

REVISITING CHILDREN'S UNDERSTANDING OF INVERSE SCOPE *

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1. Introduction

This paper investigates children's ability to access inverse scope interpretation in quantified sentences. Previous works have argued that 4 and 5 year old children differ from adults in the way they interpret sentences containing scope bearing elements (Musolino 1998, Musolino, Crain and Thornton 2000). In particular, these studies show that children display a strong preference for the isomorphic reading of the sentences in which two scope bearing elements co-occur; an effect dubbed *isomorphism*. Musolino et al. (2000) suggest that children at the age of 4-5 cannot access certain interpretations available in the adult grammar. Musolino & Gualmini (2004) and Musolino and Lidz (2006) present a series of experiments whose results challenge this conclusion. They show that under certain *manipulations*, 5 year olds can access the same range of interpretations that are found in the adult system. In particular, Musolino and Lidz (2006) test negated sentences containing a universal quantifier and show that a preceding affirmative statement facilitates children's interpretation of inverse scope in these sentences. However, Musolino & Gualmini (2004) independently test sentences with existential quantifiers and report that children cannot access inverse scope reading even in the presence of a preceding affirmative statement. These conflicting results point to a possible problem for the claim that contextual *manipulation* is key to children's access to inverse scope. The studies mentioned above investigate children's understanding of inverse scope in negated sentences. In this study, I do not appeal to negated sentences as testing items.

Primarily, I present results from an experiment in which children's abilities in accessing the inverse scope interpretation is tested in three different sentence types: sentences with Prepositional Phrases, *there*-expletive constructions, and sentences with Actional Verbs. Our main finding is that it is possible for 4-5 year olds to access the inverse scope reading in these sentence types.

This paper is organized as follows: In section 2, I outline the general findings of the

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previous studies on children's inverse scope interpretations. In section 3, I introduce the experimental settings and the methodology we used in our actual experiment of children's understanding of the inverse scope. Section 4 of the paper presents a discussion of the results we gained from the experiment and its implications for our understanding of children's ability to access inverse scope. Section 5 concludes the paper.

2. Background

It has been reported that children respond non-adult like in experiments that test their knowledge of universal quantification (Phillip 1995, Roeper and de Villiers 1991, among others). Children at the age of 4-6 respond to a question such as "Is every boy riding a pony?" by saying "No" to the pictures where there are *boy-pony* pairs and an extra *unridden pony*. This phenomenon, which is known as *symmetrical response*, gave rise to a line of study in which children's knowledge of quantification is investigated. Phillip (1995) suggests that children have a semantic representation of the universal quantifier *every* that is different from that of adults'. In particular, Phillip proposes that in children's grammar a universal quantifier such as *every* is treated as an adverb that quantifies over an event variable, rather than an individual variable, and this is the reason why children give the so-called *symmetric* responses. Children's semantic representation for a universally quantified sentence such as "Every boy is riding a pony" is as follows, according to Phillip (1995):

"All minimal events in which either a pony or a boy (or both) is a participant are events in which a boy is riding a pony".

Crain et al. (1996) challenge this proposal, and show through a series of experiments that what is referred to as children's symmetry requirement is overcome under different types of experimental settings, and that young children are in principle adult-like in their interpretation of quantifiers such as *every*. Crain et al. (1996) use a Truth Value Judgment task where a pragmatic relevance condition is satisfied. They claim that this pragmatic feature of their experimental design (called the condition of *plausible dissent*) is necessary to set up a circumstance that reveals children's adult-like knowledge of universal quantifiers as it introduces a ground for a possible outcome for the action at stake. If children are asked to assess whether a statement is true or false it should be clear to them why it is true or false. The condition on plausible dissent refers to those cases when the expected adult answer is "No". The experiments Crain et al. (1996) ran that satisfies this condition. They show that satisfying this condition significantly improves children's adult-like responses to sentences with the universal quantifier *every*. All the studies briefly represented here test the universal quantifier in the wide scope position. Rakhlin (2004) tests children's interpretation of the quantifier *every* in the narrow scope position. She observes that when the target sentences contain the quantifier *every* in the narrow scope position, half of the entire group of children she tested accepted the inverse scope reading, while the other half rejected it. Her results mainly indicate that it is possible for children at the young age to interpret the universal quantifier *every* in the adult way. Furthermore, Rakhlin (2004) suggests that it is the wide

scope indefinite that yields distinct responses among the children in the group she tested, because children interpret wide scope indefinites as ambiguous between a singleton and a multiple set reading. Rakhlin suggests that it is this ambiguity that yields children's occasional failure as they cannot fix the domain restriction of the quantifier.

