Children's Acquisition of Epistemic Modality

Anna Papafragou and Ozge Ozturk
University of Delaware

1   Introduction

This paper is concerned with the acquisition of certain aspects of the meaning of epistemic modal verbs. Epistemic modals encode the probability, predictability or certainty of the proposition embedded under the modal verb. The sentences in (1) are examples of epistemic modality[1]:

(1)   a.   It has to rain in the afternoon.
        b.   It may rain in the afternoon.

On the semantic level, epistemic modal operators encode modal force (necessity or possibility) and get interpreted against a conversational background which is a function from possible worlds into sets of propositions. In the case of epistemic modality, the conversational background is given by the speaker's beliefs or the available evidence. Necessity in a given world encodes truth in all alternative possible worlds, whereas possibility encodes truth in at least one alternative possible world (Hintikka, 1969; Kratzer, 1981, 1991; von Fintel and Gillies, 2004).

On the pragmatic level, epistemic modal verbs typically give rise to *scalar implicatures*. Notice that (1b), even though logically compatible with (1a), typically excludes (1a) in conversation – hence it implicates (2):

(2)   It does not have to rain in the afternoon.

According to the standard analysis, modal terms are ordered in terms of informational strength so that they form a scale (Grice, 1989; Horn, 1972). According to this analysis, a statement with a relatively stronger term entails a statement with a relatively weaker term. Hence, (1a) entails (1b) but not vice versa. Why did the speaker use a weaker modal when a stronger modal was available (and presumably relevant)? Recall that according to Grice (1989), "our talk exchanges do not normally consist of a succession of disconnected remarks, and would not be rational if they did. They are characteristically, to some degree at least, cooperative efforts…". According to Grice's Quantity Maxim, participants in a conversational exchange should make their contribution as informative as is required (for the current purposes of the exchange). The listener, upon hearing (1b), is entitled to reason as follows (cf. Horn, 1972):

> 1. The speaker chose a relatively weaker term (1b) from an ordered scale *<have to/must, … , may>*.
> 2. The statement containing the stronger term would have been more informative and relevant.
> 3. The speaker is trying to be a cooperative conversational partner.
> 4. The reason why the speaker chose a weaker term must be that she is not in a position to offer a stronger statement.
> 5. The stronger statement (1a) does not hold.
> 6. Hence, the scalar implicature given in (2) arises.

In order for the child to acquire epistemic modal terms, she needs to acquire both the semantic aspects of modal meaning (including the notions of possibility and necessity) and the pragmatic inferences associated with modal expressions. Elsewhere we have presented evidence showing that, by the age of five, English-speaking children have acquired the semantics of epistemic possibility and necessity (Papafragou and Ozturk, in press). Here we address the processes underlying the acquisition of the pragmatics of epistemic modality. We know that younger children have difficulty computing conversational implicatures, especially of the scalar type (Noveck, 2001; Chierchia, Crain, Guasti, Gualmini and Meroni,

---

[1] These need to be distinguished from instances of deontic modality which indicate necessity or possibility of actions, e.g. obligation and permission (*I <u>must</u> see the doctor tomorrow, The students <u>may</u> leave the classroom after submitting their papers*).

2001; Papafragou and Musolino, 2003; and Section 2 below); in particular, they seem to treat statements with epistemic modal terms logically and not pragmatically. This suggests that, even after the acquisition of modal semantics, children may have trouble understanding conversational inferences from the use of modality. These prior findings raise a host of questions: Do children first treat epistemic modal verbs semantically? That is, do they interpret these verbs only according to their lexical meanings without making any inferences based on what is said? If so, how do they ever incorporate the pragmatic interpretations into their general understanding of epistemic modality and start constructing interpretations based on what the speaker meant to communicate? Our goal in this paper is to shed light on these questions by experimentally investigating knowledge of the pragmatic properties of epistemic modality in five-year-old children.

To preface the experimental part of the paper, in the next section, we give a quick review of studies conducted specifically to test children's understanding of the pragmatic aspects of modality, especially the relative strength of epistemic modals (i.e., their position on the modal scale and the corresponding degree of speaker certainty for the embedded proposition).

