

New Directions in the Acquisition
of Romance Languages:
Selected Proceedings of The Romance Turn V

Edited by

João Costa, Alexandra Fiéis, Maria João Freitas,
Maria Lobo and Ana Lúcia Santos

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P U B L I S H I N G

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This book first published 2014

Cambridge Scholars Publishing

12 Back Chapman Street, Newcastle upon Tyne, NE6 2XX, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

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ISBN (10): 1-4438-5948-6, ISBN (13): 978-1-4438-5948-6

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ASYMMETRIC ENTAILMENT AND THE INTERPRETATION OF *POTERE* IN EARLY ITALIAN

VINCENZO MOSCATI

Introduction

The linguistic category of modality, as the one of tense, is often used to refer to situations far from the actual here and now. This property, considered from the point of view of language acquisition, poses a series of non-trivial challenges for young language learners. The matter is further complicated by the fact that modal expressions often appear together with other logic operators, as for example negation or focus. In these cases, the correct interpretation of the sentence depends not only on the meaning of each single operator but also on their mutual scope assignment relations. In particular, the interaction between two operators can generate logical ambiguities that the child has to solve in order to converge on the adult meaning. For example, consider the two different meanings ‘*not possible*’ and ‘*possible not*’. Every adult English speaker knows that the modal expression *might not* corresponds to the interpretation ‘*possible not*’ and he or she is able to exclude the alternative interpretation *‘*not possible*’. The correct mapping between form and meaning has to be learned and this can be done, in principle, in two ways. The first is to assume that both interpretations are initially active and that only the adult one survives on the basis of the input provided by the local language. The second is that children initially start off with only a single interpretation and that successively, if necessary, they revise their initial hypothesis. In order to decide between these two possibilities, it is then crucial to determine whether both the interpretations ‘*possible not*’ and ‘*not possible*’ are accessible at a given developmental stage.

This kind of research question has been central in previous studies on language comprehension and, in case of scope ambiguities, the results suggest that one interpretation is prominent over the other. Interestingly, the favoured interpretation is not always the adult one. The nature of this

interpretive bias is still a matter of controversy and different authors propose different accounts, capitalizing on pragmatic felicity conditions (Gualmini, 2008), on the syntax-semantic interface (Lidz & Musolino, 2002) and on learnability considerations rooted in the semantics (Crain, 2012; Crain et al, 1994; Moscati, 2008; Gualmini & Moscati, 2009). The goal of this paper is to test the predictions of the latter account by investigating the interpretation of the Italian modal verb *potere* in negative sentences where potential scope ambiguities are generated.

1. Informational strength and scope relations

Given that the semantic account predicts an asymmetry in language development between the two meanings ‘possible not’ and ‘not possible’, I will preliminarily introduce the notions of *force*, *informational strength* and *scope*. This will suffice to qualify the relevant semantic difference between the two meanings.

First, modals can be differentiated in relation to their quantificational *force*. According to the traditional analysis of modality based on possible world semantics (Kripke, 1959; Hintikka, 1957; Lyons, 1977), modals can be assimilated to quantifiers over sets of possible worlds. To illustrate, consider the pair below:

- (1) Mata Hari might be a spy
- (2) Mata Hari must be a spy

The difference in meaning between (1) and (2) is captured by assuming that, for sentence (1) to be true, the proposition “Mata Hari is a spy” is true in *at least one* of the possible worlds taken into consideration. In the case of (2), instead, the same proposition has to be true *in every* possible world. Therefore, *might* in (1) has an existential force while *must* in (2) has a universal force.

