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Scalar implicatures in language acquisition: Some evidence from Modern Greek

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1 Introduction

Scalar implicatures typically arise in examples such as the following:

(1) Some of the students passed the exam.
→ Not all of the students passed the exam.
(2) You can choose an apple or an orange.
→ You cannot choose both an apple and an orange.
(3) It is possible that she'll win.
→ It's not necessary that she'll win.

According to the standard analysis, quantifiers such as < *all, some* >, connectives such as < *and, or* >, modals such as < *necessary, possible* > and a host of other expressions form *informational scales* (Horn, 1972). In the canonical case, informational scales are defined on the basis of entailment (e.g. *p and q* asymmetrically entails *p or q*). Given the Gricean assumption that speakers try to say as much as they truthfully can that is relevant to the conversational exchange, the fact that an informationally weaker term was used in (1)-(3) often gives the listener reason to think that the speaker was not in a position to offer a stronger statement (presumably because such a statement would be false). Thus, even though weak scalar expressions such as *some* and *or* have a lower-bounded semantics (for instance *some* means 'some and possibly all'), their semantic content is typically upper-bounded by a conversational implicature (e.g. 'some but not all').

More recently, the precise mechanisms responsible for the computation of scalar implicatures (SIs) have become the topic of much debate. There is considerable disagreement as to whether SIs are derived on the basis of broadly Gricean quantity considerations, as the traditional account would have it, or post-Gricean relevance-oriented computations, whether they are the result of local or global calculations, and whether they are context-specific or generalized, default inferences (for varying perspectives, see Hirschberg, 1985; Sperber and Wilson, 1986/1995; Grice, 1989; Carston, 1990, 1998; Horn, 1992; Levinson, 2000; Chierchia, 2001). In several cases, SIs have been used to motivate and illustrate very different views of the architecture of the semantics-pragmatics interface.

Despite their prominent place in the theoretical linguistic literature, scalar inferences have attracted relatively little attention in psycholinguistics. Some older work has demonstrated that scalar inferences of the sort exemplified above appear regularly during utterance comprehension in adults (Newstead, 1995; cf. Noveck, 2001). More recently, it has been suggested that children, unlike adults,

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do not regularly compute SIs. According to Chierchia, Crain, Guasti, Gualmini and Meroni (2001), and Gualmini, Crain, Meroni, Chierchia and Guasti (2001), preschoolers fail to derive SIs from the use of disjunction. These researchers used a variation of the truth-value judgment task (Crain and McKee, 1985), in which children first watch a story acted out in front of them and then hear a puppet describe what happened in the story. The children's task is to say whether they agree with the puppet's description or not. In the case at hand, the puppet offered true but inappropriate descriptions of the story (using a weaker scalar term when a 'stronger' term would have been true and appropriate). For instance, children heard the statement 'Every boy chose a skate-board or a bike' in a situation where each one of a set of four boys had chosen both a skate-board and a bike to play with. It was found that children failed to reject this description of the experimental scenario and to give their own corrected version of the story (using *and*). In a related set of studies, and using a similar method, Noveck (2001) found that young children fail with SIs triggered by modal verbs and quantifiers. This behavior has been interpreted as an indication that children go through a stage during which they do not attend to pragmatically derived aspects of meaning but only to semantically encoded content; in the words of Noveck (2001: 165), children in this respect appear to be 'more logical than adults'.

Despite their non-adult behavior in these tasks, preschoolers seem to know something about the semantic-pragmatic status of scalar expressions. As Chierchia et al. (2001) went on to show, if given the choice between *or* and *and* ('Every farmer cleaned a horse or a rabbit' vs. 'Every farmer cleaned a horse and a rabbit'), children correctly pick *and* as the most appropriate expression to be used in a context where both a horse and a rabbit were cleaned by the story characters. More recently, using data from Modern Greek, Papafragou and Musolino (2002) showed that if the task demands are clear and include salient expectations of cognitive gains built around the stronger term of the scale, preschoolers' ability to derive SIs improves considerably. For instance, in a scenario where a character sets out to bring back three missing horses and succeeds in doing so, children overwhelmingly reject the statement 'He brought back two of the horses' as a description of the story outcome. The study also showed that specific scalar expressions behave differently during language acquisition: preschool children were more successful with the pragmatics of number terms than with other scalar expressions such as quantifiers ('some') or aspectual verbs ('start').[1] Overall, the authors concluded that children are not completely insensitive to implicated aspects of content but their sensitivity depends on a complex interplay of contextual factors and expectations of cognitive gains.

