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The acquisition of scope new evidence from modality

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Early scope: the observation of Isomorphism

It has been observed that children access with difficulty adult interpretations of sentences with negation and a quantified expression (Musolino, 1998; Musolino, Crain and Thornton, 2000) :

- (1) The detective didn't find some guys
- (2) Every horse didn't jump over the fence
- (3) The detective didn't find two guys

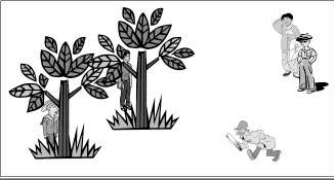


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Negation and existential quantifiers

(1) The detective didn't find *some* guys
inverse: $\exists(x) [\text{guys}(x) \wedge \neg \text{detective find}(x)]$

Testing the interpretation: TVJT (Crain & Thornton 1998)
Musolino (1998)



Sentence (1) is True given the context primed by the picture on the left.



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Negation and existential quantifiers

Musolino et al. 2000

age	rejection
G1 3.10 – 5.2	65%
G2 5.2 – 6.6	35%
Adult	0%

(1) The detective didn't find *some* guys FALSE
 $\exists(x) [\text{guys}(x) \wedge \neg \text{detective find}(x)]$ ('because the detective did find some guys')

The detective didn't find *some* guys
↓
The detective didn't find *any* guys



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Negation and universal quantifiers

(2) Every horse didn't jump over the fence
surface: $\forall(x) [\text{horse}(x) \rightarrow \neg \text{jump over the fence}(x)]$
inverse: $\neg \forall(x) [\text{horse}(x) \rightarrow \text{jump over the fence}(x)]$

Musolino et al. 2000



Sentence (2) is True under the Inverse scope interpretation.



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Negation and universal quantifiers

Musolino et al. 2000

age	rejection
4.0 – 7.3	92.5%
adults	0%

(2) Every horse didn't jump over the fence FALSE
(because some did jump)

surface: $\forall(x) [\text{horse}(x) \rightarrow \neg \text{jump over the fence}(x)]$ False \Leftarrow
inverse: $\neg \forall(x) [\text{horse}(x) \rightarrow \text{jump over the fence}(x)]$ True



Negation and numerals

(2) The detective didn't find two guys

surface: $\neg [\exists(x) [\text{detective find } 2(x) \wedge \text{guys } (x)]]$

inverse: $\exists 2(x) [\text{guys } (x) \neg \text{detective find } 2(x)]$

Test on Inverse scope interpretation. Musolino and Gualmini, 2004.

age	rejection
3.9 – 4.11	75%
adults	5%



The observation of isomorphism

(1) The detective didn't find some guys

surface: $\neg [\exists(x) [\text{detective find } (x) \wedge \text{guys } (x)]]$

inverse: $\neg \exists(x) [\text{guys } (x) \neg \text{detective find } 2(x)]$

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

surface: $\forall(x) [\text{horse}(x) \rightarrow \neg \text{jump over the fence}(x)]$

inverse: $\neg \forall(x) [\text{horse}(x) \rightarrow \text{jump over the fence}(x)]$

(3) The detective didn't find two guys

surface: $\neg [\exists(x) [\text{detective find } 2(x) \wedge \text{guys } (x)]]$

inverse: $\neg \exists 2(x) [\text{guys } (x) \neg \text{detective find } 2(x)]$



Can inverse scope be accessed ?

Other factors seem to play a role in computing the logic scope of the sentence. In particular, pragmatics may override the *preference* for surface scope readings (Gualmini 2004, Musolino & Gualmini 2004, Musolino & Lidz 2004).



(1) Existential Quantifiers

Gualmini 2004: **Negative sentences must obey to certain felicity conditions.** He replicated 'the detective stories' of Musolino et al. 2000.

Situation: two dwarves were found and two were not found by the firefighter.

'This is a story about a firefighter playing hide and seek with 4 dwarves and I know what happened':

Condition 1: 'the firefighter didn't find some dwarves'

Condition 2: 'the firefighter didn't miss some dwarves'



Gualmini, 2004

Exp.condition	rejection
Group A 4;01- 5;06: condition 1	10%
Group B 4;02 – 5;8: condition 2	50%

Children are sensitive to the lexical verb used. The proposed explanation is that the use of the verb 'miss' it is not felicitous given the expectations created by the story. In condition 1, Children may have access to the adult-like inverse scope interpretation of Some > Not.