The fact that sentence (1) has weaker truth-conditions than (2) leads us to the second notion, the one of *informational strength* (Gadzar, 1979; Horn, 1989). If the entailment relation between (1) and (2) is considered, we observe that (2) asymmetrically entails (1): there exists no possible scenario in which (2) is true and (1) false at the same time¹, while it is perfectly possible to conceive a scenario in which (2) is false but (1) true. Therefore, *must* is stronger than *might* since an asymmetrical entailment relation holds between the two:

- (3) *must* (necessity) \rightarrow *might* (possibility)

Things get more complicated if an extra operator is added to the sentence. Negative sentences are a paradigmatic case. Consider what happens when a negative operator takes *wide scope* over a pair of modal expressions:

- (4) Mata Hari can not be a spy (not > possible)
 (5) Mata Hari doesn't have to be a spy (not > necessary)

Negation being a *downward entailing* operator, the entailment now goes in the opposite direction. The relative strength of modals is inverted and (4) asymmetrically entails (5) (under wide scope of negation i.e. *not necessary, not possible*):

- (6) *doesn't have to* (not necessary) ← *can not* (not possible)

Finally, to fully capture the complex way negation and modality interact, the scope between the modal expression and negation has also to be considered. Negation may combine with a modal in two different ways: either taking wide (as in the previous examples) or narrow scope (see Moscati, 2010). At this point, strong and weak readings can be defined with respect to each scope assignment:

- | | | | |
|-----|------------------|---|------------------|
| (7) | | | |
| | STRONG | | WEAK |
| | a. not possible | → | c. possible not |
| | b. necessary not | → | d. not necessary |

We are now in a favourable position to capture a possible difference, rooted in the semantics, between the readings 'not possible' and 'possible not'.

Crain et al. (1994), extending the Subset Principle argument (Berwick, 1985; Manzini & Wexler, 1987), proposed that initially children are biased towards the strongest meaning. This will insure that positive evidence alone suffice to drive children toward the adult meanings (see Moscati & Crain 2014). The prediction, based on the entailment relations given in (7), is that the strong interpretations in (7)a-b should be unproblematic for children from early on. On the contrary, weak interpretations as in (7)c-d are expected to be delayed. This prediction, already confirmed with deontic modality (Moscati & Gualmini, 2008; Gualmini & Moscati, 2009; Moscati, 2008; Moscati, 2011), will be tested next with epistemic modals,

in order to assess whether the modal base plays any role in facilitating children's access to the weak readings.

2. Epistemic possibility: an experiment on weak readings

Languages might employ different strategies to disambiguate scope assignment. In the case of quantificational determiners, for example, the lexical alternation in (8) and (9) between Positive Polarity Items and Negative Polarity Items is well known.

- (8) John didn't read *any* books
 (9) John didn't read *some* books

In (8), *any* scopes under negation and the only possible reading is the one in which John read no book. In (9), instead, *some* scopes over negation and the result is an existential reading; in this case, there is a certain number of books that John didn't read but there might be other books that John could have read. As in the case of quantificational determiners, also modals can encode a similar sort of polarity restrictions. In English, for example, the alternation between *can* and *might* in negative sentences is used to disambiguate the logical scope of the modal operator. Consider the minimal pair below:

- (10) Mata Hari might not be a spy
 a. it is possible that Mata Hari is not a spy (weak: possible > not)
 b. *it is not possible that Mata Hari is a spy (strong: not > possible)
- (11) Mata Hari cannot be a spy
 a. *it is possible that Mata Hari is not a spy (weak: possible > not)
 b. it is not possible that Mata Hari is a spy (strong: not > possible)

In (10) and (11), scope assignment is fixed and the two sentences are used to convey two distinct interpretations: wide scope of the modal in (10) and narrow scope in (11).

However, lexically encoded polar restrictions are only one of the possible disambiguating strategies. Languages with a more impoverished modal paradigm must resort to some alternative strategy. Standard Italian, for example, has an extremely simple modal paradigm, with only two forms used to express 'possibility' (*potere*) and 'necessity' (*dovere*). Interestingly, in the case of *potere*, the scope assignment is entirely determined by the surface word order. Consider the minimal pairs in (12) and (13):

- (12) Mata Hari può non essere una spia
 Mata Hari poss. not be a spy
 a. it is possible that Mata Hari is not a spy (weak: possible > not)
 b. *it is not possible that Mata Hari is a spy (strong: not > possible)
- (13) Mata Hari non può essere una spia
 Mata Hari not poss. be a spy
 a. *it is possible that Mata Hari is not a spy (weak: possible > not)
 b. it is not possible that Mata Hari is a spy (strong: not > possible)