2   Background: The acquisition of epistemic modality

A number of experimental studies focusing on the acquisition of epistemic modality showed that preschool children have difficulties in acquiring epistemic modality. Even though children may start using modal vocabulary very early on, only at around the age of 4 do they start differentiating between modal expressions; by the age of 5-6 their performance with epistemic modal vocabulary improves significantly (Moore, Pure and Furrow, 1990). These developments have been linked to theory of mind development around the age of four, which helps the young child realize that two people may have differing beliefs with respect to the same reality. Moore et. al. (1990) claim that only after this conceptual development takes place will the young child be able to use modal expressions correctly and access their pragmatic meanings.

In a related study, Hirst and Weil (1982) explored the development of the appreciation of the relative strength of modal propositions. Children were shown a table on which the experimenter placed a plastic cup and a box. They were told that the experimenter would hide a peanut under either the cup or the box and two puppets would tell the child where to find the peanut. Children had to choose the most probable of two modal propositions offered by the puppets which involved two different containers (e.g., *The peanut must be under the box* vs. *The peanut may be under the cup*). The logic of the experiment was based on the idea that statements with stronger modals should be interpreted as indicating higher degree of speaker confidence and should be preferred over statements with weaker modals. The study's findings show that children treat possibility modals (*may* and *should*) as weaker than plain assertions (i.e., statements with *is*) before they discover that necessity modals (*must*) also communicate a weaker degree of commitment than plain assertions.

Building on Hirst and Weil's study, Noveck, Ho and Sera (1996) studied whether five-year-olds detected the relative strength of modal verbs in a contrastive situation. The modal verb pairs that they studied were *is/has to, has to/might,* and *is/might.* They confirmed that children appreciated modal force and relied on it when making decisions about the trustworthiness of speakers. In a second experiment, Noveck et.al. studied 5-, 7-, and 9-year-olds and adults to see if there were significant differences between these age groups with respect to their success in appreciating different modal contrasts. Their findings showed that children's success rates increased over time and that 9-year-olds' performance was indistinguishable from that of adults.

In a study most closely related to our own experimental efforts, Noveck (2001) examined 5-, 7-, 9-year-olds' and adults' comprehension of modality in a reasoning task. Participants were presented with two open boxes and one closed box and were told that the closed box had the same contents as one of the two open boxes. Next, participants heard eight modal statements about the content of the closed box (e.g., *There has to be a parrot in the box*) and they were asked to say whether they agreed or disagreed with each of these statements. The findings show that 5-, 7- and 9-year-olds accepted true but under-informative statements when stronger, more informative ones would have been appropriate. For instance, in a situation where there was a parrot in both the first and the second box, and therefore a parrot was guaranteed to be in the unopened box, children accepted the statement *There might be a parrot in the box*. In the same situation, the majority of adults who were presented with the weaker modal term (e.g., *might*) disagreed with the target statement, showing that they treated it as incompatible with the stronger term (e.g., *has to*). This striking finding has been interpreted as evidence that children have difficulty with pragmatic interpretations since, unlike adults, they do not seem to compute the scalar implicature from the use of weak epistemic modal terms.

In a different context, other investigators have proposed that children's inability to compute scalar implicatures is not due to lack of relevant pragmatic knowledge but rather stems from the fact that children cannot implement that knowledge in an experimental setting (Chierchia, Crain, Guasti, Gualmini and Meroni, 2001). More recent work has offered evidence against the conclusion that children at the age of 5 cannot compute scalar implicatures. For instance, Papafragou and Musolino (2003) report that 5-year-olds' sensitivity to scalar implicatures improves if they are made aware of the goals of the task. Furthermore, Papafragou and Tantalou (2004) show that, in contexts which are similar to naturalistic conversations, five-

year-olds are able to assess the informativeness expectations in a conversational exchange and derive scalar implicatures when these expectations are not met (see also Guasti, Chierchia, Crain, Foppolo, Gualmini and Meroni, 2005, for contexts promoting children's ability to compute scalar inferences). The question remains whether these recent developmental findings (which have mostly been based on scalar quantifiers such as *some* and *all*) generalize to modal scales.