Independently of the issue of whether or not children require symmetry while interpreting *every*, a significant number of studies have focused on children's interpretation of scope in sentences where two quantifiers interact. These studies have led to a variety of results: Lidz and Musolino (2006), for instance, report that children acquiring Kannada cannot access the inverse scope reading of the sentences containing an existential and negation even in the cases where this reading is the only reading available in adult grammar.¹ Krämer (2000) tests the interaction between the existential quantifier and negation and reports that Dutch children allow inverse scope interpretation even when it is not available in adult grammar.² Sano (2003) reports that Japanese children don't know that inverse scope interpretation is impossible in a canonical SOV sentence in Japanese.³

¹ More precisely, the accusative marked indefinite object results in specific interpretation that necessarily yields wide scope reading of the object in Kannada. Even in this environment, where the only possible adult interpretation of the sentence is the wide scope existential (non-isomorphic reading with respect to negation) children cannot access the non-isomorphic reading. It might be the case that the accusative marked object and the singleton indefinite have different semantic natures. In this respect we may want to reconsider their findings.

² She tested the following Dutch sentence:

(i) Een meisje is niet aan het dansen
 a girl is not PROGRESSIVE-dance
 'A girl is not dancing.'

(ii) $\exists x[\text{girl}(x) \ \& \ \neg[\text{dance}(x)]]$

(iii)* $\neg\exists x[\text{girl}(x) \ \& \ \text{dance}(x)]$

Notice that the only reading possible for adults is the isomorphic reading. Dutch children allow the reading in (iii) where the indefinite takes scope under negation.

³ Sano (2003) tests the following sentence from Japanese and reports that young Japanese-speaking children do not know that sentences with the canonical SOV order cannot have inverse scope in Japanese.

(i) Dareka-ga dono neko mo tukamaeta. (Canonical SOV)
 someone-Nom every cat caught
 'Someone caught every cat'

Below I present the cross-linguistic picture at hand:⁴

Table 1

English	Inverse scope access
$\forall > \text{Neg} / \mathbf{\text{Neg} > \forall}$ Musolino and Lidz (2006)	(without manipulation: NO) (with manipulation: YES)
$\exists > \text{Neg} / \mathbf{\text{Neg} > \exists}$ Musolino & Gualmini (2004)	(without manipulation: NO) (with manipulation: NO)
$\exists > \forall / \mathbf{\forall > \exists}$ Rakhlin (2004)	(without manipulation: 50% of the children YES)
Kannada $\mathbf{\exists_{acc} > \text{Neg}} / * \text{Neg} > \exists_{acc}$ Lidz and Musolino (2006)	NO
Japanese $\exists > \forall / \mathbf{* \forall > \exists}$ Sano (2003)	YES
Dutch $\exists > \text{Neg} / \mathbf{* \text{Neg} > \exists}$ Krämer (2000)	YES

Notice that the studies reported above do not uniformly consider the same type of quantifier, and the scopal possibilities are different in each language. What is prominent however, is that there are conflicting results on children's ability to access inverse reading. Except for Sano's (2003) work on Japanese, and Rakhlin's (2004) on English, studies investigating children's interpretation of inverse scope looked at children's interpretation of sentences where the universal quantifier interacts with negation. Below, I briefly go over the findings of the studies by Musolino (1998) and Musolino et al. (2000).

Musolino et al. (2000) test the following sentence where both $\forall > \text{NEG}$ (none) and $\text{NEG} > \forall$ (not all) readings are possible:

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

They report that children cannot access the inverse reading where negation scopes over the universal (i.e. $\text{NEG} > \forall$). In order to test whether certain manipulations enhance children's access to inverse reading, they use a preceding affirmative statement for the sentence in (1) as shown below:

⁴ The readings I marked in boldface correspond to the non-isomorphic readings in the relevant languages. The '*' mark indicates that those readings are not available in the adult grammar of the relevant languages.

(1') Every horse jumped over the log but every horse didn't jump over the fence.

They observe that children perform significantly better in accessing the inverse reading when presented with (1'), hence they suggest that manipulations such as the one in (1') where a preceding affirmative statement is introduced makes it easier for children to access inverse reading of the sentence in (1). In a study on the role of partitivity in child language, Musolino & Gualmini (2004) test sentences such as (2), where negation interact with an existential quantifier:

(2) The smurf didn't catch two birds.

They report that children cannot access the inverse reading in sentences in which the existential takes scope over negation: the inverse scope (i.e. $\exists > \text{NEG}$) in (2). They also appeal to the same type of manipulation used in (1') to test the following sentence:

(2') The smurf caught all the cats but she didn't catch two birds.

Their results indicate however that children cannot access the inverse reading (i.e. $\exists > \text{NEG}$) even though the preceding affirmative statement familiarizes them with the domain of quantification. Notice that a preceding affirmative statement does not help for children's access to inverse scope when the existential quantifier is over (a c-commanding) NEG. The fact that children can access the inverse reading of the sentence in (1'), but not the one in (2') suggests that the preceding statement cannot be the sole facilitator of the inverse scope reading, as otherwise we would expect similar success from children in their access to inverse scope in each experiment.