The acquisition of the ability to derive conversational implicatures, and scalar implicatures more specifically, is of great interest to both developmental and theoretical pragmatic work. Some of the most pressing questions in this area concern the nature of early pragmatic inferences, their systematicity and robustness. Other questions relate to the precise mechanisms whereby such

inferences are computed. In this paper, I would like to contribute to the study of early scalar inferences by focusing on a sub-category of scalar terms: aspectual verbs such as *start* and *finish* and degree modifiers such as *half*. Aspectual/degree expressions typically give rise to non-completion SIs, as shown in examples (4)-(6) below:

(4) I started eating the cake.
→ I didn't finish eating the cake.
(5) I began eating the cake.
→ I didn't finish eating the cake.
(6) I ate half of the cake.
→ I didn't eat all of the cake.

I present here experimental results from the acquisition of the scalar pragmatics of aspectual/degree expressions, using data from Modern Greek. Specifically, I compare children's and adults' derivation of non-completion inferences from *arxizo* ('start'), *ksekino* ('begin') and *miso* ('half'). My goals are, first, to offer some further data on the development of scalar inferences in children, and second, to compare the behavior of different scalar expressions at early stages of the development of the semantics-pragmatics interface. As it turns out, developmental asymmetries within the scalar class have the potential of revealing interesting theoretical differences among scalar expressions.

2 Experiment: Deriving SIs

2.1 Method

2.1.1 Participants

Participants in this study were a group of 30 Greek-speaking 5-year-olds between the ages of 4;10 and 5;11 (mean 5;6) and a group of 30 adult native speakers of Greek. Children participants were recruited from a daycare in Athens, Greece. The adult speakers were also recruited from the Athens area.

2.1.2 Materials and procedure

The present study used a pragmatic judgment task in order to tap into children's comprehension of scalar inference. The method is a variation of the truth value judgment task which was first used in Papafragou and Musolino (2002). The main phase of the experiment was preceded by a training phase which aimed at making children familiar with the task of detecting pragmatic infelicity. Children were presented with a puppet, Minnie. Minnie would be shown some acted-out stories and then she would be asked what happened in the story. Children were told that Minnie sometimes said 'silly things' and that the child should help her 'say things better'. In one of the training scenes, Minnie was shown a spoon and asked what it was. She described the object as 'something we use for eating'. When asked

whether Minnie answered well, children were expected to correct this truth-conditionally accurate but pragmatically infelicitous statement. Whenever they failed to do so, the experimenter finally corrected Minnie and offered a more appropriate description of the object ('Minnie didn't say that very well. This is a SPOON'). The training phase included two truth-conditionally correct but pragmatically inappropriate descriptions and two descriptions which were both correct and appropriate. This was to make sure that children didn't develop a bias for assuming that Minnie always said silly things.

In the main part of the experiment, children were shown a set of four test stories and four control stories. Each test story satisfied the truth conditions of an informationally stronger element within an aspectual/degree scale but was described by Minnie in terms of a weaker element from that scale. For instance, in one of the test stories, a tiger watched a lion while the lion lifted two heavy blocks and put them on top of each other to build a tower. The lion boasted that only he could build such a big tower, since he was the strongest animal. He said that the tiger could never do the same since he was younger and weaker. Nevertheless, the tiger wanted to try building a tower, too. At the end of the story, and after some effort, the tiger managed to build the tower. When asked how the little tiger did, Minnie offered a statement such as the following:

(7) To tigraki arxise na xtizi ton pirgo.
Det-tiger-dimin started to-build det-tower.
'The little tiger started building the tower'.

(8) To tigraki ksekinise na xtizi ton pirgo.
Det-tiger-dimin began to-build det-tower.
'The little tiger began building the tower'.