The prior findings we have just reviewed offer a useful starting point for further systematic tests to examine children's comprehension of epistemic modals and their pragmatic interpretations, ideally with simpler tasks. In what follows, we present two experiments designed to do this. In our first experiment, we revisit the finding that the use of a sentence with a weaker modal term is not accepted by adults if the modal term can be replaced by a stronger one but such uses are acceptable by children (Noveck, 2001). Inspired by previous studies which have used contrast as a way of testing sensitivity to informativeness of different scalars (cf. Chierchia et al., 2001), we ask whether, presented with two true epistemic modal statements of differing strength, 5-year-old children can choose the stronger/more informative one when such a term is warranted by the evidence. If they succeed in doing so, children will be shown to be sensitive to differences in informativeness between weak and strong modal statements – an ability which is a prerequisite for computing scalar implicatures (see step 2 in the reasoning schema in Section 1). In Experiment 2, we investigate the same question with a less explicitly meta-linguistic task. Specifically, we ask whether children can detect differences in informativeness between two modal statements if the statements themselves have strong positive or negative consequences.

3 Experiment 1

3.1 Method
3.1.1 Participants

A total of 21 English-speaking children (9 female and 12 male) ranging from 4;6 to 6;0 (mean age: 5;3), and 20 adults (11 female and 9 male) participated in this study. The child participants were recruited from two different preschools in Newark, DE. The adults were college students taking either an introductory psychology or an introductory linguistics course. All participants completed the experiment.

3.1.2 Stimuli and Procedure

Participants were presented with twelve animated short stories on a computer screen. At the beginning of the session the experimenter told participants that they would play a game involving two characters on the screen (Minnie and Donald) and several animals. At the beginning of each story the participant saw an animal standing by two boxes on the stage. The animal went on to hide in one of the boxes while the curtains of the stage were lowered. The experimenter told the participant that the animal was hiding in one of the two boxes on the stage. Next the curtains were lifted again and one of the boxes was opened as the participant watched on. In some of the stories, the box contained the animal, in other stories no animal was found (depending on the type of modal contrast, see below). Next the characters (Minnie and Donald) offered one statement each about the hiding place of the animal and the participant was asked to choose which character gave a better answer. The two statements were identical except for their modal strength (i.e., they contained either a strong or a weak modal). It was always the stronger statement that the participants should choose.

For instance, a mouse hid in one of the two boxes (pink or yellow) on the stage. Next, the yellow box was opened and revealed no animal. Then Minnie said: "The mouse has to be in the pink box", and Mickey said: "The mouse may be in the pink box". The participant was expected to choose the first statement over the second one, even though both statements were true, since the first one was informationally stronger.

The characters' statements illustrated three types of modal contrasts: (i) *may* vs. plain assertion (in this case, the animal was shown to be in the first box, so the plain assertion with *is* was warranted), (ii) *have to* vs. plain assertion (here again, the animal was shown to be in the opened box), and (iii) *may* vs. *have to* (here, the opened box contained no animal, hence the animal *had to* be in the other box). There were four stories for each type of contrast. The position of the box which was the hiding place of the object (L-R), the position of the box which was opened (L-R) and the order of presentation of the statements were counterbalanced. Stories were administered in two orders, one being the reverse of the other. Minnie and Donald offered an equal number of strong and weak statements each.

Each participant was presented with two pretest trials at the beginning of the experiment where the statements the characters offered did not include modal terms. This was done to ensure that the participants could reject the least informative of two true answers in cases that did not involve modality. For instance, the child saw a dog and heard one of the characters say *It is a dog* and the other character say *It is an animal.* She was asked to choose the answer that was better. No feedback was provided to the participants. For all items, adults were tested in the same way as the children.

3.2 Results

On the pretest items, children provided correct responses on 92.5% of the trials and adults on 100% of the trials. Turning to the test items, preliminary analyses revealed no significant effect of order so we collapsed across the two orders in what follows. A 2 (Age: Adult vs. Child) X 3 (Type of modal contrast: *have to/is, may/have to, may/is*) ANOVA with repeated measures on the last factor revealed a significant main effect of Age: children performed correctly 69.44 % of the time and adults 88.34 % of the time (F (1, 35) = 11.202, p< .005). There were no other significant main or interaction effects.