It has been noted in the literature that scope relations can be affected by contrastive focus (see Krifka (1998), Irurtzun & Exteberria (2005) among others for further information on this point). I suggest that what is at stake in the above discussed sentences is a similar phenomenon. The preceding statement creates the facilitation effect of contrastive focus, which then yields the inverse scope reading. More precisely, in sentence (1), contrasting a negated sentence with an affirmative one, enforces NEG to scope over the subject universal NP (where the latter c-commands the former on the surface) and this yields the inverse reading. In other words, contrasting NEG yields wide scope interpretation of the NEG, which was the targeted inverse reading ($\text{NEG} > \forall$) for the sentence in (1'). Notice that the claim that contrastive focus, rather than the preceding affirmative statement *per se* facilitates the inverse scope interpretation receives support from the results of Musolino and Gualmini's (2004) experiment in which children's understanding of inverse scope in sentences in which an interaction of negation and the existential quantifiers was tested. The fact that children cannot access the inverse scope reading in (2') is rather expected, once we make the assumption that contrastive focus affects scope relations. Consider the sentence in (2'), which I repeat below as (3):

(3) The smurf caught all the cats but she didn't catch two birds.

Surface reading: NEG > \exists

Inverse reading: \exists > NEG

Initially, examine the second conjunct: the existential quantifier is c-commanded by NEG on the surface. In sentence (3), there is a contrast between the two conjuncts, in particular a contrast between *catch* vs. *not catch*. The first conjunct (i.e. the affirmative statement) creates a contrastive focus effect on NEG. I suggest that it is this contrast that yields the interpretation of wide scope NEG. While in sentence (1') wide scope NEG (i.e. NEG > \forall) is the targeted inverse scope reading, in sentence (2'), the targeted inverse reading is the one where the existential scopes over NEG (i.e. \exists > NEG). The inverse reading in (3) does not correspond to a reading where NEG takes wide scope, which is the outcome when the sentence involves a preceding statement that creates a contrastive focus effect. Hence there is no reason to expect the preceding affirmative statement to facilitate the inverse reading for children in this case. In other words, because of the wide scope NEG interpretation yielded by the contrast that the preceding affirmative statement introduces, the inverse reading where existential scopes over NEG is not obtained in (3). This, I suggest, is the reason why children's performances were different in the experiments under discussion. To illustrate this in more detail, the contrast between *jump* vs. *not jump* in sentence (1') yields the following interpretation:

(i) It is not the case that all the horses jumped over the fence (i.e. not all horses jumped over the fence).

Also the contrast between *catch* vs. *not catch* yields the interpretation illustrated below:

(ii) It is not the case that the smurf caught two birds.

The targeted interpretation in sentence (3) however, is the one where the existential takes scope over the NEG, which results in the following interpretation:

(iii) Two birds are such that the smurf didn't catch them.

Thus, the inverse scope readings of the original sentence (i.e. Two birds are such that the smurf didn't catch them) does not overlap with the reading created after the involvement of the preceding statement, because contrastive focus yielded the wide scope negation interpretation (i.e. It is not the case that the smurf caught two birds). This distinction then is reflected in children's performance as well.

The conflicting results of the above reported experiments suggest that claiming that children's success in accessing inverse reading is contingent on the facilitation effect of the presence of a preceding statement is misleading. If indeed it were the case, we would expect to gain the same results in both sentence types (i.e. sentences (1) and (2)) above, yet we do not.

Given the discrepancy between the findings reported in Musolino and Gualmini (2004) and Musolino and Lidz (2006), and the cross-linguistic reports on children's success on inverse scope access presented in Table 1 above, I appeal to a new experiment in attempt to understand the nature of children's access to inverse scope. Unlike what has been tested in the experiments reported so far, I focus here on quantified sentences that do not involve negation. I also investigate whether or not different types of sentence structures play a role in children's access to inverse scope.

Recall that the Strong version of the Continuity Hypothesis states that the principles and parameters of UG constitute a description of the *initial state* and apply in real time course of language acquisition. From the onset of language acquisition all principles of UG are available to the child (see Pinker 1984, Poeppel & Wexler 1993). Accordingly, I state the following working hypothesis:

Hypothesis

The acquisition of mechanisms that make inverse scope interpretation accessible for children is not delayed.

2.1. Motivating the testing material

Rakhlin (2004) claims that the apparent symmetry requirements children exhibit are due to the wide scope universal, and that the reason why children seemed to fail in accessing the inverse scope in sentences involving existential and universal quantifiers can be accounted for under the assumption that the wide scope indefinite is ambiguous between the singleton and the multiple set. Since our intention is to test whether or not children possess the mechanisms that are required to access the inverse reading in quantified sentences, I set out to investigate children's success in different sentence types. Apart from the reasons I presented so far for this preference, one other motivation for considering distinct sentence structures in which quantifiers interact comes from Milsark's (1974) generalization. Milsark (1974) suggests that NPs that cannot appear in *there*-expletive constructions as in (5) are *strong* and those that can as in (4) are *weak*:

- (4) a. There are (some / two / few / many) cats in the garden.
 b. There is a cat in the garden.
- (5) a. ??There are (the / these / most / all the / my / John's) cats playing in the garden.
 b. ??There is (the / that / every / each / my / John's) cat playing in the garden.

Strong NPs are not compatible with *there*-expletive constructions, thus the subject of a *there*-expletive sentence is a weak noun phrase (i.e. an indefinite noun phrase).