(2) Universal Quantifiers

Musolino & Lidz 2004: **the context may prime for inverse scope.**

They also replied the experiment in Musolino 2000, with an additional experimental condition.

Condition 1 – No contrast



Every horse didn't jump over the fence

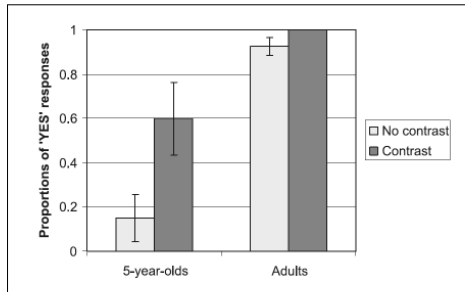
Condition 2 - Contrast



Every horse jumped over the log but...
[every horse didn't jump over the fence]



Results from Musolino & Lidz 2004



Interim conclusions

- 1) It has been observed that children are sensitive to the linear order in computing LF-Scope.
- 2) There are several counterexamples which indicates that inverse scope can be accessed by children as young as 4 years old, given certain conditions not yet understood.
- 3) This suggests that covert LF-operations are available to children.

Negation and Modality

A new set of data

Investigations on scope assignment of logical operators focused only on the interactions between negation and nominal quantifiers (O'Leary & Crain 1994, Thornton 1994, Musolino 1998, Krämer 2000, Musolino et al. 2000, Gualmini 2004, Musolino 2006). So far, isomorphism has been noticed only with relation to this kind of operators.

What about other kind of scope-bearing elements?

Modality is a natural candidate to test the predictions of the isomorphism hypothesis.

Modal operators can be treated as quantifiers over possible worlds (Hintikka 1962, Kripke 1963, Stalnaker 1968, Lewis 1973).

Necessity ($\Box\phi$) = ϕ is true in $\forall w \in W$
 Possibility ($\Diamond\phi$) = ϕ is true in $\exists w \in W$

The problem for the computation of scope is similar to the one posed by nominal quantifiers and negation. For this reason we might want to test if a preference for isomorphic readings can be found also with quantifiers over possible worlds.

Inverse scope with modals in Italian and English

We designed two experiments for testing if Italian- and English-speaking children may access the inverse scope reading in sentences with a modal operator and negation. Both Italian and English show constructions in which LF/PF forms are non-isomorphic.

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Experiment 1

Negation and Necessity in Italian

(4) Gianni non deve prendere la medicina
Gianni not must take the medicine
'Gianni must not take the medicine'

Surface
4a. It is not necessary that Gianni takes the medicine → □

Inverse
4b. It is necessary that Gianni doesn't take the medicine □ →

Can children access the reading in 4b?

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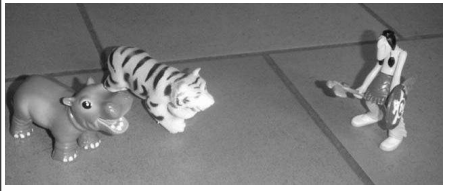
Method: act out of 4 stories with two questions at the end to test the children's interpretation.

Participants: 17 monolingual Italian-speaking children (4;5 – 6;2, mean 5;3) from 'Asilo S.Benedetto' (Siena).

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The indian and the hippo

The Indian wants to play with some animal and there are two animals to ride: an hippo and a tiger.



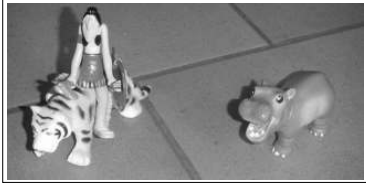
But: (5) 'l'indiano non deve cavalcare l'ippopotamo'.
the indian not must to ride the ippo
'the indian must not ride the hippo'

5a. It is not necessary to ride the hippo → he can
5b. It is necessary not to ride the hippo → he cannot

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Control: Underspecified question

We want to control if children answer 'yes' to a contextually underspecified question.

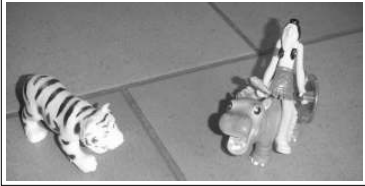


(6) il capo indiano può cavalcare la tigre?
the leader indian can to ride the tiger
'can the indian leader ride the tiger?'

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Target: Ambiguous sentence

Children are expected to answer 'yes' if they interpret the target sentence under surface scope (underspecified) and 'no' if they interpret (5) under inverse scope.



(7) il capo indiano può cavalcare l'hippo?
'can the indian leader ride the hippo?'