Sentences (12) and (13) only differ as to the position of the modal with respect to the negative marker. In (12), *non* follows the modal *potere* and the sole interpretation is the weak reading ‘possible not’. In (13), instead, the negative marker precedes the modal and the resulting interpretation is the strong ‘not possible’ reading. Given its extremely simple paradigm and the absence of polarity restrictions encoded in the modal lexicon, Italian is a perfect testing ground to assess children’s initial preferences for scope assignment.

Before turning to the experiment, let me briefly consider again the experimental hypothesis, based on the Semantic Subset Principle (see Crain, 2012; Moscati & Crain, 2014). The role of the Semantic Subset Principle is to ensure that, whenever two meanings could be generated by a potentially ambiguous sentence and these two meanings are in a subset/superset relation, both meanings could be learned on the basis of positive evidence alone. The way this can be achieved is to assume that the meaning with the more stringent truth-conditions (i.e. the strong interpretation) will be hypothesized first by young children. Therefore, in the case of sentences like (12), the stronger meaning in (12)b should be children’s initial hypothesis, even if this reading is not allowed in the adult language. The prediction is that children would misinterpret (12) and consider it as having the same meaning of (13). We then expect that children will reject (12) if the sentence is presented in a scenario where only the weak adult interpretation (12)a is true.

2.1. Method and materials

The experimental setting was similar to the one used in Noveck (2001). Children had to reason on the content of a closed box (Box C) on the basis of the content of other two open boxes (Box A and Box B) and a rule (Box C = Box A or Box B). Let me illustrate with an example. Imagine that in the two open boxes A and B there are some toy animals as in (14).

- (14) Content of the open boxes
 Box A = cow, horse
 Box B = horse

Now, given the following restriction in force on the content of the closed box

- (15) Box C = Box A OR Box B

the content of Box C could be hypothesized, even if the box remains closed. In this case, only two possibilities exist

- (16) Possible content of the closed Box C
 a. cow, horse
 b. horse

On the basis of this scenario, a series of modal statements can be evaluated. For example, a sentence as “there might be a cow in the box” is true given (16)a, while a sentence as “there must be a cow in the box” is false, given that the closed box could also contain no cow as in (16)b. With respect to Noveck (2001), a minor variation was introduced. In addition to the objects within the open boxes, also an extra object (e.g. a strawberry) was placed outside the boxes².

The test sentences were counterbalanced for true and false answers and divided into three conditions: *positive* (17), *negative strong* (18) and *negative weak* (19):

- (17) a. Ci può essere una mucca nella scatola (T)
 “there might be a cow in the box”
 b. Ci può essere una fragola nella scatola (F)
 “there might be a strawberry in the box”
- (18) a. Non ci può essere una fragola nella scatola (T)
 “there cannot be a strawberry in the box”
 b. Non ci può essere una mucca nella scatola (F)
 “there cannot be a cow in the box”
- (19) a. Ci può non essere una mucca nella scatola (T)
 “there might not be a cow in the box”
 b. Ci può non essere un cavallo nella scatola (F)
 “there might not be a horse in the box”

Consider these sentences in relation to the content of box C. According to the experimental setup, box C contained either a cow or a cow plus a

horse. The extra object (strawberry) was positioned outside the boxes, so it could not be contained in box C. Given this state of affairs, sentence (17)a was true, given that in box A there is a cow. By contrast, sentence (17)b was false, because the strawberry is not in box A or in box B.

In the second pair, the negative strong condition in (18), the modal is contained in a negative statement. In (18) the modal *potere* follows the negative marker *non* and, here, the only interpretation for adults is the strong *not possible* reading. Under this interpretation, the assertion in (18)a that “there cannot be a strawberry” is true, whereas the assertion in (18)b that “there cannot be a cow” is false.