In a pilot study that I had conducted with undergraduate students at the University of Connecticut, I observed that whether or not having the existential quantifier as the structurally

higher element in the sentence or embedded in under an expletive construction seems to make a distinction for the interpretation of wide scope universal *every*. Consider the sentences in (6) and (7) in this respect:

(6) A boy is in front of every building.⁵

(7) There is a boy in front of every building.

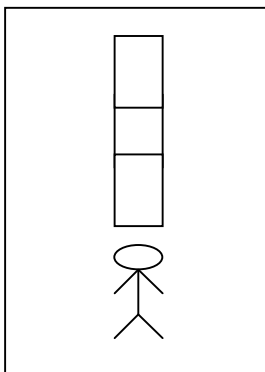
The sentences in (6) and (7) may formally have two possible interpretations due to the interaction of the quantifiers:

$$\exists > \forall: \quad \exists x[\text{boy}(x) \ \& \ \forall y[\text{building}(y) \ \rightarrow \text{in front of}(x,y)]]$$

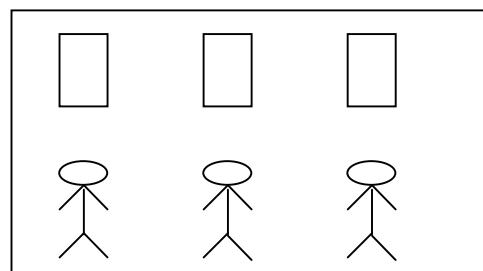
$$\forall > \exists: \quad \forall y[\text{building}(y) \ \rightarrow \ \exists x[\text{boy}(x) \ \& \ \text{in front of}(x,y)]]$$

Recall however, that the sentence in (7) is a *there*-expletive construction, so the status of its subject is different from the subject in (6), namely that its subject is interpreted necessarily as weak. This then may bring up the question of whether or not there is any interpretive difference (semantic or pragmatic, that is) between (6) and (7) even though formally both (6) and (7) may receive both of the interpretations illustrated above. In order to understand whether there is such an interpretive distinction, I investigated the interpretation of (6) and (7) and asked the native speakers of English whether they notice any difference between the sentences in (6) and (7) in their compatibility with the contexts below:

Context 1



Context 2



I gave a questionnaire to 7 (under)graduate students at the University of Connecticut School of Education, Writing Center. The sentences I tested were the ones in (6) and (7) and the pictures given are those illustrated above in Context1 and Context 2. The questionnaire posed the following question for the sentences in (6) and (7), respectively: ‘Would you use the sentence in (6) to convey the meaning denoted by the picture in Context 1, Context 2, both or

⁵ The structure I assume throughout this study for the sentences such as (6) *A boy is in front of every building* and (11) *There is a dwarf on top of every book* is that the existential subject c-commands the prepositional phrase that contains the universal quantifier. Therefore, the former scopes over the latter. This implies that in sentences in which the universal quantifier contained within the prepositional phrase that takes scope over the existential subject must involve the quantifier raising operation.

neither?' The same question is also asked for the sentence in (7) in the same contexts. The results from this preliminary investigation showed that 6 out of the 7 subjects preferred the picture in Context 2 to convey the meaning of the sentence in (7). The judgments of the informants varied, however for the sentence in (6). One thing that is clear is that native speakers of English (at least the ones in this small sample) dominantly chose the picture in Context 2 to convey the meaning of the sentence in (7), whereas they did not exhibit such a strong preference towards either of the contexts illustrated with the pictures for the sentence in (6). This result may be taken to suggest that there are pragmatic restrictions towards interpreting the weak quantifier in sentences such as (7). The interpretation of the existential quantifier as an indefinite noun phrase leads to the strong tendency towards interpreting the sentence in its surface scope reading, whereas in the case of sentences such as (6) no such preference is relevant towards either scope readings (i.e. the surface or the inverse scope readings).

Interpreting the results of the pilot study as an indication of a preference tendency among the native speakers of English motivated the testing of whether or not the structural differences between quantified sentences with and without *there*-expletives would be effective in children's access to inverse scope reading.⁶ I also considered sentences that involve both a universal and an existential quantifier, and a prepositional phrase in which the universal quantifier *every* is introduced. This is used as a variation for understanding whether or not structure plays a role in children's access to inverse scope interpretation. The third condition I tested is a replication of Rakhlin's (2004) experiment in which sentences involving Actional verbs were tested as a base line case for understanding whether or not children are symmetry-biased. This condition was intended as a baseline comparison to previous studies.

The three conditions of the current study and the target sentences are as follows:

There-expletive condition:

Sample target sentence

(8) There is a dwarf on top of every book.

Context: three books, four dwarfs. Each book has a dwarf on it, and the fourth dwarf stands out.

book — dwarf
 book — dwarf
 book — dwarf
 — dwarf

⁶ Our actual tests did not involve the pictures in Contexts 1 and 2, as I did not intend to understand whether it was specifically these picture settings that would create an effect in children's access to inverse reading.

Picture 1



Prepositional Phrase condition:

Sample sentence

(9) A bottle is in front of every girl.

Context: three girls, four bottles. Each girl has a bottle in front of her, and the fourth bottle stands out.

girl — bottle
girl — bottle
girl — bottle
— bottle

Picture 2



Actional Verb condition:

Sample sentence

(10) A dinosaur fixed every plane.

