatic development and bears on major accounts proposed to date for children's problems with SIs.

1. Introduction

1.1. Scalar implicatures

Implicatures are components of speaker meaning that constitute an aspect of what is *meant* in a speaker's utterance without being part of what is *said*. A *scalar implicature* (SI) is a pragmatic inference triggered by certain lexical items such as quantifiers. Often, the use of a proposition containing a quantifier such as *some* is taken to implicate that another proposition containing a logically stronger quantifier (*all*) would not hold. For example, the statement in (2a) below can be used to implicate (2b).

(2) a. Megan ate some of the cupcakes.
b. Megan did not eat all of the cupcakes.

The term *scalar* comes from the fact that linguistic terms like *some* and *all* form an ordered set of alternatives (a *scale*) based on informational strength[1] (<*all*, …, *most*, *some*, >; Horn, 1972). Informational strength is based on asymmetrical logical entailment where a proposition containing the informationally stronger term (*all*) logically entails a proposition containing the weaker one (*some*) but not vice versa.

On this account, the quantifier *some* has lower-bounded semantics ('at least some and possibly all'; Horn, 1972). The upper-bounded meaning ('some but not all') corresponds to the scalar implicature and is therefore a pragmatic enrichment of the semantic content of the quantifier. The conclusion that the upper-bounded meaning is a pragmatic, not a semantic, contribution is further supported by the fact that this meaning can be explicitly canceled without logical contradiction ("Megan ate some of the cupcakes. In fact, she ate all of them"). Other logical scales are based on logical connectives (<*or*, *and*>) or modals (<*might*, *must*>).

* Corresponding author.
E-mail addresses: dskordos@udel.edu (D. Skordos), apapafragou@psych.udel.edu (A. Papafragou).

http://dx.doi.org/10.1016/j.cognition.2016.04.006
0010-0277/

[1] There are newer re-interpretations of the original notion of Horn scales (e.g., Geurts, 2010) that view scales as a way to restrict scalar alternatives to what is relevant. However, the original and still widely used Horn (1972) notion of scales had very little (if anything) to do with relevance: scales and scalars were purely based on informativeness/quantity, with an allowance perhaps for the Quality maxim (see Matsumoto, 1995 for detailed discussion).

For instance, the statements in (3a) and (4a) below can be taken to implicate (3b) and (4b) respectively.

(3) a. Megan ate a cupcake or a cookie.
b. Megan did not eat both a cupcake and a cookie.

(4) a. Bert might be in his lab.
b. It is not the case that Bert must be in his lab.

Scalar implicatures can also be derived from non-logical scales, based on contextual information (Hirschberg, 1985). In some sense the terms "scales" and "scalar" are actually a misnomer: As Hirschberg has convincingly shown (1985) any partially ordered set can give rise to SIs. For instance, the response in (5b) implicates that the action of changing the oil was not completed.

(5) a. Did you change the oil?
b. I opened the hood.

The first account of how scalar implicatures are derived was described by Paul Grice. He suggested that communication is a co-operative effort largely governed by rational expectations about how a conversation should proceed. These expectations were formalized as a number of principles or maxims that are thought to guide the inferences which hearers usually entertain when interpreting utterances (Grice, 1975). When these expectations seem to be violated, the assumption that this was done on purpose creates a variety of effects (see also Horn, 1972). For instance, in (2a), the speaker has violated the Quantity maxim that asks speakers to make their contribution as informative as is required by the current conversational purposes: *some* is the less informative term within the scale <*some*, *all*>. Thus the choice of the weaker term *some* is reason to believe that the speaker cannot commit to an informationally stronger statement ("Megan ate all of the cupcakes."). Therefore, the stronger statement does not hold, thus (2b).

1.2. How children calculate SIs

The psycholinguistic literature has shown that adults are very adept at deriving scalar inferences (e.g., Bott, Bailey, & Grodner, 2012; Breheny, Ferguson, & Katsos, 2013; Breheny, Katsos, & Williams, 2006; Huang & Snedeker, 2009a). Young children, however, seem to face difficulties. For instance, Noveck (2001) showed that French speakers between the ages of 5 and 10 interpreted the French existential quantifier *certains* ("some") in statements such as "Some giraffes have long necks" as compatible with *tous* ("all"), while adults were equivocal between the logical and the pragmatic interpretations. Similarly, in another study, Greek-speaking 5-year-olds, unlike adults, accepted statements such as "Some of the horses jumped over the fence" as descriptions of story outcomes where *all* of the horses in the scene jumped over the fence (Papafragou & Musolino, 2003).

