

# Navigating negative quantificational space\*

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## *Abstract*

*This paper reports the findings from an interconnected set of experiments designed to assess children's knowledge of the semantic interactions between negation and quantified NPs. Our main finding is that young children, unlike adults, systematically interpret these elements on the basis of their position in overt syntax. We argue that this observation can be derived from an interplay between fundamental properties of universal grammar and basic learning principles. We show that even when children's semantic knowledge appears to differ from that of adults, the observed differences occur within well-defined boundaries, that is, within the limits imposed by the theory of universal grammar. Moreover, we point to the (positive) evidence needed by children in their passage to adulthood. We conclude that children have incomplete rather than inaccurate knowledge, in accordance with the continuity hypothesis. Together, these observations support the conclusion that children draw from an arsenal of innately specified principles in the acquisition of the grammar of quantification.*

## **Introduction**

This paper investigates the acquisition of quantificational competence. We present the findings of a series of experiments that were designed to assess children's knowledge of the semantic interactions between negation and quantified NPs. On the basis of these findings we conclude that children display early mastery of a complex array of facts pertaining to the interaction of negation and quantification. Moreover, we show that even when children's knowledge appears to differ from that of adults, the observed differences always occur within well-defined boundaries, that is, within the limits imposed by the theory of universal grammar. Specifically, we show that children's erroneous hypotheses regarding the

interpretation of negation and quantified NPs are constrained by the positions that these elements occupy in overt syntax. In short, children's wrong turns in the acquisition of semantic knowledge are constrained by syntactic factors. Taken together, the observation of early mastery and confined variation support the conclusion that children draw from an arsenal of innately specified principles of universal grammar in the acquisition of semantics, just as they do in the acquisition of syntax.

This conclusion should not be surprising given the abstract character of the knowledge under investigation. Nevertheless, there are few solid results of this kind in the literature. Indeed, some experiments in the acquisition of the grammar of quantification have often led to the opposite conclusion, that children lack certain principles that characterize adult linguistic systems (e.g. Philip 1995). The conclusion we draw is different. On the basis of our findings, we contend that even in the few instances where children differ from adults, it is possible to maintain that children do not lack any of the relevant universal linguistic principles. That is, we argue that children have *INCOMPLETE* rather than *INACCURATE* knowledge of the adult grammar of their target language, in accordance with the continuity assumption (Pinker 1984). We then point to the positive evidence needed by children in their passage to adulthood.

The paper is organized as follows. Section 1 situates the present investigation within the growing body of work on the acquisition of quantificational competence. Section 2 introduces the basic facts about the interaction of negation and quantified NPs in English. In section 3, we present a series of experiments designed to assess children's knowledge of the interaction between these elements. We conclude that children most often display adultlike knowledge in this domain, but there are also instances where children's interpretations do not coincide with the relevant adult ones. In section 4, we attempt to show that children's incorrect interpretations are nevertheless compatible with UG and do not raise problems for learnability. Section 5 summarizes the conclusions we reach on the basis of the experimental findings.

## **1. Children and quantifiers**

From a developmental perspective, children's difficulties with quantified expressions have been a long-standing puzzle at least since Piaget's seminal studies on class inclusion. Inhelder and Piaget (1964) attempted to explain children's difficulty with quantified expressions in nonlinguistic terms, as the result of the child's inability to distinguish part-whole relationships among sets. On the basis of recent theoretical advances in

the study of quantifiers, however, a growing number of acquisition studies have advanced linguistically based accounts of children's difficulty with quantified expressions (Lee 1991, 1997; Philip and Aurelio 1991; Roeper and de Villiers 1991; Takahashi 1991; Philip 1991, 1992, 1995; Brooks and Braine 1996; Drozd and van Loosbroek n.d.; Chien and Wexler 1989; Chien 1994). The main observation that has emerged from this body of work is the fact that children are often reported to disregard the position of quantifiers in their comprehension of relative scope; in particular, it is claimed that the universal quantifier *every* is interpreted in the same way regardless of its position in a sentence; this phenomenon is referred to as *quantifier spreading* (see Inhelder and Piaget 1964; Bucci 1978; Donaldson and Lloyd 1974 for early observations of the phenomenon, and Philip and colleagues who coined the term).<sup>1</sup> For languages like Chinese where relative-scope ambiguity is more restricted than it is in English, it has been observed that children, unlike adults, do not seem to map scope relations isomorphically with the surface positions of QNPs (e.g. Lee 1991; Chien and Wexler 1989).