Context: three dinosaurs, three planes and Grover. Each dinosaur fixes a plane and Grover does not.

dinosaur — plane
dinosaur — plane
dinosaur — plane
— Grover

Picture 3



Since the last condition, namely the Actional Verb condition is used as a replication of Rakhlin's (2004) experiment, it is important to illustrate Rakhlin's testing sentences.

Target sentence: A girl tasted every cookie

Context: three girls taste different cookies and the boy intends to but then he does not. The condition can be illustrated as follows:

girl — cookie
girl — cookie
girl — cookie
boy —

If children's errors resulted from the lack of symmetry, since in the above condition the symmetry requirement is satisfied by the three matching characters and objects singling out the fourth one, we would expect children not to make any errors in this condition. Rakhlin (2004) observed, however, that even if the symmetry condition was satisfied, some children still made spreading errors. Thus, I used this test as a baseline and I used Conditions 1 and 2 so as to apply to the standard method for testing quantification. Note that all the testing items whose samples I illustrated above for each condition looks for the inverse scope True reading (i.e. target 'Yes' contexts).

3. Experiment 1- Adults

3.1. Method

3.1.1. Subjects

17 adults who are undergraduate students at the University of Connecticut participated in the experiment. 2 subjects who were non-native speakers of English were excluded as well as one subject who couldn't complete the experiment. The data from the remaining 14 subjects are reported here.

3.1.2. Procedure

We tested adults using the Truth Value Judgment Task methodology (TVJT) (Crain and Thornton, 1998). The task involves two experimenters. One experimenter tells a story. The other experimenter plays the role of a puppet, which has a problem in paying attention to the stories told. A story involving characters and objects is introduced and the puppet is asked to tell one thing about the story. The puppet utters a sentence, which is in fact a target sentence for the experiment. Subjects are asked to tell whether the puppet was right in his response or not. In Experiment 1, adults were tested in two sessions in a classroom setting and they were given a score sheet and asked to indicate their responses to the puppet's statements on the score sheet they were given.

3.1.3. Materials

In Condition 1, native speakers of English were tested on their interpretation of sentences like the following:

(11) There is a dwarf on top of every book.

In the story corresponding to (11), there are four dwarfs and three books. The dwarfs think the books are very special. They think they can make a person smart if s/he stands on them. They decide that each one of them stands on top of a book to get smart. One of the dwarfs who wanted to stand on top of a book as his friends did then remembers that his teacher told him that they can only get smart if they read books rather than standing on them. So he didn't stand on top of a book. One of the dwarfs stood on the science book, the second one on the art book, and the last one stood on the English book. At the end of the story the puppet described the situation using the sentence in (12):

(12) Experimenter: Hootie, can you tell us one thing about what’s going on?

Hootie (the puppet): There is a dwarf on top of every book.

Setting:

book — dwarf

book — dwarf

book — dwarf

— dwarf

Expected response: ‘Yes’

Notice that in the context of the story just described, the sentence in (12) is true on the inverse scope reading (i.e. Every book is such that there is a dwarf on top of it). If subjects access the inverse scope interpretation of (12), we expect them to accept the puppet’s statement. By contrast (12) is false on surface scope reading (i.e. A dwarf is such that he is on top of every book), so if subjects interpret the sentence in its isomorphic reading we expect them to reject the puppet’s statement.

The test items for Conditions 2 and 3 were constructed in a similar way. The number of items tested per condition is 8. There were 4 original ‘Yes’ response target items, and 4 control ‘No’ response sentences. 1 out of the 4 target ‘Yes’ sentences for the *there*-expletive condition was not taken into consideration as adults responded unexpectedly low in this particular sentence.⁷ The complete sets of test sentences used in target YES cases is given in tables (2), (3) and (4) below:

- The non-isomorphic ‘Yes’ sentences

Puppet’s statements on test stories in Condition 1:

Table 2

Test story 1	‘There is a girl behind every donut.’
Test story 2	‘There is a dwarf on top of every book.’
Test story 3	‘There is a cup in front of every policeman.’
Test story 4	‘There is a cake next to every animal.’

⁷ This decision was made as all other three target *there*-expletive sentences as well as the ‘No’ controls for *there*-expletives were performed overridingly accurate by the adults. The reason why adults had difficulty in this particular sentence might be due to the fact that the sentence in question was the initial testing item of the entire experiment and that the subjects did not understand the task accurately. Since this decision was made for adults’ data, this sentence was taken out from the children’s data too.

Puppet's statements on test stories in Condition 2:

Table 3

Test story 1	'A bottle is in front of every girl.'
Test story 2	'A hat is next to every troll.'
Test story 3	'A child is on top of every stone.'
Test story 4	'A pear is behind every truck.'

Puppet's statements on test stories in Condition 3:

Table 4

Test story 1	'A chicken tasted every cookie.'
Test story 2	'A dinosaur fixed every plane.'
Test story 3	'A troll kissed every lizard.'
Test story 4	'A child milked every cow.'