Target: 'l'indiano non deve cavalcare l'ippopotamo'.
Surface: It is not necessary to ride the hippo → he can
Inverse: It is necessary not to ride the hippo → he cannot

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Results

Table 1: answers to control question

Story	'yes' answers to control question (n/total)	%
Story 1	14/17	82,3
Story 2	15/17	88,2
Story 3	17/17	100
Story 4	16/17	94,11
Tot.	59/68	86,7%

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Results

Table 2. Answers to test question

Story	'no' answers to target question (n/ total)	%
Story 1	11/14	78,5%
Story 2	14/15	93,3%
Story 3	15/17	88,2%
Story 4	12/13	92,3%
Tot.	52/59	88,1%

There are only 7 'yes' to the target question. One children Sveva answered 'yes' to both the control and the target of story 2-3, but she added: *'Kermit said it cannot, but I say yes'*

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Experiment 2

Negation and Possibility in English

(12) John cannot take the medicine

Surface scope
12a. *It is possible for John not to take the medicine $*\diamond > \neg$

Inverse scope
12b. It is not possible for John to take the medicine $\neg > \diamond$

Sentence 12 do not allow an isomorphic reading in adult English. We know, however, that children may access other interpretations forbid for adult (Musolino et al. 2000). Is this the case for (12)?

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Method: act out of 4 stories with two questions at the end to test the children's interpretation.

Participants: 15 monolingual English-speaking children (4;0 – 5;5, mean 4;9).

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Buzz and the Alien


Hi Alien, here is a fun game you can play. You need to put the balls away and there is only one rule:



(13) The red ball cannot be with the yellow ball


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Control




(14) can I put the blue ball with the yellow ball?

Ok, good.



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Target




now the red ball....
(15) Can I put it with the yellow ball?

Control 2

(16) Can I put it with the green ball then?

I'm done!



Results

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Table 3: 'yes' answers to control question

n/total	%
47/60	78,3

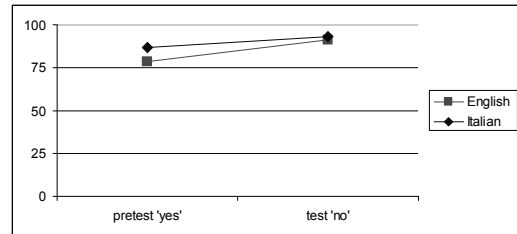
Table 4: 'no' answers to test question

Story	N° 'no' answers to target question (n/total)	%
Story 1	9/11	81%
Story 2	9/10	90%
Story 3	12/12	100%
Story 4	13/14	92,8%
Tot.	43/47	90,9%

General Results

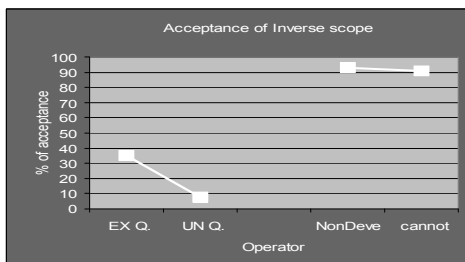
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Fig1. Answers to the pre-test and to the test question by Italian and English children.



General Results

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- 1) $\exists x$, Musolino et al. 2000 (age 4,7)
- 2) $\forall x$, Musolino et al. 2000 (age 5,11)
- 3) $\neg\phi$, Moscati & Gualmini 2007 (age 5,3)
- 4) ϕ , Moscati & Gualmini 2007 (age 4,9)

Two models for scope resolution

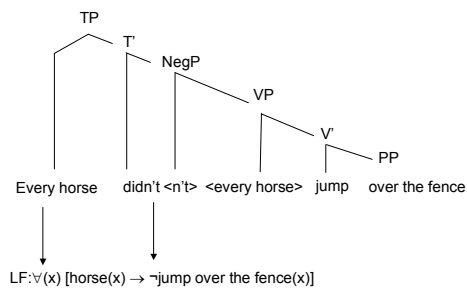
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- Isomorphism by default (Musolino & Lidz 2006)
- Question-Answer Requirement (Husley, Hacquard, Fox & Gualmini, 2005)

Isomorphism by default

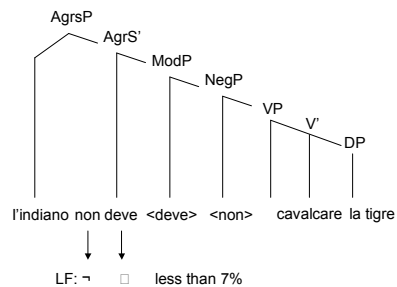
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Isomorphism is a real syntactic phenomenon, due to the parsing mechanism.