Pairwise comparisons showed that children's performance on the *may/is* contrast (M= 80.95 %) was significantly different from their performance on the *have to/is* contrast (M= 63.1 %) (F (1, 20) = 64.873, p<.001), and the *may/have to* contrast (M= 64.29 %) (F (1, 20) = 145.08, p <.001). Pairwise comparisons of adults' results showed no significant difference between their performances on the *may/is, have to/is* and *may/have to* contrasts.

Children's percentages of correct responses for all three contrasts were compared to chance level with single-sample t-tests. Performance on the *may/have to* contrast (t (20) = 2.677, p < .05, 2-tailed) and the *may/is* contrast (t (20) = 5.20, p < .001, 2-tailed) but not the *have to/is* contrast was found to be significantly different from chance.
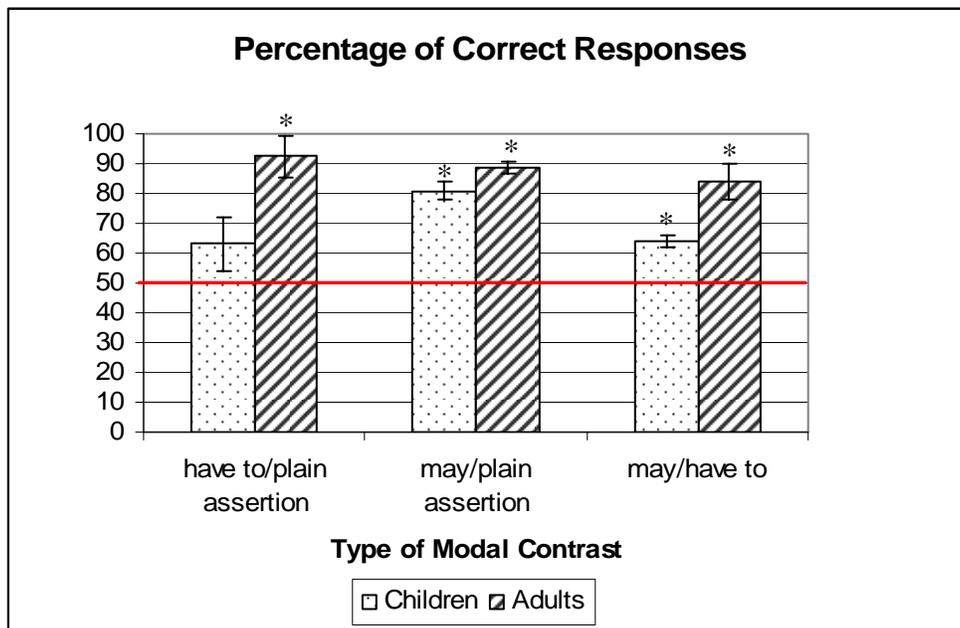

Figure 1. Percentage of adults' and children's correct responses for three modal contrasts.

3.3 Discussion

The present findings extend data in the literature showing that children distinguish between statements with different modal force and rely on the strongest modal statements when making reliability judgments (Hirst and Weil, 1982; Noveck et al., 1996). Unlike these prior studies, however, the present study directly sheds light on the issue of whether children are aware of the Gricean informativeness requirement, i.e. whether they expect speakers to offer the strongest (relevant) statement warranted by the available evidence. Our findings suggest that five-year-olds are sensitive to this conversational requirement, since they are successful in choosing an informationally stronger modal statement over a true but weaker one most of the time. The ability to make informativeness comparisons is a key component of the pragmatics of modality and one of the requirements for the calculation of scalar inferences from the use of epistemic modal terms (see Section 1).