In the last pair, the negative weak condition, the order between negation and the modal is reversed and in (19) the modal precedes the negative marker. The only reading allowed in adult grammar is the weak interpretation *possible not*. Under this meaning, (19)a is true, since a cow is not necessarily in box C, while (19)b is false, since box C must contain a horse, either alone (box A) or with a cow (box B).

The experimental materials included eighteen white cardboard boxes, divided into six sets and disposed on a table in front of the participants. Different objects were placed inside the boxes (animals, fruits, small toys) and a hand puppet was employed to present the sentences. The participants’ role was to determine whether the puppet’s statement was ‘right’ or ‘wrong’ on the basis of the items placed within the cardboard boxes. Children rewarded the puppet with a prize every time they thought it said something right, while they gave it a neutral object when they thought it was wrong. Every time a sentence was judged ‘wrong’, the subject was asked to provide a brief comment and to say the reasons for his/her rejection.

The experimental session consisted of two parts. In the first part, two sets of boxes served to familiarize children with the task. At this stage, there was no modal and the puppet uttered a declarative sentence like “*there is/isn’t a X in the box*”. Similarly to the subsequent test phase, participants had to judge the puppet’s statement, but this time they were allowed to look into the closed box before deciding whether the puppet was right or wrong.

At the end of the familiarization procedure, children still had four sets of boxes in front of them and modal statements were now introduced. At this stage, six sentences were presented for each set of boxes. The order of presentation of the four sets was randomly varied and for each set, four different lists were prepared, varying the sequence of the test sentences. Participants were randomly assigned to one of these four lists. At the end

of the test session, every subject heard 8 sentences per condition, 4 true and 4 false, for a total of 24 sentences.

2.2. Participants

Twenty monolingual Italian-speaking children took part in the experiment, recruited from kindergartens in the cities of Siena and Florence. The age range was between 5;1 and 5;11 ($M=5;4$). A group of 18 adults served as a control group.

2.3. General Results

The proportion of correct answers for Positive, Negative Weak and Negative Strong sentences is reported in Figure 1. Participant's responses were considered successful whenever they accepted true sentences and rejected false ones, in accordance to the presentation setup. In case of 'wrong' answers, children had to say why the puppet was wrong and, in case the answer was inconsistent with the reasoning scenario, it was excluded from the count (e.g. "*wrong, because cows don't like boxes*").