With respect to our experiments 1 & 2, this mechanism incorrectly predicts that children will interpret the modal operator within the scope of negation in Italian, and the other way around in English.

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A pragmatic theory of scope assignment: Question-Answer Requirement

The selected interpretation should be or entail a good answer to the Question-Under-Discussion selected by the context:

QUD: Did the firefighter found all the dwarves ?

Condition 1: 'the firefighter didn't find some dwarves'
Surface: the firef. didn't find any dwarves
Inverse: there are some dwarves that the firef. didn't find

Condition 2: 'the firefighter didn't miss some dwarves'
Surface: the firef. didn't miss any dwarves
Inverse: there are some dwarves that the firef. didn't miss

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Question-Answer Requirement: Modals

Experiment 1 (and 2)

QUD: l'indiano può cavalcare la tigre? NO ?

Target: l'indiano non deve cavalcare la tigre

Inverse: l'indiano deve non cavalcare la tigre

Surface: l'indiano non deve cavalcare la tigre

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Experiment 3 : Evaluating the QAR

We expect that the interpretation is dependent on the QUD.
 We could than manipulate the QUD in order to vary between surface and Inverse scope.

Method: act out of 4 stories using the Truth Value Judgment Task (Crain & Thornton, 1998) to test the children's interpretation. Each children heard 2 stories with the QUD1 and 2 stories with the QUD2.

Participants: 17 monolingual Italian-speaking children (4;0 – 5;5, mean 4;9).

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The farmer's story




The farmer must feed his animals...

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he has turnips and carrots . . .



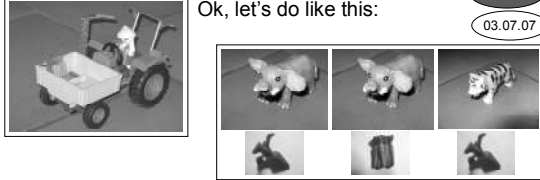
And he has to feed two elephants and a tiger.



But the tiger does not like carrots.

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Ok, let's do like this:



*Now the story is finished. Did you pay attention Kermit?
 I'm gonna ask you a question...*

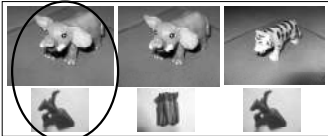
QUD-1: Il contadino deve dare le carote all'elefante?
'must the farmer give carrots to the elephant?'

QUD-2: Il contadino può dare le carote all'elefante?
'Can the farmer give turnips to the elephant?'

Target: Il contadino può non dare le carote all'elefante
'the farmer need not to give turnips to the elephant'

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QUD-1



QUD-1: Il contadino deve dare le carote all'elefante? NO
'must the farmer give carrots to the elephant?'

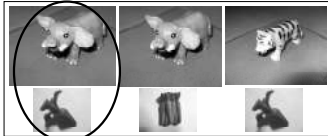
Target: Il contadino può non dare le carote all'elefante
'the farmer need not to give turnips to the elephant'

surface: It is possible not to give carrots to the elephant TRUE

inverse: *It is not possible to give carrots to the elephant FALSE

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QUD-2



QUD-2: Il contadino può dare le carote all'elefante? ??? NO
'can the farmer give carrots to the elephant?'


Target: Il contadino può non dare le carote all'elefante
'the farmer need not to give turnips to the elephant'

surface: It is possible not to give carrots to the elephant TRUE

inverse: *It is not possible to give carrots to the elephant FALSE

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Dwarves in a 500



We must give a car to all the characters. The big Roman need a big car, but for the dwarves the size of the car does not matter.

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QUD-1: Dobbiamo dare l'auto grande al nano?
'must the farmer give turnips to the elephant?'

QUD-2: Possiamo dare l'auto grande al nano?
'must the farmer give turnips to the elephant?'

Target: Possiamo non dare la macchina grande al nano
'we need not to give the big car to the small dwarf'

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Results

Story	QUD	Rejection
1	a	4/8
	b	4/4
2	a	7/7
	b	3/7
3	a	3/5
	b	2/6
4	a	4/6
	b	6/8
Tot		33/51

Children reject the target sentence in 64% of the cases. There is a strong preference for Inverse scope, even if this reading is not allowed in adult Italian.

Remember that the target sentence is True on its surface scope interpretation. This data is in clear contrast with the Isomorphism-by-default.