It is interesting to note that the bulk of this research has focused on the interaction between two quantified NPs and in particular on children's interpretation of sentences containing a universally quantified NP and an existentially quantified one, as in *A boy kissed every girl* or *Every girl kissed a boy*. In spite of the growing volume of research on children's understanding of quantificational interactions, very few studies have looked at the acquisition of scope phenomena involving the interaction of quantifiers and negation (but see Roeper and Matthei 1975, and more recently, Drozd and Philip 1993; O'Leary and Crain 1994; Thornton 1995; and Krämer 1998, forthcoming, for related work).

By systematically investigating the acquisition of these phenomena, this article represents an attempt to refine our understanding of the acquisition of quantificational competence. More generally, we take the present investigation to contribute to a broader understanding of children's semantic knowledge. In order to achieve this goal, we present the results from a series of interconnected experiments designed to assess children's comprehension of sentences containing quantified NPs and negation. To set the stage for these experiments, we begin by reviewing the main facts regarding the interactions of quantified NPs and negation in English.

## 2. Negation and quantification in English

To preface our discussion of children's knowledge, this section introduces some basic facts about the interpretation of negation and quantified NPs

in English. Specifically, we describe how two types of quantified NPs, existentially and universally quantified NPs, are interpreted with respect to sentential negation. In English, as in many languages, the relative interpretation of negation and quantified NPs does not always mirror the position that these elements occupy in overt syntax (Horn 1989; Jackendoff 1972; Lasnik 1972). To illustrate this point we consider the interpretation of existentially quantified NPs such as *some N* and *any N* with respect to negation. In the examples below, where both quantified NPs occur in object position, *any students* must be interpreted in the scope of negation whereas *some students* must be interpreted outside the scope of negation.<sup>2</sup> In other words, (1a) means that there are no students seen by John (abbreviated  $\neg \exists$ ). In this case, we use the term *isomorphic interpretation*, since the overt positions of negation and the quantified NP *any students* coincide with their relative interpretation. By contrast, (1c) asserts the existence of students that were not seen by John (abbreviated  $\exists \neg$ ). Here, since the relative interpretation of negation and the QNP *some students* does not mirror their overt position, we will use the term *nonisomorphic interpretation*.<sup>3</sup> The LF representations for (1a)–(1c) are given below.

- (1) a. John didn't see any students.  
 $\neg \exists(x)$  [student(x)  $\wedge$  John saw(x)] (narrow scope)  
 $*\exists(x)$  [student(x)  $\wedge$   $\neg$  John saw(x)] (wide scope)
- b. \*John saw any students.
- c. John didn't see some students.  
 $\exists(x)$  [student(x)  $\wedge$   $\neg$  John saw(x)] (wide scope)  
 $*\neg \exists(x)$  [student(x)  $\wedge$  John saw(x)] (narrow scope)

The scope properties of expressions like *some N* and *any N* with respect to negation are usually believed to follow from the fact that the determiners *some* and *any* belong to the class of so-called positive- and negative-polarity items (PPIs and NPIs). The main property of NPIs is their need to be licensed, as shown in the contrast between (1a) and (1b) (see, e.g., Baker 1970; Ladusaw 1979; Linebarger 1980; Progovac 1994).<sup>4</sup> This example also illustrates that negation is a possible licenser for NPIs. Notice also that negative polarity items must be interpreted in the scope of the element that licenses them (see Linebarger 1980 for a precise formulation of this requirement). By contrast, positive-polarity items like *some* cannot be interpreted in the scope of clausemate negation, as illustrated in (1c).

Lack of isomorphism between overt position and relative interpretation can also be observed in sentences with universally quantified NPs and

sentential negation. To illustrate this fact, we consider how a universally quantified NP can be interpreted with respect to sentential negation.