(9) To tigraki extise to miso pirgo.
Det-tiger-dimin built det-half tower.
'The little tiger built half the tower'.

After hearing Minnie's statement, children were asked whether Minnie had 'answered well'. In case they responded 'Yes', no further questions were asked. In case they responded 'No', children were asked whether we can 'say it better'. It was expected that, if children are pragmatically savvy, they should reject statements such as (7)-(9) as descriptions of the story and offer utterances such as (10)-(11) as improved ways of describing what happened:

(10) To tigraki extise ton pirgo.
Det-tiger-dimin built det-tower.
'The little tiger built the tower'.

(11) To tigraki teliose ton pirgo.
Det-tiger-dimin finished det-tower.
'The little tiger finished the tower'.

Children were randomly assigned to one of the three proportional expressions, *arxizo*, *ksekino*, and *miso*. All test stories were identical across all conditions: for instance, children in all conditions saw the tower-building scene as described above. What differed across conditions were the critical statements used to describe these stories. The purpose of this step was to ensure that, other things being equal, any differences among conditions should be attributable only to aspects of the semantics-pragmatics of individual scalar terms.

Control items (which were identical across conditions) also involved two characters engaged in some sort of contest. They were always correctly (and felicitously) described by Minnie and never involved the use of scalar terms. For instance, in one of the fillers a red and a green frog were chasing a squid. The red frog with a giant leap caught the squid. Minnie's description was: 'The red frog caught the squid'. It was expected that children should find no difficulty accepting all control statements as good answers. The test stories and the control stories were administered in a pseudo-random order. Within each condition, order of presentation was counterbalanced.

Adult participants were randomly assigned to one of the three conditions in a modified version of the same task. They were given a leaflet which contained in written form the instructions verbally given to the children. For the warm-ups, the control and critical trials, adults read a description of the stories which did not contain any scalar items and which did not specify the ending. For instance, for the tower-building story, adults read the following description (translated from Greek):

(12) A tiger and a lion are playing with two building blocks. The lion boasts that he can put one on top of the other and build a tower and shows the tiger how to do this. However, he says that the tiger probably can't do the same because he is younger and weaker. Nevertheless, the tiger wants to try for himself. He takes the blocks one by one and the story ends as shown in picture {number of picture provided}.

To see how the story ended, adults had to consult a digital photograph in the booklet which showed the outcome of the event (e.g. the tiger next to a completed tower). Participants then read Minnie's statement and had to answer the same questions as the children did ('Did Minnie answer well? If not, can we say it better?') by filling in their answers in the space provided. It was expected that adults would overwhelmingly correct the puppet's statements on all critical trials.

2.2 Results

Beginning with test trials, it was found that adult subjects overwhelmingly rejected the puppet's statements in all three conditions (95% of the time for 'start', 97.5% of the time for 'begin', and 95% of the time for 'half'). By contrast, it was found that 5-year-olds rejected the puppet's statements in the critical trials about

one-third of the time (32% of rejections for ‘start’, 37% for ‘begin’), with the exception of ‘half’ (where 67% of the answers were rejections).

On the control items, adults gave correct answers 70% of the time for ‘start’, 82.5% of the time for ‘begin’, and 97.5% of the time for ‘half’. On the same items, children gave correct responses 97.5% of the time in the ‘start’ condition, 87.5% of the time in the ‘begin’ condition, and 100% in the ‘half’ condition.

Recall that, in case they rejected Minnie's statement, subjects had to offer an improved version of her utterance. This gave the opportunity to participants to justify their rejection of the puppet's utterance by providing their own description of the outcome of the story. It was expected that adults would not only reject Minnie's underinformative statements on the critical trials but also go on to reformulate her descriptions using a stronger (more informative) term - cf. (10)-(11). This expectation was borne out: all corrections provided by adult subjects were of this sort.

Unlike adults, 5-year-old children generally accepted Minnie's statements containing aspectual expressions (even though not ‘half’). In those cases where children did reject the puppet's statement, they did so for the right reason, since their corrections invoked a more informative item than the one used by Minnie. Such adult-like corrections accounted for all of the children's corrections across the three conditions.

