

The Early Steps of Modal and Negation Interactions: Evidence from Child Italian

1. Introduction

One difference between natural and formal languages is that natural languages are ambiguous in many respects, one of them being the ambiguity of sentences with more than one logic operator. In this paper we focus on sentences containing negation and modal operators and their interpretation by 4- and 5-years old.

In many cases, a sentence with multiple operators is ambiguous and grammars of human languages need formal means to express a one-to-many mapping from a sentence to its different possible meanings. A widely shared assumption is that such a mapping can be generated by the application of non-visible movement operations, which make available interpretations different from the ones that can be read off the surface syntax (see Fox (2000), May (1985), Reinhart (1997), Reinhart (2006)). To illustrate, a sentence like (1):

(1) Every horse didn't jump over the fence

might be used to describe two different states of the world. According to one interpretation, (1) describes a situation in which none of the horses of a given set were able to cross an obstacle, but under a different interpretation the sentence in (1) is true also in the case were some horses jumped but others did not. The availability of these two interpretations might be explained by assuming that more than one logical representation corresponds to a single syntactic structure. Whatever theoretical solution we adopt to derive the multiple interpretations of scopally ambiguous sentences, what is important is that the hearer of a sentence like (1) must be able to map this sequence of words onto two distinct logic forms.

One research question which has been addressed in the last ten years concerns the learnability of such mapping between a sentence and its different possible meanings. The first results came from Musolino (1998). In a series of experiments, he investigated English-speaking children's interpretation of sentences like (1) and other sentences which contain more than one logical operator, such as (2) and (3):

(2) The detective didn't find some guys

(3) The detective didn't find two guys

Each of the sentences in (1) through (3) contains two operators: negation and a quantified noun phrase. This yields two logically possible scope assignments for each sentence. To illustrate, (1) is ambiguous between the two interpretations listed below.

- (4) Every horse is such that it did not jump over the fence
 $\forall x [\text{horse}(x) \rightarrow \neg \text{jump over the fence}(x)]$
'for every x, if x is a horse then x did not jump over the fence'
- (5) Not every horse jumped over the fence
 $\neg \forall x [\text{horse}(x) \rightarrow \text{jump over the fence}(x)]$
'it is not the case that for every x, if x is a horse then x jumped over the fence'

The two interpretations of (1) listed in (4) and (5) result from the relative scope assignment to negation and *every*, as suggested by the order of the operators \neg and \forall in the logical formulae. We will follow the semantic literature terminology and we will refer to the interpretation in (4) as the 'surface scope' interpretation of (1), and to the interpretation in (5) as to the 'inverse scope' interpretation of (1). This is because the scope bearing elements *every* and *not* in (4) are interpreted in the same order with which they appear in the overt syntax, whereas in (5) they are interpreted in the opposite order.

The research question that Musolino (1998) and others have addressed is whether young children are capable of accessing both the surface scope and the inverse scope interpretation of sentences containing negation and another scope-bearing element. The experimental evidence collected by Musolino (1998) suggests that this is not the case and, for all the constructions in (1), (2) and (3) 4- and 5-year-old children seemed to consistently resort to their surface scope interpretations. This finding led Musolino to propose the Observation of Isomorphism, the claim that children's semantic scope coincides with overt syntactic scope (see also Musolino, Crain and Thornton (2000)).

More recent studies, however, have led to a revision of the picture suggested by Musolino's early findings. In particular, recent works have shown that children's interpretation of sentences like (1), (2) and (3) is affected by the context. For instance, Gualmini (2004a) has shown that, in a context in which the Troll is expected to deliver all the relevant pizzas, children easily access the inverse scope interpretation of (6).

- (6) The Troll didn't deliver some pizzas

In the same vein, Gualmini (2004b) demonstrated that children are perfectly capable of assigning wide scope to the indefinite *some* with sentences such as (7), and Gualmini (in press) has shown that the same is true for Italian-speaking children.