- (2) a. Every student didn't solve the problem.  
 b. The students didn't solve every problem.

Consider (2a) first. This example sentence is ambiguous. On one interpretation, it can be paraphrased as meaning that every student is such that he or she didn't solve the problem; that is, none of them did. In this case, *every* is interpreted outside the scope of negation (abbreviated,  $\text{every} > \text{not}$ ). This corresponds to an isomorphic interpretation. The other interpretation of (2a) denies that every student solved the problem. One circumstance that verifies this reading is one in which one student solved the problem, but all of the others did not. Here, *every* is interpreted inside the scope of negation (abbreviated  $\text{not} > \text{every}$ ). This is a nonisomorphic interpretation. The example sentence (2b) finds the universally quantified NP in object position. In this case, there is no scope ambiguity. The NP *every problem* must be interpreted within the scope of negation. Thus, (2b) must receive an isomorphic interpretation, which can be paraphrased as meaning that not every problem was solved by the students ( $\text{not} > \text{every}$ ). Thus, in the case of universally quantified NPs, the availability of a nonisomorphic interpretation with respect to negation depends on the syntactic position occupied by the quantified NP: in the subject case, (2a), both isomorphic and nonisomorphic interpretations are possible, whereas in the object case, (2b), only an isomorphic interpretation is available. To summarize, the interpretation of sentences with negation and quantified NPs cannot be systematically predicted from the overt position of the elements they contain. In addition to isomorphic interpretations, such sentences may also allow nonisomorphic interpretations. Moreover, the availability of nonisomorphic interpretations varies according to the lexical nature of the quantificational elements involved, as well as their position in the sentence.

From the point of view of a child acquiring English, this complex interaction of factors poses familiar problems of learnability (Baker 1979; Pinker 1989; Fodor and Crain 1987). The potential problems arise from the fact that the relative scope of negation and quantified NPs represents an example of a partial generalization, or a partial linguistic paradigm. That is, isomorphic or nonisomorphic interpretations may be optional, obligatory, or impossible depending on the lexical nature of the quantified NP involved and its position in the sentence (subject vs. object). The problem with partial generalizations is that they provide the basis for overgeneralization, as well as for undergeneralization and mistaken generalization. Undergeneralization leads to undergeneration. This would

arise, for example, if the child assumed that a sentence containing negation and a QNP could only receive an isomorphic interpretation whereas that sentence in fact allowed both an isomorphic and a nonisomorphic interpretation. Conversely, the child may overgeneralize and assume that a sentence allows both an isomorphic and a nonisomorphic interpretation whereas, in fact, only an isomorphic (or a nonisomorphic) interpretation is possible. This would lead to overgeneration. Finally, the child may assume that a sentence only allows an isomorphic interpretation when, in fact, just the opposite is true. This would represent a case of mistaken generalization.

In view of these potential learnability problems, acquiring the meaning of sentences containing negation and quantified NPs would be prone to error if acquisition is not held in check by principles of UG and/or learning mechanisms that constrain the child's hypothesis space in advance. However, the observation that all language learners ultimately reach similar conclusions, presumably without (direct) negative evidence, invites the inference that innately specified knowledge is operative in the acquisition of semantics. It is reasonable to assume, *ceteris paribus*, that this knowledge is encoded in children's grammars from the earliest stages in the course of language development. These observations motivated our experimental investigations and led us to ask how children navigate through the maze of quantificational interactions, what routes they follow, and how conservative or adventurous they are in grammar formation.

### 3. Experimental investigations

This section reports the findings of a series of experiments designed to assess children's knowledge of the interaction between negation and quantified NPs. In light of the potential learnability problems described in the previous section, the primary research question to be addressed is the extent to which children assign the correct scope interpretations to sentences containing negation and quantified NPs.

#### 3.1. *Negation and existentially quantified NPs*

Before we begin our experimental investigations, it will be helpful to consider previous research on children's knowledge of the interaction of negation and existentially quantified NPs such as *some N* and *any N*. We review the findings from studies by Thornton (1995) and O'Leary and

Crain (1994), which suggest that four- and five-year-old children correctly produce and interpret the NPI *any* with respect to negation, but that the same children often incorrectly produce the PPI *some* in situations requiring the use of *any*. This latter finding led to a comprehension experiment in which we tested children's interpretation of *some* with respect to negation. We found that in comprehension too, children incorrectly interpret *some* in the scope of clausemate negation.