In addition to the four test stories (i.e. target 'Yes' sentences), adults also heard 4 control stories (i.e. target 'No' sentences) for each condition. Unlike the test items, the statements made by the puppet on the control items were false under the given story. On the false items the stories showed that only two of the three characters referred to by the 'every NP' were engaged in the relevant action.

The list of statements on control ('No') stories in both conditions are given in Table 5, Table 6 and Table 7 below:

- The non-isomorphic 'No' sentences

Puppet's statements on control stories Condition 1:

Table 5

Control story 1	'There is a dwarf in front of every dog house.'
Control story 2	'There is a boy next to every horse.'
Control story 3	'There is a boy behind every skate board.'
Control story 4	'There is a bird on top of every bucket.'

Puppet’s statements on control stories Condition 2:

Table 6

Control story 1	‘A boy is behind every girl.’
Control story 2	‘A man is next to every horse.’
Control story 3	‘A guy is in front of every plane.’
Control story 4	‘A dinosaur is on top of every truck.’

Puppet’s statements on control stories Condition 3:

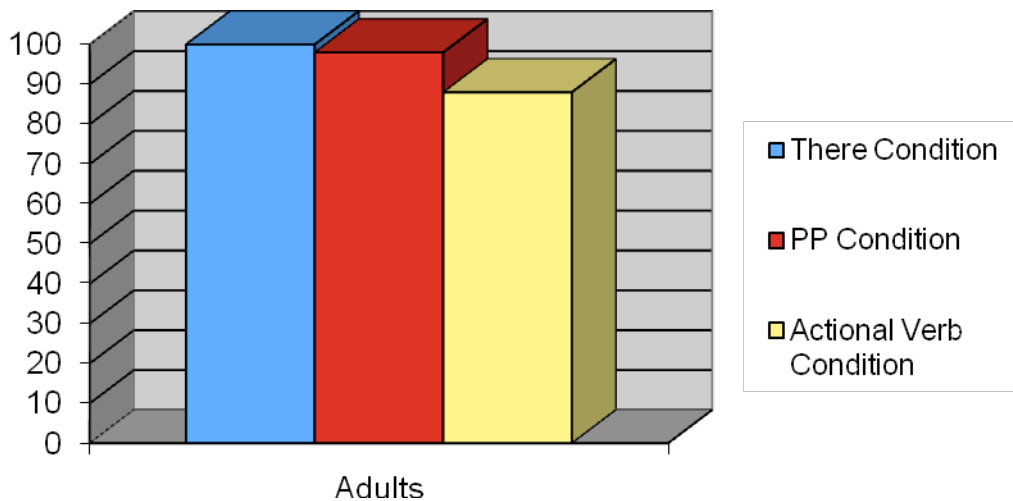
Table 7

Control story 1	‘A boy fed every snake.’
Control story 2	‘A giraffe lifted every road sign.’
Control story 3	‘A lion opened every package.’
Control story 4	‘A dinosaur fixed every car.’

3.1.4. Results

The results from Experiment 1 show that adults perform near ceiling in all of the above conditions. More precisely, they overridingly accept inverse scope interpretation in the sentences provided. Also no significant difference is observed with respect to adult’s access to the inverse reading across conditions. Graph 1 illustrates the correct response rates across conditions:

Graph 1



3.2. Experiment 2 - Children

The second experiment tested children's interpretation of inverse scope in the same conditions that adults were subjected to, namely *there*-expletive condition, Prepositional Phrase condition and Actional Verb condition (see experiment 1 for the testing items).

3.2.1. Method

3.2.2. Subjects

The participants were 11 children: 5 preschoolers and 6 kindergarteners at the Child Development Laboratories at the University of Connecticut. One preschooler could not pass the task in the training session, and one preschooler was not cooperative in the game, so they were taken out of the experiment. Children who were tested were at the ages between 4;0 and 5;4 (m: 5.0).

3.2.3. Procedure

The Truth Value Judgment Task methodology (TVJT) (Crain and Thornton, 1998) was used for children as well. The only difference between the experiment with adults and the experiment with children was that children were asked to give judgments on the puppet's statements, which had been both written down in a score sheet by the experimenter and recorded on a voice recorder. Children were asked to feed the puppet with his treats (either with a slice of bread when he fails to answer correctly or with grapes when he answers correctly as grapes are the puppet's best treat). The advantage of this task is that it makes it easier for the children to see the possible outcome since the plausible dissent is satisfied in these tasks and children would never feel as if they were being tested, since the design of the experiment creates the impression that the puppet is the one who is being tested.

3.2.4. Materials

The testing materials are the same as the one in experiment 1.

3.2.5. Procedure

Before the actual experiment was introduced, we trained children individually in a 20-minute session in a quiet research room and we tested them in three 20 minute sessions for the actual experiment.