- (7) Every farmer didn't clean some animal

Furthermore, Gualmini, Hacquard, Hulseley and Fox (2005) have recently shown that the same contextual maneuver discovered by Gualmini (2004a, b) leads children to select the inverse scope interpretation of sentences equivalent to (1) and (3) to a higher extent than

observed in previous literature. Finally, Musolino and Lidz (2006) report that children access the inverse scope interpretation of (8) to a larger extent than they did for (1).

(8) Every horse jumped over the log, but every horse didn't jump over the fence

The finding that children may select different logic representations for the same sentence depending on the context poses a challenge for the original view of Isomorphism and suggests that children have access to covert operations. This has led to a debate on whether surface scope interpretations have a special status in child or adult grammar (see Musolino (2006), Musolino and Lidz (2004), Hulse, Hacquard, Fox and Gualmini (2004), Gualmini (2007b), Gualmini (2007a)).

To sum up, the current debate on children's interpretation of sentences like (1) through (3) focuses on the resolution of the relevant ambiguity. The reason is that for all of the sentences discussed above, children can generate both readings from the earliest stages of language development. Although this finding has enriched our understanding of children's parsing abilities, it does not bring us any closer to children's first hypothesis. In other words, the question remains whether children acquire scope ambiguities step-by-step. In this paper, we pursue a slightly different line of research by looking at children's interpretation of sentences containing an ambiguity between different scope-bearing elements, namely negation and a modal verb

2, Previous studies on children's interpretation of modals and negation

Modal verbs occurring in sentences containing negation give rise to ambiguities similar to the ones found with nominal quantifiers. This parallel did not go unnoticed in the semantic literature, and modal operators have been reduced to quantification over sets of worlds rather than individuals (Hintikka (1962), Stalnaker (1968), Lewis (1995)).¹ The existence of scope ambiguities involving modals led Moscati and Gualmini (in press) to investigate children's interpretation of sentences like the following:

(9) The lion cannot be in the same cage as the tiger

(10) It is not the case that the lion can be in the same cage as the tiger $\neg > \diamond$

(11) It is possible for the lion not to be in the same cage as the tiger
 $\diamond > \neg$

¹ It has been long recognized in logic that modality is not a homogeneous category and that different kinds of attitudes toward the truth of a given proposition may be distinguished. Albeit it is possible to distinguish between different kinds of modality (see Palmer (1986), Cinque (1999)), a general opposition between epistemic and deontic modality will be sufficient here. When it comes to child language, children start using modals very early and they have been argued to initially produce modals in their deontic meaning (see Wells (1979)). These results are not so surprising, given that children are likely to be exposed in their first years to utterances expressing the permission or the prohibition to do something. For these reasons, the sentences discussed in this paper are all compatible with a deontic interpretation.

As the morphology suggests, the verbal form *cannot* can be decomposed into the modal operator *can* (\diamond) and negation (\neg). Interestingly, these two scope-bearing elements are interpreted in a way that does not match surface syntax. In other words, the preferred – if not the only – interpretation of (9) is the inverse scope interpretation paraphrased in (10), whereas the interpretation paraphrased in (11) is largely dis-preferred, if at all available to adults.

Let us now consider the Italian sentence in (14):

(12) Il leone non deve stare nella stessa gabbia con la tigre
 the lion not must be into-the same cage with the tiger

(13) It is not the case that the lion can be in the same cage as the tiger $\neg > \square$

(14) It is possible for the lion not to be in the same cage as the tiger
 $\square > \neg$

Although both interpretations in (13) and (14) are possible for sentence (12), the inverse scope reading in (14) is the preferred one, while the surface scope reading in (13) is marked.

Due to previous claims about the privileged status of surface scope interpretations, English sentence in (9) and the Italian sentence in (12) were used in two experiments conducted by Moscati and Gualmini (in press). The results of the experiments suggest that 4-year-old children robustly interpret such sentences as expressing a prohibition. In both cases, this amounts to an inverse scope interpretation of the target sentence. This is an important finding by itself because it adds to the growing body of empirical evidence showing that 4-year-olds do not experience any sort of problems with inverse scope interpretations. Nevertheless, since children seemed to behave like adults from very early on, we are still looking for a protracted stage of non-adult behavior that could help us understand how children approach the acquisition of scope ambiguities.