3.1.1. *Previous studies: Thornton (1995), O'Leary and Crain (1994).* We begin with a review of Thornton (1995), who tested children's comprehension of questions containing the NPI *any* and negation. The study asked whether children are aware of subtle meaning differences necessary to sort out scope relations between *any* and negation in the following examples.

- (3) a. Did any of the turtles not buy an apple?  
 $\exists(x) [\text{turtle}(x) \wedge \neg \text{bought an apple}(x)]$   
 b. Didn't any of the turtles buy an apple?  
 $\neg \exists(x) [\text{turtle}(x) \wedge \text{bought an apple}(x)]$

Notice that in (3a), existential *any* takes scope over negation,<sup>5</sup> so the question asks if there exists a turtle such that it did not buy an apple. In (3b), on the other hand, negation takes scope over existential *any*, so the question asks if there do not exist any turtles that bought an apple. In other words, in order to calculate the appropriate scope relations between *any* and negation in (3), one needs to attend to the surface position of these quantificational elements. Using a truth-value judgment task, Thornton tested ten children, ranging in age between 3;6 and 4;11. The child subjects had no problems interpreting *any* with respect to negation. Indeed, the subjects correctly pointed to the turtle that hadn't bought an apple 93% of the time in response to (3a) and they correctly pointed to the turtle(s) that had bought an apple 85% of the time in response to (3b).

This brings us to the second study on the acquisition of polarity sensitivity, by O'Leary and Crain (1994). These researchers report the findings of a set of experiments designed to assess young children's knowledge of the constraints governing the use of the NIPs *any/anything* and the PPIs *some/something*. In a truth-value judgment task with an elicitation component, 11 children between the ages of 4;4 and 5;4 were presented with four kinds of target sentence. These sentences, uttered by a puppet, were descriptions of stories acted out for the child subjects by one of two experimenters. In each case, the puppet's statements were inaccurate descriptions of the stories and children were therefore expected to reject these statements. The first two types of target sentence contained

the NPI *anything* and in their responses to the puppet, children were expected to use a PPI instead of an NPI. These examples are illustrated in (4) and (5). By contrast, the target sentences in (6) and (7) each contained the PPI *some/something*. In this case, children were expected to use a NPI in their answers but not a PPI.

- (4) *Type 1*  
Puppet: None of the Ninja Turtles got anything from Santa.  
Child: *No, this one found something from Santa.*
- (5) *Type 2*  
Puppet: Only one of the reindeer found anything to eat.  
Child: *No, every reindeer found something to eat.*
- (6) *Type 3*  
Puppet: Every dinosaur found something to write with.  
Child: *No, this one didn't find anything to write with.*
- (7) *Type 4*  
Puppet: Only one of the friends had some presents for Gonzo.  
Child: *No, none of the friends had anything for Gonzo.*

O'Leary and Crain found that NPIs were (almost) never used in response to sentences of type 1 and 2; suggesting that young children are aware of the distributional constraints on *anything*. By contrast, children were often found to (incorrectly) use PPIs like *some* or *something* in their responses to sentences of type 3 and 4. Below are some examples in which children produce the PPI *some* in contexts where it is not expected to appear:<sup>6</sup>

- (8) a. He didn't get something to eat. (C.E-K. 4;6)  
b. Well, they didn't get some food. (E.E. 4;7)  
c. None people had some presents. (E.P. 4;9)  
d. So he didn't get some money. (E.G. 4;10)

So far, the evidence from the findings of both production and comprehension studies of the NPI *any* supports the view that children have adultlike linguistic knowledge of the licensing conditions on NPIs. The same cannot be said for PPIs, however, in light of the finding by O'Leary and Crain that children produce the PPI *some* in contexts in which the NPI *any* is appropriate.

3.1.2. *Experiment 1. Children's comprehension of some with respect to negation.* This experiment, by Musolino (1998a), was designed to assess children's comprehension of sentences like (9), in order to determine how they would interpret *some* when it occurs within the scope of



negation. The experiment sought to find out if the production problem observed by O'Leary and Crain also extends to children's comprehension.