Even though five-year-olds appreciate modal strength, their performance is not perfect. Specifically, unlike adults, and despite their success in choosing the stronger alternative in the *may/ is* and *may/ have to* contrasts, children face problems choosing the plain assertion statements over *have to* statements. This finding is reminiscent of prior results in the literature (Hirst and Weil, 1982; Noveck et. al., 1996). The difficulty of determining that, in natural language, plain assertions generally convey greater speaker certainty than statements with epistemic necessity may be partly due to the fact that, in

conversational exchange, the two types of statements are very often used interchangeably. There are even cases where statements with a necessity modal (such as *have to*) entail plain assertion (this happens in any domain in which theories produce necessary conclusions that anticipate subsequent discoveries; see Noveck et. al., 1996).

Our next study further probed into children's ability to infer speaker certainty from the use of weak and strong modal statements. Rather than using meta-linguistics tasks where participants have to judge who 'said it better', we instead turned to a task targeting a more implicit understanding of the connection between modality and speaker certainty. Specifically, we tested sensitivity to speaker certainty associated with different modal statements in situations where the modal statements themselves have positive or negative consequences for the child. This method builds on a long line of findings in developmental psychology according to which children are more likely to reveal underlying cognitive competence in tasks that directly engage their interests and goals (e.g., Bever, Mehler and Epstein, 1968; Gelman and Greeno, 1969).

4   Experiment 2

4.1   Method
4.1.1   Participants

A total of 15 English-speaking-children (7 female and 8 male) ranging from 4;1 to 5;7 (mean age: 4;10), and 15 English-speaking adults participated in this study. The children were recruited from two preschools in Newark, DE. Adults were graduate students at the University of Delaware who participated for course credit. All participants completed the experiment.

4.1.2   Stimuli and Procedure

Participants were presented with eight pictures of twin siblings on a computer screen. The siblings were exactly the same and they were shown facing each other, one on the left and the other on the right-hand side of the screen. At the beginning of the session, the experimenter told participants that they would play a game together with the twin siblings. These siblings looked alike, dressed alike but would tell participants different things. Participants should choose one twin sibling over the other one depending on what they said.

The experiment consisted of two types of stories, positive and negative ones. In the positive stories, the experimenter asked the participant to say a favorite type of food or something they would like to get as a present for their birthday. Once the participant gave an answer to that question, the experimenter brought up one pair of twin siblings on the computer screen. For instance, one participant told the experimenter that ice-cream was her favorite type of food. The experimenter then presented the participant with two twin ladies. Pointing to the lady on the left hand side, the experimenter imitated the lady's voice and told the participant: *I will give you ice-cream!* Then, pointing to the lady on the right hand side, the experimenter imitated that lady's voice and said: *I may give you ice-cream!* The experimenter then asked the participant which sibling she would choose. Since ice-cream was something desirable for the participant and the modal *will* is associated with higher speaker certainty than the modal *may,* the participant was expected to choose the twin who offered the stronger modal statement with *will*.

The procedure in the negative stories was almost identical but this time participants were asked to tell the experimenter a type of food they really did not like or something they really would not like to get as their birthday present. For instance, one participant told the experimenter that cauliflower was her least favorite type of food. Pointing to and speaking as one of the siblings, the experimenter told the participant: *I will give you cauliflower!* Then, pointing to and speaking as the other sibling, the experimenter said: *I may give you cauliflower*! Again the participant was asked to choose one sibling. Since cauliflower was something the participant was trying to avoid and the modal *may* is associated with reduced speaker certainty compared to the modal *will,* the participant was expected to choose the twin who offered the weaker modal statement with *may*.

Four positive and four negative stories were intermixed and administered in a fixed order. The experimenter always started with the utterance of the sibling on the left hand side. The position of the sibling who offered a stronger modal statement (left-right) was counterbalanced.

The procedure for the adult control group was exactly the same but adults were asked by the experimenter at the beginning of the experiment to list four things they did not like to eat or they would not like to get as their birthday present and four things they liked to eat or they would like to get as their birthday present instead of being asked at the beginning of each trial.

4.2   Results

A 2 (Age: Children vs. Adults) x 2 (Item type: Negative vs. Positive) ANOVA with the proportion of correct responses as the dependent variable and Item Type as a within subjects factor revealed a significant main effect of Age (F (1, 28) =

16.489, p<.001): overall, adults performed better than children in this task (M_{adults}= 100 % vs. $M_{children}$= 68.33 %). The analysis revealed no significant main effect of Item Type: participants gave correct responses 88.28 % of the time in the negative stories and 82.03 % of the time in the positive stories. There was no significant Age x Item Type interaction. Closer inspection reveals that adults performed perfectly on both story types but children performed significantly better on negative stories: $M_{negative}$= 75 %, $M_{positive}$= 61.67 %.