2.3 Discussion

The experiment reported above offers evidence that adults regularly compute scalar inferences during language comprehension. Using data from Modern Greek, the study shows that adults readily draw non-completion inferences from aspectual verbs such as ‘start’ and ‘begin’ and proportional modifiers such as ‘half’ in contexts which support such inferences. By contrast, 5-year-olds mostly fail to compute scalar inferences of non-completion triggered by aspectual verbs in the same contexts; however, they are above chance at non-completion inferences triggered by the proportional modifier ‘half’. The present results confirm and empirically extend what is now becoming a robust finding in the literature: even though SIs surface regularly in adult utterance comprehension, they are not derived consistently by young children.

An interesting observation which emerges from the pattern of present results is that children’s (and adults’) treatment of SIs conforms to the Gricean non-detachability requirement. Recall that one of the basic properties of conversational implicature is persistence across synonyms (with the exception of Manner implicatures); the idea is that conversational implicatures are attached to the content and not the form of specific linguistic expressions and hence cannot be removed if one expression is substituted by a synonym in the same context. In our examples, ‘start’ (*arxizo*) and ‘begin’ (*ksekino*), being synonyms (with more or less the same frequency and register), would be expected to give rise to SIs in roughly parallel ways. This expectation is borne out for both children and adults,

even though in different ways (adults are at ceiling for all scalar expressions used, while children have low success rates for both aspectual verbs).[2]

Perhaps the most interesting finding of the present study is the asymmetry between aspectual verbs such as 'start' and the degree modifier 'half' in terms of children's sensitivity to their scalar pragmatic profile. This asymmetry shows that children's success with scalar pragmatics crucially depends on the interplay between the semantics of individual scalar expressions and the context of the experimental scenario. I consider the asymmetry (and some possible explanations for it) in detail in the General Discussion section. Before doing that, however, I want to address a possible hypothesis about the source of difficulty with non-completion inferences from aspectual verbs: one might argue that preschool children have not mastered the scalar semantics of inchoative verbs (but have already acquired the scalar structure of the modifier 'half'). If so, difficulties with certain interpretations of aspectual verbs would stem from semantic, rather than pragmatic, problems. In order to address this possibility, it is useful to consider whether the difference between aspectual verbs and 'half' disappears in contexts where the scalar implicature is canceled. A control task was designed in order to test for children's knowledge of the 'bare' semantic content of scalar expressions in environments which do not support SIs.

3 A control task: Canceling SIs

3.1 Method

3.1.1 Participants

A group of 30 Greek-speaking preschoolers (age range: 4;4-5;11, mean age: 5;6) participated in this task. Children were recruited from the same Athens daycare as in the main study.

3.1.2 Materials and procedure

Participants were told that they would see a drawing competition. Four animals participated in the competition: a lion, a bear, a giraffe and a horse. Each animal was given a sheet of paper and a pencil and was informed of the terms of the competition by one of the following statements:

(13) Whoever starts drawing a star gets a prize.
(14) Whoever begins drawing a star gets a prize.
(15) Whoever draws half a star gets a prize.

At the end of the contest, each of the animals produced something different: the lion drew a star; the bear drew a circle; the giraffe drew half a star; and the horse drew nothing. Children, after being briefly reminded what the condition for winning a prize was, had to determine for each animal whether it gets a prize or not.

The environments in (13)-(15) are contexts where the non-completion SIs typically carried by aspectual/degree terms are canceled. Intuitively, in all conditions, a prize should be awarded to both the animal which started drawing a star (and ended up drawing half of it) and to the one which produced a whole star: the first action corresponds to the semantic content of the scalar expressions, the second is compatible with this semantic content. It was expected that, if children could assign the correct scalar semantics to all three expressions (the Greek equivalents of 'start', 'begin' and 'half'), they would be able to pick the correct two animals as winners of the contest and noone else. This should happen regardless of whether children of this age can recognize the pragmatic (SI-triggering) potential of scalar expressions. It is worth pointing out that several features of the experimental set-up leave open the possibility that the contest will have multiple winners. For instance, the experimental scene includes many more prizes than contestants. Furthermore, the formulation of the terms of the contest ('Whoever…') clearly allows for the presence of more than one winner.