(9) The detective didn't find someone/some guys.

More specifically, the question was whether or not children would (incorrectly) interpret *someone/some guys* in the scope of negation. If so, they should understand (9) to mean *The detective didn't find anyone/any guys*. The research strategy was to devise an experimental situation in which the narrow-scope reading and the wide-scope reading of the example in (9) are both available, such that the sentence is false on the former reading and true on the latter, in the context of the story. If children correctly interpret *some* with respect to negation, then they should accept a statement of the form in (9) in this situation. On the other hand, if children take (9) to mean *The detective didn't find anyone/any guys*, thus incorrectly interpreting *some* in the scope of negation, then they should reject (9).

The subjects were 30 children ranging in age between 3;10 and 6;6: a first group of 15 children, G1, ranging in age from 3;10 to 5;2 (mean 4;7) and a second group of 15 children, G2, ranging in age from 5;2 to 6;6 (mean 5;7). We also tested a group of adults on the basis of a videotaped version of the stories used with children.<sup>7</sup> Each subject received two warm-up stories, four test stories, that is, four sentences of the form *NP didn't V some NP*,<sup>8</sup> and three fillers. The protocols for the stories involved a set of characters and a specific action to be performed by the main character and accomplished with respect to some object(s) or other character(s). In a first round of activity, the main character failed to accomplish the action altogether. In a second round of activity, the main character accomplished the action with respect to some object(s) or character(s) but, crucially, failed to accomplish it for a specific object(s) or character(s). In the end, therefore, a sentence of the form *The character didn't V someone/something/some N* was true.

In one story, for example, a detective and his two friends decide to play "hide and seek." While the detective has his eyes closed, one of the characters hides behind a tree and the other one hides under the seat of a covered wagon. After inspecting the tree, the covered wagon, and a third hiding place without success, the detective observes that his friends are really well hidden. He nonetheless refuses to give up and inspects the hiding places again, this time more carefully. The detective successfully spots the character hidden behind the tree but again misses the one hidden inside the covered wagon. Kermit's description of the story is *The detective didn't find someone*. In this situation, it is felicitous to say "yes," that is, to assign wide scope to *someone*. The context of the story also

falsified the narrow-scope reading of *someone*; that is, the interpretation where it is taken to mean *anyone*. Indeed, it is not true that the detective didn't find anyone, as he found the character hiding behind the tree. Therefore, a child who could assign only the narrow-scope interpretation should have responded "no" to Kermit's assertion that the detective didn't find someone. Notice also that the last event mentioned in the experiment is the detective who has failed to find the character hiding under the seat of the covered wagon. The wide-scope interpretation should, therefore, be readily available if this is consistent with children's grammars.

Here are the main results. The proportion of children's "yes" responses to the puppet's statements gradually increased with age. Children in G1 accepted the puppet's statements 35% of the time, whereas children in G2 accepted the puppet's statements 65% of the time; finally, the adults in a control group accepted the puppet's statements 100% of the time. A series of t-tests confirmed that the differences observed in the proportions of "yes" responses between G1 and G2 and between G2 and the adult group are significant,  $t(28) = 2.2$ ,  $p < 0.5$  and  $t(28) = 3.4$ ,  $p < 0.01$ , respectively. As usual, whenever children rejected the puppet's statement, they were asked to explain to the puppet why they thought he was wrong. In the case of the detective story, children said that the puppet was wrong because the detective DID find someone, and they pointed to or mentioned the character hidden behind the tree. We conclude from the findings that younger children, who rejected the puppet's statements 65% of the time, have a strong tendency to (incorrectly) assign sentences like *The detective didn't find someone* an isomorphic reading, thus equating *some* with *any* when the former occurs in the scope of clausemate negation. As children get older, this tendency decreases (i.e. 35% rejection for children in G2), and when they become adults they exclusively assign a nonisomorphic interpretation.