3.2.6. Results

For each of the three conditions in the study, children's responses to both the 'Yes' items and the 'No' items were coded as 'Correct' or 'Incorrect', and then combined into a single data set. This data set was compared against chance performance (i.e. 50% correct) by means of a single-sample t-test. The accuracy rate for the combined items for all conditions are

shown below:

Condition 1 (*There*-expletive condition): $t(3.857) = 71, p < .001$

Condition 2 (PP-condition): $t(5.278) = 71, p < .0001$

Condition 3 (Actional Verb condition): $t(7.575) = 71, p < .0001$

The performance was significantly better than chance in all of the conditions. In a separate analysis, the proportion of YES responses to the puppet's statements were used as a dependent measure and were entered into an analysis of variance namely, one-way repeated measures ANOVA. The analysis revealed a significant effect of sentence types on the rate of acceptance of inverse scope reading (one-way repeated measures ANOVA, $F(2,16) = 7.154, p = .006$).

Table 8 below illustrates the summary of the ANOVA:

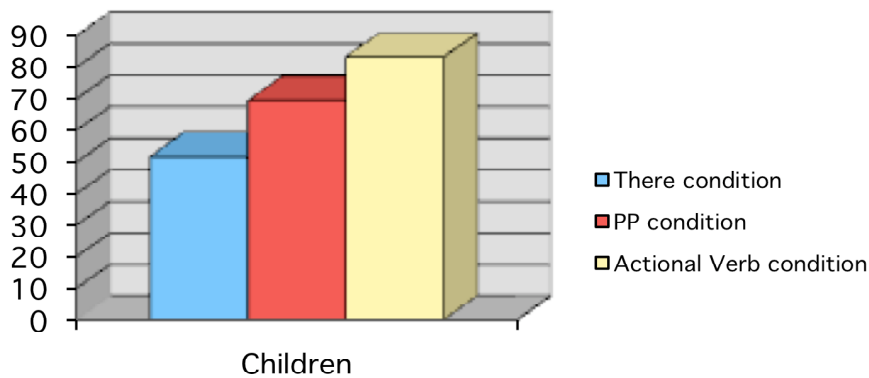
Table 8

Source	SS	Df	MS	F	P
Treatment	4502.2963	2	2251.1482	7.1535	0.006034
Error	5035.0371	16	314.6898		
Ss/BI	22064.7407	8			
Total	31602.0741	26			

Ss/BI = Subjects or Blocks depending on the design.
Applicable only to correlated-samples ANOVA.

Graph 2 illustrates the results across conditions:

Graph 2



The proportion of ‘Yes’ responses to the puppet’s statements for children was different in the three conditions.

The TUKEY HSD test was applied to see whether there is any difference between the mean percentage of children’s access to inverse scope reading across pairs of conditions. The analysis suggests that the difference between children’s access to inverse reading in *there*-expletive condition and the Prepositional Phrase condition was non-significant. Also the difference between Prepositional Phrase condition and the Actional Verb condition was non-significant. The TUKEY HSD test shows, however, that there was a significant difference between children’s performance in *there*-expletive condition and the Actional verb condition: $p < .01$.

Notice that children’s acceptance of ‘Yes’ items in the *there*-expletive condition was only about 50%, on average. One might suspect that children were simply guessing randomly. Yet, the results of the single-sample t-test on the combined ‘Yes’ and ‘No’ items speak against this interpretation. The ‘No’ items took the following form:

(13) There is a dwarf in front of every dog house.

dwarf	—	dog house
dwarf	—	dog house
baby girl	—	dog house
dwarf	—	

This situation made the test sentence false on both the inverse-scope and the surface-scope interpretations. In contrast, the ‘Yes’ items were false on the surface-scope interpretation, but were true on the inverse-scope interpretation. The statistical significance of the single-sample t-test, therefore indicates that children were sensitive (specifically) to whether the inverse-scope reading was true or false.

4. Discussion

My main goal in this study has been to investigate the question of whether or not children are adult-like in their understanding of inverse scope. Following the strong continuity hypothesis, which states that from the onset of language acquisition all principles of UG are available to the child, I hypothesized that the acquisition of the mechanisms that make it possible for children to access the inverse scope reading should not be delayed. Despite the fact that there have been claims about children's isomorphism bias, the findings presented in the present paper show that children are able to access inverse scope reading.

I suggest that describing what is at issue for children in accessing the inverse scope reading as *the facilitation effect of the preceding affirmative statement* is misleading. I submit, instead, that the contrast between the *affirmative statement* vs. *the negated statement* is what yields the performance raise in children's access to inverse reading.⁸ Consider the sentences tested in Musolino & Gualmini (2004) and Musolino & Lidz (2006) below once again:

(14) Every horse did not jump over the fence.

Inverse reading: $\text{NEG} > \forall$ (*i.e. not all horses jumped over the fence*)

This sentence is manipulated by a preceding affirmative statement that yields the contrast between *jump* vs. *not jump*, hence we get the following:

(14') Every horse jumped over log, but **every horse did not jump over the fence.**

Inverse reading: $\text{NEG} > \forall$ (*i.e. not all horses jumped over the fence*)

Consider also the sentence in (15):

(15) The smurf did not catch two birds.