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Evaluation of the QAR

The QAR predicts that both interpretations of the target sentence are good answers to Question 1.

In the case of Question 2, only inverse scope is a good answer. We should find a preference for inverse scope and an higher rate of rejections.

QUD	acceptance	rejection	% of acceptance
#1	8	18	30,7
#2	10	15	40


The expectation is disconfirmed:

- Results are not significant
- We have even an higher acceptance for inverse scope with QUD#1

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Checking of rejection cases

Target: Possiamo non dare la macchina grande al nano



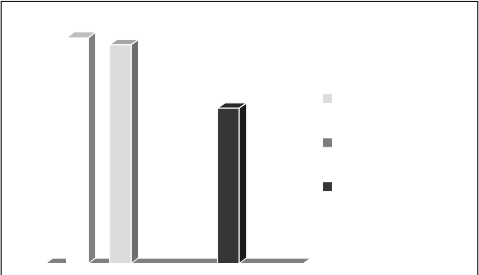
We ask for explanations in every case of rejection. All the children justify their answer as follows: 'Because you can give the big car to the dwarf'

Target: Possiamo non dare la macchina grande al nano
inverse: *It is not possible to give the big car to the dwarf

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Experimental results

Inverse Scope in modal constructions



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Two (or more?) possible accounts

Language specific or General Principles

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Principle of Charity

(1) l'indiano non deve cavalcare l'ippopotamo
(2) The alien cannot put the red ball with the yellow
(3) Il contadino può non dare le carote all'elefante

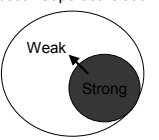
} Inverse Scope

All the selected interpretations are STRONG:

- The inverse scope reading has more restrictive truth conditions
- The inverse scope reading asymmetrically entails the surface scope reading

Subset - Superset relation

(1) Non deve : MUST > NOT → NOT > MUST
(2) Cannot : NOT > CAN → CAN > NOT
(3) Può non : NOT > CAN → CAN > NOT

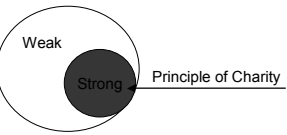


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Wilson's principle of Charity (1959)

(or Rational Accomodation, Davidson)

The hearer interpret the speaker's statement by rendering the best, strongest possible meaning



This is conform to the Semantic Subset Principle (Crain, Ni & Conway 1994), thus there will be no problem of learnability. Note that the SSP could be a different viable explanation of the data.

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Restructuring Domains

Another proposal will consider the results found in experiment (3) as dependent on the particular syntax of the relevant italian construction.

(1) l'indiano non deve cavalcare l'ippopotamo } Conform to adult grammar
(2) The alien cannot put the red ball with the yellow }
(3) Il contadino può non dare le carote all'elefante } Deviant Interpretation

The case in (3) represent a problem for every theory of Scope. But it may be due to special properties of Italian Syntax.

Constituent negation in 3 years old Italian children.

In the transcriptions of Martina, Raffaello and Rosa constituent negation is unattested.

	Sentential	Constituent
Martina	44	1
Raffaello	124	0
Rosa	87	1
tot.	255	2

It is possible that Italian-speaking children ignore constituent negation



Negation in 3 years old Italian children: copular omissions

The absence of constituent negation is compatible with the findings in Moscati 2006b: copular omissions are unattested with negation.

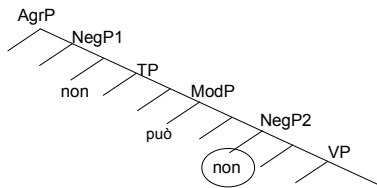
Tab. 9. Omission in negative contexts: Italian and English

	%	n. on total
Italian	0%	(0/63)
English	21%	(84/393)

An explanation of this phenomenon is that the X° status of 'non' forces the presence of a verbal host.



Low Negation



The correct status to negation in NegP2/constituent negation is problematic for children. They might 'normalize' it reducing to NegP1.



Conclusions

Pars destruens

- Sentences with modal verbs and negation cannot be explained by theories based PF/LF on isomorphism.
- Certain Italian sentences cannot be explained by pragmatic theories as QAR.

Pars construens

- The interpretations of sentences with modals and negation are in subset/superset relation. Children have no problem to access subset-inverse scope readings. In some cases they actually are biased toward them.
- The bias can be pragmatic in nature (Principle of Charity) or due to learnability (Semantic Subset Principle)

We can also explain the deviant interpretations assuming some deficit with restructuring construction or with constituent negation.