To summarize the findings of this section, the focus has been on the interaction between negation and existentially quantified NPs like *some N* and *any N*. We found that children assign the correct scope relations between *any* and negation, but not between *some* and negation. Not only do children inappropriately use the PPI *some* where *any* is required, it was found that younger children, especially, exhibited a strong tendency to assign sentences like *The detective didn't find someone* an isomorphic interpretation, thereby (incorrectly) interpreting *someone* in the scope of negation, as though it meant *anyone*. In contrast, adults obligatorily assign such sentences a nonisomorphic interpretation; that is, they interpret *someone* outside the scope of negation. Assigning a sentence an isomorphic interpretation when it should be assigned a nonisomorphic

interpretation is what we defined as a mistaken generalization. We consider the consequences of this mistaken generalization in section 4.

### 3.2. Negation and universally quantified NPs

The topic of this section is children's comprehension of sentences containing negation and universally quantified NPs, such as *every horse*. The first experiment was designed to assess children's comprehension of sentences like *Every horse didn't jump over the fence*, where a universally quantified NP occurs in subject position of a negated clause. In the second experiment, we tested children's comprehension of sentences like *The smurf didn't buy every orange*, where a universally quantified NP occurs in object position of a negated clause. The main finding is that children systematically reject the *not > every* interpretation of sentences containing a universally quantified subject whereas they overwhelmingly accept this reading when the sentences contain a universally quantified object.

#### *Experiment 2. Comprehension of subject every and negation*

As we discussed in section 1, sentences like (10) are ambiguous between an isomorphic, (10a), and a nonisomorphic, (10b), interpretation. Given our previous finding that children fail to assign nonisomorphic interpretations to sentences like *The detective didn't find someone*, we asked whether this observation would also apply to sentences like (10).

- (10) Every horse didn't jump over the fence.  
 a.  $\forall(x) [\text{horse}(x) \rightarrow \neg \text{jump over the fence}(x)]$   
 b.  $\neg \forall(x) [\text{horse}(x) \rightarrow \text{jump over the fence}(x)]$

The research question was therefore to determine whether children have access to the nonisomorphic interpretation of sentences like (10), that is (10b). The research strategy was to place children in an experimental situation where both readings of (10) were consistent with the context. The contexts were constructed to make the test sentences true on the nonisomorphic (*not > every*) interpretation, but false on the isomorphic (*every > not*) interpretation.<sup>9</sup> If children have access to both interpretations, then they should accept statements such as *Every horse didn't jump over the fence* in this situation, because they are true. On the other hand, if children only have access to the isomorphic interpretation, they should reject such statements in the contexts provided in the experiment.

The participants were 20 English-speaking children ranging in age between 4;0 and 7;3 (mean 5;11) and a control group of adults who witnessed a videotaped version of the stories used with children. Each subject received two warm-up stories, four test stories, that is, four sentences of the form *Every N didn't VP*,<sup>10</sup> and three fillers. The stories typically involved three characters and an action to be performed with respect to different objects. In a first round of activity, all three characters fail to perform the action with respect to the first object. Next, two of the characters — but not the third one — performed the action with respect to the second object. In the end, therefore, a sentence of the type *Every N didn't VP* is true of the action performed with respect to the second object, since not all of the characters performed that action.

In one story, for example, three horses decide to jump over various obstacles to test their skills. First they consider jumping over a barn. They start running toward it but as they get closer they realize that the barn is too high for them to jump over. The horses then decide to jump over a fence, which isn't as high as the barn. The first horse jumps over the fence and the second one does too. The third horse considers jumping but remembers that he hurt his leg the day before and decides that he should rest it. So the third horse's decision is not to jump over the fence. The puppet's description of the story is *Every horse didn't jump over the fence*. In this situation, it is felicitous to say "yes" and therefore assign the sentence a nonisomorphic interpretation. Therefore, a child who could assign the *not > every* interpretation should respond "yes" to the puppet's statement. The context of the story also falsified the wide-scope reading of *every* over negation since it is not true that every horse is such that it didn't jump. In other words, it is not true that none of the horses jumped over the fence, since two of them did. Therefore, a child who could only assign the wide-scope interpretation should respond "no" to the puppet's statement.