A possible reason behind children's early mastery of the ambiguities investigated by Moscati and Gualmini (in press) is their frequency in the primary linguistic data. For this reason Moscati and Gualmini (2008) decided to test a construction which is unambiguously interpreted as a permission not to do something, rather than a prohibition. The study by Moscati and Gualmini (2008) used the standard Truth Value Judgment Task (see Crain and Thornton (1998), Crain and McKee (1985)) to investigate children's interpretation of sentences such as (15).

(15) To be a good farmer, you need not feed the zebra

Children were asked to evaluate whether the target sentence accurately described the outcome of a story. The story was constructed in such a way that the target sentence (15) was true under its weak inverse scope reading, but false under its strong surface scope

reading.² Fifteen English-speaking children participated in the experiment. They ranged in age from 3:9;5 to 6:2;26 (mean age: 4:10;5). Each child was presented with four target trials interspersed with an equal number of fillers, to balance the number of ‘yes’ and ‘no’ responses. Let us illustrate one of the trials.

- (16) This is a story about a boy, a pirate and a little girl. The boy is a farmer and wants to know if his friends are good at farming. He asks them to feed some animals to find out who is a good farmer. He has two presents to give to his friends if they are good at farming. The pirate goes first and feeds the pony, but not the zebra (because he doesn't look hungry). Then the little girl goes, and she feeds both the pony and the zebra. The boy awards both the pirate and the little girl a prize for being a good farmer.

At this point, the puppet uttered the target sentence in (15). This sentence is true on its weak inverse scope reading, since it is not necessary to feed the zebra in order to be a good farmer. If that was the case, then only the little girl would have received a prize. By contrast, the sentence is false on its strong surface scope interpretations. Here are the results: children rejected the statement in (15) 41 times out of 60 trials (68.3%). When children rejected the target sentence, they were asked to explain ‘what really happened.’ Children’s responses suggested that they were accessing the strong surface scope interpretation of the target sentence. For instance, children would point out that the puppet was wrong because the pirate had also received a prize. By contrast, a group of fourteen adult controls accepted the target sentences 87% of the time.

To sum up, the experiment conducted by Moscati and Gualmini (2008) provides us with one instance of non-adult behavior in children’s interpretation of sentences containing negation and a modal operator. The next step is to determine what accounts for children’s non-adult behavior. Assuming that the context used by the experiment was an appropriate context for children to select the adult interpretation of the target sentence, the response uncovered by Moscati and Gualmini (2008) might indeed be indicative of children’s initial hypothesis. In particular, it is possible that children approach the acquisition of privative ambiguities by initially positing only the strong interpretation (see Crain, Conway and Ni (1994)) To corroborate this hypothesis, we conducted an experiment with Italian-speaking children on their interpretation for sentences that express the same proposition targeted by Moscati and Gualmini (2008),

3. An experimental study on children’s interpretation of sentences containing *puo’* and *non* in Italian

In this experiment, we tested Italian-speaking children’s interpretation of sentences that adult speakers of Italian can only interpret on their surface scope interpretation. Consider the following example.

² When the two interpretations of an ambiguous sentence stand in an entailment relation, it is standard practice to label as ‘weak’ the reading that is entailed by the other, and as ‘strong’ the reading that entails the other.

- (18) a. Il contadino può non dare le carote all'elefante
 b. *it is not possible that the farmer gives carrots to the elephant
 c. it is possible that the farmer doesn't give carrots to the elephant

In this sentence, only the surface scope reading (18) is allowed in adult Italian³. Notice that this is the weak reading, since it is entailed by the other reading in (15a)

4.1. Materials

We conducted a standard Truth Value Judgement task (Crain & Thornton, 1998) and we presented children four sentences like (18) in a context like the following.