Figure 1. Proportion of correct answers for condition in children and adults

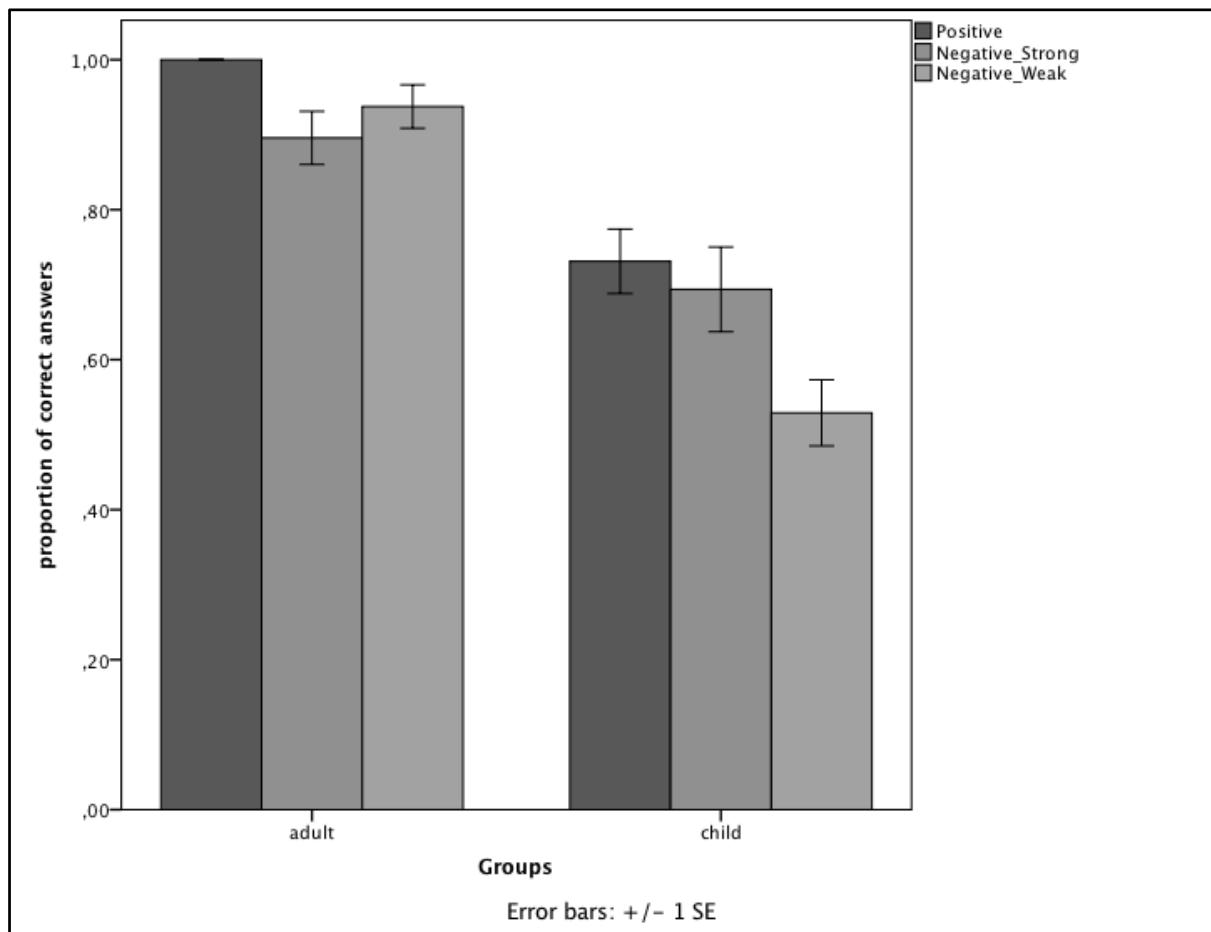


Figure 1 shows that the overall proportion of correct answers is lower in the children group, with the lowest proportion of correct answers found in the Negative Weak condition. A 2×3 ANOVA was conducted to analyse the data, with Age as a between-subject factor (adult, children) and Condition (positive, negative weak, negative strong) as a within-subject factor. The proportion of correct answers was transformed using the arcsin function and encoded as the dependent variable. The analysis showed a significant main effect of Condition ($F(2, 36) = 7.064, p < 0.005$) and Age ($F(1, 36) = 90.851, p < 0.001$). The interaction between Age \times Condition was also significant ($F(2, 36) = 3.352, p < 0.05$). A series of post-hoc comparisons (Bonferroni correction) revealed that the difference between the two groups was significant in both the Negative Weak and the Positive condition.

Let us discuss first the difference found in the Negative Weak condition. The low proportion of correct answers found with Negative Weak sentences is consistent with our experimental hypothesis and a difference between Negative Strong and Negative Weak sentences is in line with the predictions of the SSP. However, the SSP also predicts that children's difficulties should be confined to weak sentences that are true

only under their weak interpretation. If children would misinterpret Weak Negative sentences and assign them a strong interpretation, a high proportion of non-target rejection has to be expected under the given reasoning scenario. In order to verify this prediction, Weak Negative sentences should be observed separately for True and False answers. In table 1, the proportion of correct answers for true and false sentences is reported separately.