One sample t-tests revealed that adults' performance on both negative and positive story types and children's performance on negative story types were significantly different from chance level (p<.05). However, children's performance on positive story types was not found to be significantly different from chance.
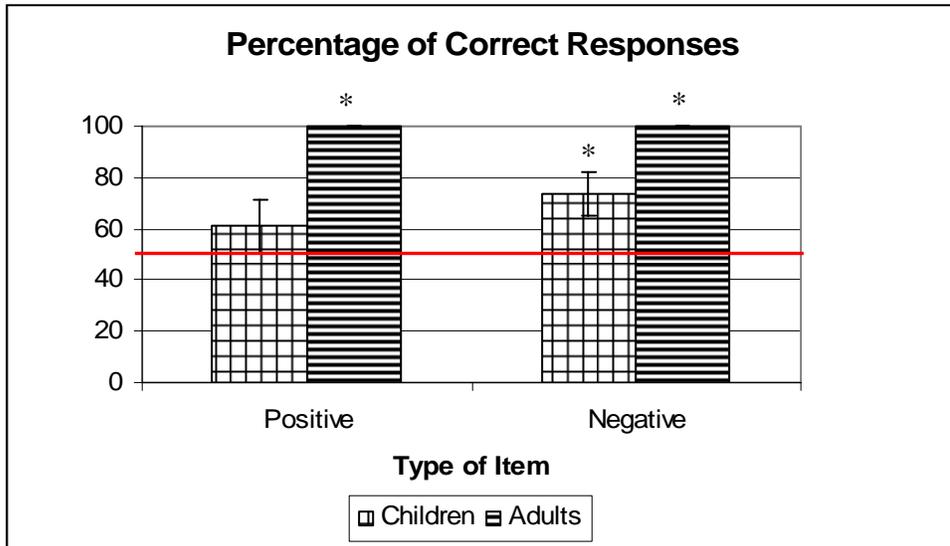

Figure 2. Percentage of adults' and children's correct responses for the positive vs. negative type of stories.

4.3   *Discussion*

Our results show that adults performed at ceiling on both negative and positive items. However, children performed at a level significantly different from chance only on negative items but not on positive ones. This shows that children have at least a partial understanding of epistemic modal pragmatics (more specifically, the connection between epistemic modality and speaker certainty) but that this knowledge is fragile and its use is subject to situational variables. In our study, it is more crucial for children to avoid the negative situations (getting to eat cauliflower, even in a virtual world) than it is to choose the most desirable situation (getting to each ice cream) among two situations which have different desirability levels. Hence the type of decision involved forces the child to pay more attention in the former situation than in the latter – and as a result, fewer errors in evaluating speaker certainty emerge in the negative situations than in the positive ones.

5   **Conclusion**

In this paper, we investigated 5-year-old children's sensitivity to the pragmatic properties of epistemic modal vocabulary. We found that 5-year-olds are aware of the effects of epistemic modal scales since they could choose an informationally stronger modal statement over a true but underinformative one most of the time (Experiment 1). We also found that spontaneous estimates of the relative certainty of a speaker uttering a modal statement depend on the type of expected outcome (positive or negative) of the experimental scenario (Experiment 2).

These findings have implications for accounts of the acquisition of modality, and for theories of the development of the semantics-pragmatics interface more generally. Recall that earlier work has shown that children fail to spontaneously compute scalar inferences from the use of modal expressions (Noveck, 2001). The present data demonstrate that such failures cannot be due to a complete lack of sensitivity to the pragmatic properties of epistemic modality: when given the opportunity, young children are capable of judging that a stronger statement is a more appropriate description of an experimental scenario compared to a weaker (albeit true) one. Furthermore, they seem capable of linking the use of modality to speaker certainty even in situations that do not explicitly involve the evaluation of the felicity of linguistic stimuli (as in our second

experiment). Naturally, sensitivity to informativeness differences within a set of modal alternatives presented contrastively does not guarantee that these alternatives will be spontaneously generated and compared in situations that involve the on-line computation of a scalar inference. Nevertheless, the ability to perform such judgments shows that children at least possess some key components required for the calculation of conversational implicatures (see reasoning schema in Section 1).