- (19) There is a farmer who has to feed his animals. He has turnips and carrots and there are three animals: one tiger and two elephants. But the tiger says that she doesn't like carrots. Thus the farmer decides to give a turnip to the tiger. The elephants do not have any preference, and the farmer decides to give a turnip to the first elephant and a carrot to the second one.

We then asked a puppet to describe what had happened in the story and the puppet uttered the target sentence (18). In the given context, the weak surface scope reading makes the sentence true, since there is one elephant who did not receive any carrots. The existence of this elephant establishes that it is indeed possible not to give carrots to an elephant, as expressed by the weak reading (18)b. By contrast, according to the strong inverse scope reading, which amounts to the proposition in (18)a, it is prohibited to give carrots to the elephant. This reading is false in the context, since one elephant did indeed receive some carrots. Adult speakers of Italian were expected to select the later interpretation, arguably the only interpretation licensed by their grammar. By contrast, based on the results documented by Moscati and Gualmini (2008) we expected children's responses to be dictated by the strong inverse scope interpretation.

In addition to the target sentences, children were also presented with four control items. The control items were of two kinds. In the first type of controls (Type A) we gave children affirmative sentences containing the modal 'potere' after a brief story:

- (20) Semola knows that there is a king who has objects with magic properties and he wants to visit the king to have the magic objects. When he arrives, the king says that he has a harp and two swords: the harp makes one able to run very fast, but only if you can play it, while the swords give the power to fly if someone can lift them and hold them. First, Semola tries with the harp, he plays it and he is now able to run very fast. Then he gives it a try with the

³ It is unclear why the reading (18a) is blocked. One possible explanation is that *potere* belongs to the class of *restructuring verbs*, which take a sentential complement and through a *restructuring rule* (Rizzi 1982) a biclausal structure is transformed in a monoclausal structure. The presence of negation might block such a rule (Rizzi 1982, Kayne 1989) and it will be impossible to eliminate the clause boundary. The negative operator is then unable to cross a CP border (Moscati 2006, 2007) and its scope is bounded to the lower clause. Inverse scope reading of negation over the modal will then be ruled out.

swords. He tries the first sword, but it is too heavy and he fails. He tries with the second one, and this time he manages to lift it and he flies away.

At this point, a puppet is asked whether Semola can lift the sword and the puppet utters the following sentence:

- (21) Semola può sollevare la spada
Semola can lift the sword

If children are cooperative, they should assume that the relevant sword is the sword that was actually lifted and they should accept the target sentence. Let us illustrate the reason behind this type of control sentences. As the reader may have noticed, the target sentence in (18) contains a singular definite determiner in order to avoid the insertion of another scope-bearing element such as an indefinite. This choice may be a source of confusion and children's rejection of the target sentence might be due to the inappropriateness of the definite determiner. If this is indeed the case, then children's confusion should also surface in response to sentences like (21).

In the second control (Type B), we gave children sentences in which also a negative operator was present, preceding the modal 'potere'. Here is an illustrative trial.

- (22) There is a Pilot who wants to go out and he has a motorbike and an F1 car. He decides to take the motorbike, but when he tries to climb on it, he falls down since it is too high. He tries again, but he falls again. Thus, he decides to take the car and goes away.

At the end of the story, the puppet was asked whether the pilot could drive the motorbike. The puppet then answered as follows:

- (23) a. Il pilota non può guidare la moto
the pilot not can drive the motorbike
b. it is not possible that the pilot drives the motorbike
c. *it is possible that the pilot does not drive the motorbike

This type of control sentences were inserted to ensure that children are able to process the negative operator with modal verbs and to test if they have problems in accessing strong surface scope readings.

4.2. *Participants*

Twenty monolingual Italian-speaking children (age: 3;9 – 5;7. mean age: 4;5) from two kindergartens in the Siena area participated in the experiment.