Table 1. Mean proportion of correct answers for true and false answers

Group	Positive		Negative Strong		Negative Weak	
	T	F	T	F	T	F
Children	0.53 (42/79)	0.94 (75/80)	0.64 (50/78)	0.75 (60/80)	0.38 (30/78)	0.67 (53/79)
Adults	1.00 (72/72)	1.00 (72/72)	0.79 (57/72)	1.00 (72/72)	0.94 (68/72)	0.93 (67/72)

Table 1 shows that True Weak Negative sentences are the most problematic for young children. In fact, they correctly accepted this kind of sentences only in the 38% of the cases. A series of t-tests revealed that the proportion of correct answers was significantly below chance only for True Negative Weak sentences ($t(24) = -2.366$, $p < .001$), while for all the other types of sentences in table 1, with the exception of True Positive sentences, children's proportion of correct answers was always significantly above chance (Positive False: $t(24) = 20.189$, $p < .001$; Negative Strong True: $t(24) = 6.859$, $p < .001$, Negative Strong False: $t(24) = 4.106$, $p < .001$; Negative Weak False: $t(24) = 4.226$, $p < .0001$).

The results of experiment 1 then indicate that the True Negative Weak sentences are systematically misinterpreted by young children, who consistently rejected them.

2.4. Positive conditions: subject's comments and focus

Let us now turn to children's answer in the positive condition. By inspecting the data (Table 1), it turns out that children's mistakes are largely confined to True Positive sentences like (17)a, where the proportion of correct answers drops to 53%. For the ease of the reader, (17)a is repeated below in (20).

- (20) Ci può essere una mucca nella scatola
 “there might be a cow in the box”

A first possibility is that the high rate of rejections is due to a misinterpretation of the modal verb. For example, rejections would follow if children confuse *potere/might* with *dovere/must*. Under this view, children would interpret (20) as “there must be a cow in the box”, which is false in the experimental setting. However, this kind of explanation is inconsistent with the motivations given by the children. Remember that, whenever the puppet’s sentence was judged ‘wrong’, we asked the subjects to say why they thought the sentence was inappropriate. Now, when they had to justify their rejections of (20), the majority of the children commented that the sentence was false “because there is also a horse in the box”. On the basis of this kind of comments, the idea that children interpret (20) as “there must be a cow in the box” seems not to be on the right track. In fact, the great majority of their comments would then become inconsistent, as shown by the following exchange:

- (21) Puppet: There *must* be a cow in the box
 Children: False. #There is also a horse in the box

This encourages us to explore a second alternative. As just said, children often used the expressions *also* in many of their comments, giving us a useful hint. In fact, this particle is related with focus (Krifka, 2007) and it is appropriate in responses to sentences with *only*, where an assertion excluding alternatives is generated (Horn, 1969), like in (22).

- (22) Every other x, where $x \neq$ cow, is not in the box

Now, (22) is clearly false in the context, given that a horse must also be in the box. According to this view, children correctly interpret the modal in (20), but they assign exhaustive focus to the nominal constituent “the cow”: a reading equivalent to “*only a cow*”. When children’s comments are considered, this second line of reasoning seems to be more appropriate, as the perfectly natural exchange below shows:

- (23) Puppet: There might be *only* a cow in the box
 Children: False. There is also a horse in the box

Under this account, children know the meaning of *potere/may* but they reject (20) by virtue of an interpretation that exhaustively focuses the constituent “the cow”. We may reason as follows: the test sentences

involve one animal that, in accordance to the experimental scenario, cannot appear alone in the closed box. In this context, it may be quite infelicitous to mention only this animal among the possible content of Box C, without saying anything about the other animal. One way to accommodate the felicity conditions of the sentence, however, is to assume that the mentioned animal (e.g. the cow) is focused. In this case the sentence becomes felicitous, but its truth-conditions result strengthened by the generation of an implicit assertion of exclusivity as in (22).

2.5. Discussion

We observed two major differences between children and adults: children gave a significant higher rate of rejections of true sentences in the negative weak and in the positive condition. On the basis of children's comments, I argued that these differences are qualitatively different and they must be related to two distinct factors. For what concerns the negative weak condition, the low rate of acceptance was predicted by the initial experimental hypothesis. While children found it relatively easy to access the correct truth-values for negative strong sentences, they rejected negative-weak sentences. The other interesting asymmetry between adult and children regards instead the positive sentences. This difference is likely to be unrelated to modality, as suggested by children's comments. In fact, it can be accounted for by assuming that an implicit assertion of exhaustivity is generated.