Children were randomly assigned to three groups so that there were ten children per group. Each group received one scalar term ('start', 'begin' or 'half') in a one-trial task.

3.2 Results and discussion

Across groups, children correctly awarded a prize to the animal which drew the target object 92.5% of the time and to the animal which drew half of the target object 97.5% of the time. Children also rightly refused to give a prize to the animal which drew an irrelevant object 90% of the time and to the animal which drew nothing at all 95% of the time. Overall, 85% of the children gave errorless responses, i.e. (a) they awarded a prize to both the animal which drew a star and to the animal which drew half of the star, and (b) they didn't give a prize to anyone else. Errorless performance was observed on 90% of the responses in the *ksekino* ('begin') group, 80% of the responses in the *arxizo* ('start') group, and 80% of the responses in the *miso* ('half') group.

These results clearly demonstrate that children are able to assign a lower-bounded interpretation to both aspectual verbs and the degree modifier 'half' in contexts in which the upper-bounding reading is not warranted. Specifically, in appropriate contexts, children can suspend SIs which have been shown to be within their computational capacity (e.g. the inference from 'half' to 'not all'). In such contexts, children attend to the semantic content of scalar expressions (e.g. 'start and possibly finish' for 'start', 'half and possibly all' for 'half'). This task shows minimally that the differences between individual scalar expressions observed in the main study cannot be straightforwardly attributed to children's insufficient grasp of scalar semantics.

4 General discussion

The experimental results reported in this paper add to recent attempts to investigate the acquisition of scalar implicature experimentally (Chierchia et al.,

2001; Gualmini et al., 2001; Noveck, 2001; Papafragou and Musolino, 2002). Using data from Modern Greek, it was shown that preschoolers, even though they understand the basic scalar structure of a range of proportional expressions such as *arxizo* ('start'), *ksekino* ('begin') and *miso* ('half'), consistently derive non-completion inferences only from the degree modifier *miso*. Adults, by contrast, are sensitive to such inferences for all three scalar terms.

An obvious question raised by this research concerns the source of the asymmetry between the pragmatic behavior of aspectual verbs and the degree modifier 'half'. One possible explanation lies with the fact that aspectual verbs such as 'start' or 'begin' are inherently vague, so the conditions of their appropriate use may not be immediately obvious to young language learners. Consider some of the problems in determining the starting point for even the simplest action or process: when can I say that I have started reading a book? Perhaps not after having simply picked it up with the intention of reading it. What about after having glanced at the contents? After having read the first word? The first sentence? The indeterminacy of the applicability of inchoative predicates may be at least partly responsible for children's failures with some pragmatic aspects of their interpretation.[3]

There is a second line of explanation for the asymmetry which is worth exploring in some detail. Notice that the contrast between the indeterminate aspectual verbs and the degree modifier 'half' closely parallels the difference between aspectual verbs and numbers discovered in some earlier work by Papafragou and Musolino (2002). As I mentioned in the Introduction, that study, using the same method as the present work, found that children were much more successful with SIs triggered by number terms than with SIs prompted by the use of the verb 'start' (*arxizo*) or by vague quantifiers such as 'some' (*meriki*). Interestingly, this difference is predicted by recent proposals which treat numbers differently from the class of semantically lower-bounded scalar expressions. In the remainder of this section, I want to outline these proposals and argue that they naturally extend to the case of degree modifiers such as 'half'.

There are several reasons for assuming that numbers are discrete (i.e. have an 'exact' rather than an 'at least' semantics) and that they acquire a range of interpretations through some process of pragmatic adjustment of their semantic content.[4] As Carston (1990, 1998) and Horn (1992) among others have argued, when inspected closely, the cardinals turn our to be very different from other classic examples of scalar terms such as quantifiers. As (16) shows, numbers allow 'at most' interpretations, which are unavailable for closely related scalar expressions such as *some*:

(16) You can have three cookies.

Similarly, in incorporation, numbers clearly have an 'exact', not an 'at least', reading: a four-sided figure has exactly four sides, and a four-seat plane has exactly four seats. Furthermore, numbers in mathematical statements are always

assigned an 'exact' interpretation. For these, and related reasons, it is reasonable to assume that the cardinals are different from other scalar expressions for which a 'minimalist' ('at least') semantics is plausible.