Several questions remain open about children's understanding of the pragmatics of modality. Notice that our experimental efforts have focused on five-year-olds' ability to choose the strongest modal statement when it was warranted by observational evidence. In order to evaluate pragmatic development more fully, one would need to test for the opposite pattern, namely the ability to choose the weaker of two modals if the state of the evidence did not guarantee a stronger statement. For instance, in a situation where a subject is presented with two unopened boxes and has to guess the location of a hidden object, subjects should be prepared to accept that the object simply *might* be in one of the boxes, not that it *has to* be there. A separate, but related issue concerns the connection between modality and the speaker's epistemic state: appreciation of the pragmatic properties of modality includes the ability to infer that a weak modal (e.g., *might*) indicates lack of decisive evidence and is therefore appropriate for a speaker who lacks full access to relevant information. We are currently pursuing these directions in further experimental work.

References

Bever T., Mehler, J., & Epstein, J. (1968). What children do in spite of what they know. Science, 162 (3856), 921-924.

Chierchia, G., Crain, S., Guasti, M., Gualmini, A., & Meroni, L. (2001). The acquisition of disjunction: evidence for a grammatical view of scalar implicature. In A. H. J. Do (ed.), BUCLD Proceedings 25, 157-168. Somerville, MA: Cascadilla Press.

von Fintel, K. & A. Gillies (2004). "Might" made right. Institute of Cognitive Science Colloquium, Osnabrück, December 16.

Gelman R. & Greeno. J. (1989). On the nature of competence: principles for understanding a domain. In L. Resnick (ed.), Knowing and learning: Essays in honor of Robert Glaser, 125-186. Hillsdale, NJ: Erlbaum.

Grice, H. P. (1989). Studies in the way of words. Cambridge, MA: Harvard University Press.

Guasti, M. T., Chierchia, G., Crain, S., Foppolo, F., Gualmini, A., & Meroni, L. (2005). Why children and adults sometimes (but not always) compute implicatures. Language and Cognitive Processes, 20, 667-696.

Hintikka, J. (1969). Models for modalities. Dordrecht: Reidel.

Hirst, W., & Weil, J. (1982). Acquisition of the epistemic and deontic meaning of modals. Journal of Child Language, 9, 659-666.

Horn, L. (1972). On the semantic properties of the logical operators in English. Doctoral diss. UCLA Distributed by IULC, Indiana University.

Kratzer, A. (1981). The notional category of modality. In H.-J. Eikmeyer & H. Rieser (eds.), Worlds, words, and contexts, 38-74. Berlin: de Gruyter.

Kratzer, A. (1991). Modality. In A. von Stechow & D. Wunderlich (eds.), Semantics: An International Handbook of Contemporary Research, 639-650. Berlin: de Gryuter.

Moore, C., Pure, K., & Furrow, D. (1990). Children's understanding of the modal expression of speaker certainty and uncertainty and its relation to the development of a representational theory of mind. Child Development, 61, 722-730.

Noveck, I. A. (2001). When children are more logical than adults: Experimental investigations of scalar implicature. Cognition, 78(2), 165-188.

Noveck, I. A., Ho, S. & Sera, M. (1996). Children's understanding of epistemic modals. Journal of Child Language, 23, 3, 621-643.

Papafragou, A., & Musolino, J. (2003). Scalar implicatures: Experiments at the semantics-pragmatic interface. Cognition, 86, 253-282.

Papafragou, A., & Ozturk, O. (in press). On the acquisition of modality. Proceedings from the 30th Annual Penn Linguistics Colloquium. Department of Linguistics, UPenn.

Papafragou, A., & Tantalou, N. (2004). Children's computation of implicatures. Language Acquisition, 12, 71-82.