A residual question is to assess whether the effects of exhaustivity can be put in relation with children's rejections of weak negative sentences. Let me briefly discuss this point, by assuming, for the moment, that also weak negative sentences such as (19)a are enriched by an assertion of exhaustivity similar to the one introduced by *only*. Following this reasoning, children's interpretation of (19)a is the same as in (24) below.

(24) "*there might not be only a cow in the box*" True

However, according to this interpretation, the sentence would still be true, given that in any case there is a horse in the closed box. This would then not explain why children reject true weak negative sentences. Let us consider what happens instead, if children assign the wrong inverse logic scope to sentence (19)a. In this case, a non-target strong reading as in (25) is generated.

(25) "*there cannot be one cow in the box*" False

Children's rejections now follow straightforwardly, given that the interpretation (25) was false in the context. This reading is also consistent with children's explanations. In fact, most of the time, children commented their rejections by saying that the sentence was false because "a cow *may* be in the box".

Let me take stock and summarize here the results of the experiment. The main result is a significant difference between adults and children, due to a lower performance of the 5 year olds in the positive and in the weak negative condition. What is interesting for our hypothesis is the fact that a sharp asymmetry between negative strong and negative weak sentences emerges, confirming that these two constructions pose different challenges. A residual question concerns the high rate of rejections found in the positive condition. However, children's explanation of their rejections suggests that an extra factor, related with focus, might be at play here³.

3. General Discussion

Broadly speaking, the category of epistemic modality allows the speaker to modulate his degree of confidence about a proposition. This is to say that, on the basis of world knowledge, an event is judged more or less likely to happen in accordance with the strength of our beliefs. This intuition played a central role in language development as modals have been often compared in relation to their strength. However, in previous studies, the notion of strength was not fully explored in those cases where two (or more) logic operators interact. In particular, strength relations can be reversed when negation is entered into the equation and the strength of the proposition crucially depends on the scope assigned to the negative operator. It is easy to check that, while in positive sentences *necessary* is stronger than *possible*, in cases where negation takes wide scope *not necessary* becomes weaker than *not possible*. On the basis of these considerations, it is possible to isolate a family of weak negative readings, stemmed from the interaction between modality and negation. For the ease of the reader, I repeat (7) in (26) below, where the entailment relation defines the weak readings:

(26)		
STRONG		WEAK
a. not possible	·	c. possible not
b. necessary not	·	d. not necessary

The goal of this paper was to show that weak readings could be delayed with respect to strong ones, at least in Italian, a language with an extremely simple modal paradigm: the experimental results presented in the previous section show that children do not have problems in negative sentences tout court, but only with the weak negative ones.

This account could explain some of the results reported in the previous studies on modal comprehension. As an example, the sentences from (20) to (22) have been listed among the most difficult to process:

- | | |
|---|-------------------------|
| (27) It might not be under the blue cup | (Byrnes and Duff, 1989) |
| (28) There might not be a bear | (Noveck, 2001) |
| (29) There does not have to be a bear | (Noveck et al., 1996) |

Now, to the extent that our results on Italian could be generalized, the complexity posed by (27), (28) and (29) ceases to be unexpected. In fact, all these sentences belong to the same family of weak readings.

In concluding this paper, I wish to consider one last point and discuss why weak readings should be disadvantaged with respect to strong readings. Up to now, we assumed that the special status of weak readings is confined to early stages of development. In this case, a learnability account could explain not only the difference between strong and weak readings, but also the difference between adult and children. For a proposal along these lines, I remand to the literature on the Semantic Subset Principle (Crain et al., 1994; Moscati, 2008; 2009; Gualmini & Moscati, 2009; a.o.). Under this account, strong and weak readings have the same computational cost and the initial advantage of strong readings is explained by a learnability bias. A second possibility, which I would like to briefly consider, is that the processing cost of negation is variable and that it increases for weak readings⁴. Let me conclude by introducing the main intuition behind this idea.