Turning to the results, children overall accepted the puppet's statements, on the interpretation with negation taking scope over *every*, only 7.5% of the time. By contrast, the adults in a control group accepted these statements 100% of the time. The difference between children and adults was highly significant,  $t(38) = 17.92$ ,  $p < 0.0001$ . When children rejected the puppet's statements, (i.e. over 90% of the time), they were asked, "what really happened in the story?" Children said that the puppet was wrong because two horses did jump over the fence. In other words, children failed to access the nonisomorphic interpretation where negation takes scope over *every*. Instead, they accessed the isomorphic interpretation where *every* takes scope over negation. These results clearly indicate that children were not aware of the fact that sentences like *Every horse*

*didn't jump over the fence* can receive a nonisomorphic interpretation (not > every). Children appear to be restricted to the isomorphic interpretation of such sentences, whereas in the adult grammar, both isomorphic and nonisomorphic interpretations are available.<sup>11</sup> This is a typical case of undergeneralization. We examine the consequences of undergeneralization in the next section.

### *Experiment 3. Comprehension of object every and negation*

The observation that children reject the *not > every* interpretation of ambiguous sentences like *Every horse didn't jump over the fence* led us to ask whether they would accept this interpretation in response to sentences like *The Smurf didn't buy every orange*, where the *not > every* interpretation is the only interpretation. In order to address this issue Musolino (1998b) conducted an experiment designed to assess children's comprehension of sentences like (11), using the truth-value judgment methodology. The research question was to determine whether or not children would assign *every* narrow scope with respect to negation (not > every).

(11) The Smurf didn't buy every orange.

The research strategy was to place children in a situation where both the narrow-scope and the wide-scope reading of *every* with respect to negation are under consideration. We decided to make the wide-scope reading false in the story, and to make the narrow-scope reading true.<sup>12</sup> Children who access the narrow-scope reading of *every* should therefore accept statements like (11). On the other hand, children who have access only to the wide scope reading of *every* should reject such a statement.

The subjects were 20 children, ranging in age between 3;11 and 6;0 (mean 4;10). Each subject received two warm-up stories, four test stories, that is, four sentences of the form *NP didn't V every N*,<sup>13</sup> and three fillers. The stories typically involved a main character who considers performing an action such as eating, buying, cleaning, etc., with respect to two sets of three objects. In a first round of activity, the main character considers performing to one set of objects but, upon reflection, decides not to do so. He then performs the action with respect to one of the objects of the second set but not the two others. In the end, therefore, a sentence of the form *The character didn't V every N* is true of the second set of objects.

In one story, for example, a Smurf decides to go to the grocery store to buy some apples. He examines the three apples in the store to see if he can buy them. The first two have big bruises and the third one has a worm inside. The Smurf then decides that he is not going to buy the

apples. Instead, he thinks he may buy some oranges. There are three oranges in the store and the Smurf starts to inspect them. The first one is big and firm and he decides to buy it. The second one is not firm enough and the third one is too small. So the Smurf ends up buying only one of the three oranges. The puppet's statement at the end of the story is *The Smurf didn't buy every orange*. In this situation, it is felicitous to say "yes" since it is indeed true that the Smurf didn't buy all the oranges. The context of the story also falsified the wide-scope reading of *every* over negation; that is, the interpretation where it is taken to mean that none of the oranges were bought. Indeed, it is not true that the Smurf didn't buy any oranges since he actually bought one. Therefore, a child who could only assign the wide-scope interpretation should have responded "no" to the puppet's statement that the Smurf didn't buy every orange.

Here are the main results. We found that children accepted the puppet's statements, that is, the *not > every* interpretation, 85% of the time. Recall that this interpretation was accepted only 7.5% of the time in the case of sentences like *Every horse didn't jump over the fence*. We found the difference between these two acceptance rates to be highly significant,  $t(38) = 9$ ,  $p < 0.0001$ . We conclude that while children cannot assign sentences like *Every horse didn't jump over the fence* a *not > every* interpretation, they correctly assign such an interpretation to sentences like *The smurf didn't buy every orange*.<sup>14</sup>