4.3. *Results*

Let us first look at the results of the control sentences. In the Type A controls, children did not show any problems with declarative modal sentences, nor with the use of the singular definite article in the experimental context. The results are illustrated in the table below:

Table 1. Children's acceptance of Type A control sentences

Condition	Type A control		
	Trial 1	Trial 2	Total
Acceptance	17/20	16/20	33/40 (82,5%)

The results from the Type B control condition were somewhat surprising. In particular, the rate of acceptance we recorded was lower than we expected: children only accepted Type B control sentences 65% of the times. Results are given in Table 2:

Table 2. Children's acceptance of Type B control sentences

Condition	Type B control		
	Trial 1	Trial 2	Total
Acceptance	13/20	13/20	26/40 (65%)

Upon inspection of the individual scores, however, we noticed that two children failed all control sentences and three children always reject true negative sentences. These children possibly show a 'no' bias. Since, the experimental hypothesis is indeed associated with a 'no' response, we decided to exclude these children from the analysis of the results. This leaves us with 15 children out of the initial twenty (age: 3;9 – 5;7. mean 4;5) which pass at least one control for each Type. These are children who do not have problems with (i) the modal *potere* (ii) the use of the definite determiner or (iii) negative modal sentences. These fifteen children heard four target stories, and at the end of each story they were asked to judge the puppet's statement. Recall that the target sentences were always true under the weak interpretation, the only reading permitted in adult Italian. If children can access this reading, which doesn't involve covert operations, they are expected to accept the puppet's statement. Table 3 summarizes children's response:

Table 3. Children's acceptance of the target sentences

	Story 1	Story 2	Story 3	Story 4	Total
Acceptance	6/14	4/14	3/15	3/15	16/58 (27,5%)

Looking at Table 3, we can see that children tend to reject the target sentence⁴. In the experiment, every time the children rejected the target sentence, we asked for an explanation. In the vast majority of cases, the explanation was consistent with the strong

⁴ Notice that if we include also the answers to the five children excluded on their bases of their responses to Type A and Type B control sentences, we would have only a slightly higher acceptance rate: 30.9% (22/71).

reading, confirming that a non-adult interpretation was the source of children's rejection. Even if we exclude the cases in which children gave an inconsistent explanation (for example: *because elephants are strange*), we are left with only 16 acceptances out of 52 trials i.e., 30.7%). Children's responses stand in contrast with the responses of a group of ten adult controls, who always accepted the target sentence.

To sum up, the experimental results suggest that Italian speaking children initially interpret sentences like (18) on a non-adult inverse scope interpretation. Although recent developments in the study of ambiguities remind us that our interpretation of the findings would change as soon as a successful contextual manipulation eliciting adult behavior is put forward, for the time being we must register this finding together with English-speaking children's behavior documented by Moscati and Gualmini (2008).

4. Concluding remarks

In this paper we have considered experimental evidence suggesting that indeed children do not assume that sentences containing negation and a modal verb are ambiguous right off the bat. In particular, it looks as if children initially start off with the strong reading.

We would like to conclude by acknowledging that our description of children's non-adult behavior is still in need of an explanation. The same is true for other cases in which it looks as if children initially start off from the hypothesis that a sentence only has one reading, which turns out to be informationally stronger than the adult reading (see for instance Crain et al. (1994), Goro and Akiba (2004) and possibly the youngest children in Unsworth and Helder (2007) and Unsworth and Gualmini (2007)). One explanation that is often invoked to explain this sort of findings is the learnability argument advanced by Crain et al. (1994). According to these authors, children must start off from the strong reading, because this is the only way for them to add a weaker reading on the basis of truth-conditional evidence. This is the Semantic Subset Principle. However, Gualmini and Schwarz (2007a) and Gualmini and Schwarz (2007b) recently showed that this claim ignores a wide range of sources of alternative evidence as well as truth-conditional evidence from sentences containing downward entailing operators. We must leave to further research the task of finding an explanation for the fact that strong interpretations seem to have a special place in the early stages of language acquisition. In fact, an interesting question for future research is why strong interpretations seem to play a crucial role for adults when it comes to many linguistic phenomena (e.g., among many others reciprocals (Dalrymple, Kanazawa, Kim, Mchombo and Peters (1998)), plurals (Winter (2001)), implicatures (Chierchia (2004)) and accommodation (Singh (2008)) among many others).

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