The fact that the processing of negation has a cognitive cost is well known at least since Wason (1965) and it is plausible that this cost is not fixed, but it varies in accordance to the scope-interaction between negation and other sentential operators. For example, the processing cost of negation could be higher when weak readings are generated. Consider all the necessary computational steps required to form the correct meaning. In accordance with the principle of compositionality, the meaning of the sentence is built incrementally and, in a bottom-up derivation, the first element that is passed to the semantic interface (Chomsky, 2001) is the event structure. Successively, all the other sentential operators in the inflectional system, including modals, are processed. Thus the event structure will be the first to be sent to the interface, followed by the modal

base and the quantificational force of the modal. The processing order of negation will instead vary in accordance to its scope and in the case of strong sentences with *potere*, negation will be the last element to be processed. Thus, for a strong sentence as “the cow cannot be in the box”, the computation will proceed as follows, moving from the core event structure to the negative operator:

(30) [_Cnot [_Bexists a world where [_Ainside (cow, box)]]]]

The first operation is to create the event structure (30)_A. Successively, the modal is interpreted (30)_B in accordance to its force (existential)⁵. Finally, the negative operator is added (30)_C. Let’s consider each step in turn:

(30)_A. Event structure: the representation *inside(cow, box)* is created.

(30)_B. Modal: The accessibility relation (in this case epistemic) denotes the set *W* of worlds where the relation *inside(cow, box)* is validated. The (existential) quantifier insures that this set is not empty: $W \neq 0$

(30)_C. Negation inverts the truth-value: $W = 0$

According to this derivation, when the modal is processed (30)_B a set of world is created. Notice that, in this case, only the set of possible worlds where a cow is within the box is taken into consideration: alternative event structures (e.g. worlds where a horse or a crocodile are inside the box) are not examined. In the case of weak readings, instead, it can be shown that a wider set of worlds needs to be taken into account.

Consider the case of weak ‘*possible not*’ readings. Here negation has narrow scope and enters into the computation at a different stage, preceding the modal. Negation now is processed immediately after the event structure:

(31) [_Cexists a world [_Bnot [_Ainside (cow, box)]]]]

(31)_A Event structure: the representation *inside(cow, box)* is created.

(31)_B. Negation is applied: alternative events are taken into consideration (the box is empty, a horse is in the box, a crocodile in the box, ...)

(31)_C Modal: The accessibility relation (in this case epistemic) denotes the set *W* of worlds where the relation *not inside(cow, box)* is validated. The (existential) quantifier ensures that this set is not empty: $W \neq 0$

Notice that now negation is considered after the event structure, and it applies on its complement set. This forces us to consider a wider array of possible events (e.g. worlds where a horse or a crocodile are inside the box). Negation then has the effect of enlarging the set of worlds under

consideration. Under this account, weak readings require extra cognitive resources both for adults and children. However, these resources might not be fully available to children at this stage. Thus, children may opt for the less demanding reading and interpret the sentences in accordance to the stronger meaning.

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Notes

¹ When (2) is true, normally speakers reject (1) even if (1) is logically true. In this case, (1) is true but infelicitous once scalar implicatures are computed.

² This allowed an extra condition, the one in (18)a, with true strong negative sentences.

³ If this idea is on the right track, the effect of focus can be disentangled from the one of strength by manipulating the context. For example, if only a single animal is allowed in Box C (either a cow or a horse), the positive sentences “there might be (only) a cow” would become true, regardless of the presence of a covert *only*. We then expect a steady increase in the acceptance rate for positive sentences. On the contrary, no improvement should be observable in negative weak sentences (see Moscati 2013, Moscati & Crain 2014).

⁴ Under this account, we might expect that even adults, provided with a sufficiently demanding task, should encounter certain difficulties with weak negative sentences.

⁵ To simplify, in the paraphrases in (30) the modal base has been omitted since it is not directly relevant to the discussion. A more accurate paraphrase would have been “It does not exist a world, on the basis of the available knowledge, where a cow is inside the box”.