Inverse reading: $\exists > \text{NEG}$ (*i.e. two birds are such that the smurf did not catch them*)

This sentence is manipulated by a preceding affirmative statement, which highlights the contrast between *catch* vs. *not catch*, hence we get the following:

(15') The smurf caught all the cats, but **she did not catch two birds.**

Inverse reading: $\text{NEG} > \exists$ (*i.e. it is not the case that the smurf caught two birds*)

⁸ Notice that the invalidity of the argument that a preceding statement is necessary for children to access the inverse reading does not exclude the fact that children demand pragmatic support in experimental settings. One major point that deserves attention is the nature of the Truth Value Judgment Task (Crain et al. 1996, 1998) I used in this study. This task differ from no-context studies using pictures in that a pragmatic condition, namely the condition on plausible dissent by which a possible alternative outcome is introduced to children is satisfied. Thus, if this condition is satisfied, it is not necessary to further manipulate the context with a preceding statement.

When the inverse reading in the second conjunct corresponded to the inverse scope reading after manipulation by the contrast, children performed significantly better in sentence (14'), whereas when the inverse reading did not correspond to the inverse scope reading after manipulation by the contrast, children could not perform as good in the sentence (15'). Thus, some other problem must be causing the difficulty. It may be possible to attribute children's difficulties in interpreting sentences such as the one in (15') even in the presence of a preceding statement, not to the inverse scope access in general, but possibly to having difficulties in interpreting negation. In fact, Lidz (2007), citing Wason (1973), also argues for children's problems with negation. He suggests, however that children's problem with negation is a parsing problem, a possibility that may also account for why children in the above reported studies were not equally successful. Therefore, I take this to imply that what seemed to be children's deficiency in accessing the inverse reading is not in fact a deficiency in activating the mechanisms that are necessary to interpret inverse scope.

Testing children's ability to access inverse scope reading in structurally different types of sentences was important as we intended to understand whether children manage to activate the mechanisms that make the inverse scope reading possible in distinct grammatical structures. The testing materials we used in this study involved inverse reading true sentences in different sentence structures. Thus, if indeed it were the case that children are in some ways deficient in their grammar, they would have difficulties in accessing the inverse scope reading. In the Prepositional Phrase condition, the universal quantifier *every* is inside the prepositional phrase, in the *there*-expletive condition, the universal quantifier appears inside the prepositional phrase and the subject position is occupied by the *there*-expletive, and in the Actional verb condition, *every* appears as the complement of the VP. In the pilot study I illustrated in section 2, native speakers showed distinct interpretive tendencies for the interpretation of inverse scope in sentences with and without *there* expletives. I interpret this tendency to be suggestive and speculate that despite the fact that the semantic representations of the inverse scope in the sentence types we tested are uniform, it is possible that each sentence type may be restricted by distinct pragmatic conditions, and this may be related to their syntactic organizations. If this is true, then children's access to inverse scope in each sentence type points out that they can manage to deal with these differences in accessing the inverse scope interpretation.

The reason for the statistically significant difference between children's performance in the Actional Verb condition and the *there*-expletive condition, following Rakhlin's (2004) account, I suggest is the following: As opposed to the wide scope indefinite in the subject position in the Actional Verb condition, the wide scope indefinite in a *there*-expletive sentence is interpreted as weak, and this facilitates the singleton set reading on the existential quantifier *a*. It is possible that children are biased towards the surface scope true reading since this reading is the one compatible with the singleton set reading of the indefinite, and in the inverse scope reading it is false truth conditionally. Even though this may be a plausible explanation for the observed performance difference, I will leave this explanation at that for the time being, as a detailed analysis of this is beyond the limitations of the current study. As

for the statistically significant results in access to inverse reading in the Prepositional Phrase condition, a possibility is that due to the presence of Prepositional Phrase, a *locational* information is introduced and this helps children to figure out the domain of quantification and this leads them to perform better in the inverse scope reading, as the preposition phrase mainly determines the domain of quantification of *every* that appears inside it.

Finally, compared to the study by Rakhlin (2004), we had greater acceptance rates in the Actional Verb condition. The reason for this result, I contend, is the following: In Condition 3 (Actional Verb condition), children perform better, because having these settings, namely Conditions 1-2 and 3 in contrast, in the course of the experiment might have resulted in a *priming* effect for children towards a better understanding of the inverse scope reading in Condition 3.

5. Conclusion

The goal of this paper has been to understand children's capabilities of activating the mechanisms in accessing inverse scope reading. The main finding of the present study is that English acquiring children between the ages of 4-5 can successfully deal with scope phenomena. Our findings suggest that under well-defined conditions (such as the condition on plausible dissent satisfied) children can access inverse scope reading. Once other intervening factors such as the interpretation of negation is averted, it can be shown that children can access inverse reading without further requirement for contextual manipulation that is reported to be necessary for accessing inverse scope interpretation for what the literature reports as *Isomorphism*-biased children. The fact that children can access inverse scope reading in the sentence types used in this study significantly above the chance levels suggests that they have access to the linguistic mechanisms that underlie scope interpretation. This result presents a counter argument (at least partly) to the claim that children are *Isomorphism-biased* in their interpretation of quantified sentences unless a further *contextual manipulation* (in Musolino and Lidz (2006) and Musolino & Gualmini's (2004) terms) is introduced.

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