Subsequent studies have replicated and confirmed the finding that children typically display non-adult behavior when interpreting scalar statements (Feeney, Scrafton, Duckworth, & Handley, 2004; Foppolo, Guasti, & Chierchia, 2012; Guasti et al., 2005; Katsos & Bishop, 2011; cf. also Braine & Rumain, 1981; Smith, 1980). Importantly, children's difficulties emerge even in studies that used eye movement measures, as opposed to overt pragmatic judgments, to gain insight into comprehension (Huang & Snedeker, 2009b). Furthermore, a variety of factors seems to affect children's success with scalar implicatures. These include training in detecting pragmatic infelicity and/or a strong supporting context (Foppolo et al., 2012; Guasti et al., 2005; Papafragou & Musolino, 2003; Papafragou & Tantalou, 2004); the type of scale (logical vs. ad hoc; Barner, Brooks, & Bale, 2011; Stiller, Goodman, & Frank, 2015) and scalar item (number vs. quantifier; Papafragou, 2006; Papafragou & Musolino, 2003); and the type of response children have to provide (Katsos & Bishop, 2011; Pouscoulous, Noveck, Politzer, & Bastide, 2007; see Papafragou & Skordos, 2016, for a review).

Several strands of evidence suggest that part of children's problem with SIs lies in generating scalar alternatives when faced with a weak scalar term. In early studies that examined the interpretation of the disjunction operator *or* (Chierchia, Crain, Guasti, Gualmini, & Meroni, 2001; Gualmini, Crain, Meroni, Chierchia, & Guasti, 2001), adults were shown to be sensitive to the scalar implicature from the use of disjunction: when faced with statements like "Every boy chose a skateboard or a bike" to describe the outcome of a story, adults tended to interpret the statement as meaning 'Every boy chose either a skateboard or a bike'. However, 3–5-year-old children seemed oblivious to this pragmatic interpretation and treated *or* as being compatible with the stronger term *and*. In a follow-up task, however, children were presented with two statements and they overwhelmingly preferred stronger/more informative statement with *and* ("Every farmer cleaned a horse and a rabbit") over the weaker/less informative statement with *or* ("Every farmer cleaned a horse or a rabbit") when the story made the stronger statement true. Thus children could compare alternatives to a weak scalar term and assess their relative informativeness when these alternatives were explicitly presented to them but did not seem to independently access those scalar alternatives and use them to compute implicatures (see also Ozturk & Papafragou, 2015, for similar results with epistemic modals such as *may* and *have to*).

A study by Barner et al. (2011) offers further evidence for the role of the accessibility of unspoken lexical alternatives on children's SI calculation. Barner et al. tested 4-year-old children in a task that involved answering questions about a group of three animals. In critical trials, all three animals (a dog, a cat and a cow) were sleeping and children were asked whether "...some/only some of the animals are sleeping". Children responded affirmatively about 66% of the time even to the question with *only some*. This was taken to indicate that children have difficulty generating scalar alternatives even when this is predicted to be triggered by the grammar (*only* is a focus element requiring the generation and negation of appropriate alternatives). However when a different group of children were simply asked whether "the cat and the dog are sleeping", children accurately responded with an affirmative answer 93% of the time. More importantly, when asked whether "only the cat and the dog are sleeping", children correctly gave *No*-responses 86% of the time. Barner et al. (2011) interpreted these findings as strong evidence that children's problem with SIs lies mainly in realizing what terms can come together to form a scale: when scalemates are explicitly provided (e.g., when the experimenter listed the animals that were supposed to be sleeping), children's generation of SIs improved significantly.

Even though these studies suggest that the accessibility of scalar alternatives contributes to children's difficulties with SIs, the precise role and potency of lexical alternatives in the derivation of SIs at present remain open. One issue is that children's apparent insensitivity to SIs has been found even in contexts that should make stronger scalar alternatives highly accessible. For instance, in Noveck's (2001) judgment study, the critical true but infelicitous *some*-statements (e.g., "Some giraffes have long necks") were embedded within a larger battery of statements that also included other types of *some* statements and a variety of *all* statements (e.g., "All elephants have trunks"): even though this paradigm presumably made the stronger scalar alternatives accessible, children did not seem to benefit from the presence of the stronger term. In another study, when 5-year-olds were asked to evaluate an underinformative *some*-statement accompanying a story (e.g., "Some