The same reasons extend straightforwardly to the case of 'half'. Example (17) is the counterpart to (16) and shows that the degree modifier can readily accept 'at most' interpretations:

(17) You can have half of my chocolate.

Cases of incorporation work very similarly: a *half-cooked stew* has been cooked halfway and a *half-painted fence* cannot be a fence that has been painted completely. And 'half' interpreted as a fraction in mathematical statements always has an 'exact' interpretation. In sum, just like the cardinals, and unlike other scalar expressions, 'half' seems to have an 'exact' semantics.

This view of 'half' has a number of advantages over the minimalist approach. First, it offers an attractive explanation for the fact that 'half', just like the cardinals, is particularly useful in approximations. In this sense, 'half' resembles geometric expressions (e.g. *square, round*) which, although precisely definable, are frequently used loosely to refer to objects which normally fall outside their definitional range (cf. *a square face*; Sperber and Wilson, 1986). Second, the proposed semantics for 'half' squares well with a series of experimental findings which show that early proportional reasoning makes heavy use of the 'half' boundary (Spinillo and Bryant, 1999; Singer-Freeman and Goswami, 2001). Finally, this semantic view offers natural links to theories of numerical and mathematical cognition and of their development, which tacitly assume that cardinals (and 'half') are discrete (Gelman and Gallistel, 1978; Gelman, 1993).

If this line of argument is correct, it follows that non-completion inferences from the use of 'half' (and the cardinals) are not derived pragmatically from a lower-bounded semantics – and hence children's successes with discrete (numerical, degree, etc.) modifiers does not rely on the computation of scalar implicatures of the standard sort at all. This view makes the interesting prediction that young children should be better at judgment tasks of the sort used in the present study when the judgments involve discrete expressions such as 'half of x' rather than non-discrete expressions such as 'part of x', even when the experimental materials are otherwise identical. Moreover, this view predicts that the discrete/non-discrete asymmetry should also surface in the acquisition of aspectual adverbials such as 'halfway' vs. 'partway'. These predictions are currently being experimentally tested (Papafragou, in prep.).

Numerical and degree modifiers present an interesting case where developmental data can offer additional support for a certain semantic-pragmatic analysis. They also open up an area where semantic, pragmatic and developmental theories can make contact and interact in mutually informative ways. More generally, scalar expressions bring into the foreground important

issues about the architecture of the developing semantics-pragmatics interface. To the extent that young children have difficulty in using and co-ordinating contextual cues and communicative expectations to derive conversational inferences (as in the aspectual verb cases), we need to explain what sort of change takes place in order for them to achieve adult-like pragmatic sophistication. Relatedly, given the richness of the theoretical machinery developed to account for the computation of scalar inferences by mature interlocutors, it would be interesting to see how the developmental data fit into current competing theories of conversational implicature.

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Notes

1. I use scare quotes in glosses of Modern Greek scalar terms and italics for English scalar terms mentioned in the text.
2. It is not clear that non-detachability is a general property of implicatures in child language. Using the same method as the present experiment, Papafragou (in press) found that Greek *mexri ti mesi* ('up to midpoint'/'halfway') yielded much lower success rates with 5-year-olds than 'half' (and was, in fact, more similar to the 'start/begin' pair). Noveck (2001) reports that 7- and 9-year-olds are more successful with the scalar inferences triggered by *might* than with those prompted by the closely related modal *could*. I refer the reader to those papers for further discussion.
3. Other facts further complicate the conditions of appropriateness for aspectual verbs such as 'start'. Some members of the CLS audience, for instance, felt that 'start' is often used when reaching the endpoint/completing an action is not excluded but is, in fact, expected (since in several quite ordinary circumstances actions are carried through in the normal course of events). It would be interesting to check whether it is true that inchoative verbs give rise to SIs less systematically than other scalar terms.
4. Alternatively, the cardinals may be underspecified between an 'exact', an 'at least' and an 'at most' reading (or even ambiguous among the three); for discussion, see Carston (1990, 1998) and references therein.

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