In this section, we have presented a number of experiments designed to investigate children's knowledge of the semantic interactions between quantified NPs and negation. Let us now take stock. In this series of experiments, we have been concerned with the extent to which children can assign relevant adultlike interpretations to sentences containing negation and quantified NPs. The pattern emerging from our findings is that, when the relevant adult interpretations correspond to what we have been calling isomorphic interpretations, as in the case of sentences like *Did any of the turtles buy an apple/Didn't any of the turtles buy an apple* or *The Smurf didn't buy every orange*, children display adultlike knowledge. On the other hand, whenever the appropriate adult interpretations correspond to nonisomorphic interpretations, as in the case of sentences like *The detective didn't find someone* and *Every horse didn't jump over the fence*, children typically fail to assign such interpretations. Instead, they assign these sentences isomorphic interpretations. This leads us to the descriptive generalization in (12):

- (12) The observation of isomorphism:<sup>15</sup>  
 Unlike adults, young children systematically interpret negation and quantified NPs on the basis of their position in overt syntax.

It is interesting to note that while some studies on the acquisition of quantificational knowledge have (implicitly) reached a similar conclusion about quantifier–negation interaction (e.g. Thornton 1995; Krämer forthcoming) and other scope phenomena (such as the interaction between universally and existentially quantified NPs, e.g. Brooks and Braine 1996); others such as Roeper and Matthei (1975), Drozd and Philip (1993), and Philip (1995) have found that children often disregard the overt position of quantifiers in their calculation of scope. However, it is hard to compare the results from these different studies since they used different experimental methodologies. It is also not clear whether the phenomena under investigation, quantifier–quantifier interaction vs. quantifier–negation interaction, should be treated uniformly (see discussion in section 4). In the next section, we explore the origins and the consequences of the observation in (12).

#### 4. The roots and consequences of isomorphism

At the outset of our investigation, we remarked that acquiring the meaning of sentences containing negation and quantified NPs poses a potential learnability problem. Our experimental findings and the observation in (12) suggest that this problem is real. Seemingly adhering to (12), children were found to undergeneralize in the case of sentences like *Every horse didn't jump over the fence* and to form a mistaken generalization in the case of sentences like *The detective didn't find someone*. The observation that children do not always arrive at the correct generalization raises two main questions. First, one needs to explain how children eventually arrive at the correct generalization and hence converge on the adult system of interpretation. In other words, how do children recover from undergeneralization and mistaken generalization? Second, we need to determine what drives children to deviate from the correct generalizations in the first place. That is, how can we account for the observation of isomorphism? The remainder of this article is devoted to addressing these two questions.

##### 4.1. *The consequences of isomorphism*

Let us start with an analysis of children's isomorphic interpretations of sentences like *Every horse didn't jump over the fence*. For adult speakers, such sentences are ambiguous between an isomorphic and a nonisomorphic interpretation. Adults have a strong preference for the nonisomorphic

interpretation. This fact was established by Musolino, who interviewed 15 adults (all undergraduates at the University of Pennsylvania) and asked them what they thought the sentence *Every horse didn't jump over the fence* meant, without any further specification. For 12 of the 15 subjects, the sentence was taken to mean that not all the horses jumped over the fence; a nonisomorphic interpretation (not > all). For two subjects, the sentence was taken to mean that none of the horses jumped over the fence; an isomorphic interpretation (every > not). Finally, one subject found the sentence to be ambiguous between an isomorphic and a nonisomorphic interpretation. On the basis of these results,<sup>16</sup> it seems implausible to suppose that children fail to assign sentences like *Every horse didn't jump over the fence* a nonisomorphic interpretation simply because such interpretations are in general less preferred or somehow harder to access than isomorphic interpretations. Rather, the finding is that interpretations that are highly preferred by children are highly dispreferred by adults, and vice-versa (Crain et al. 1994 provide a model of parsing and learning that predicts this pattern of behavior for children and adults).

From the perspective of learnability, children's undergeneralization in the case of sentences like *Every horse didn't jump over the fence* does not pose a serious problem. Children's interpretations, although different from adults', are nonetheless perfectly compatible with UG and the adult system. Children just happen to have INCOMPLETE knowledge, rather than INACCURATE knowledge. To converge on the adult grammar, children simply need to add to the interpretations that their grammars already generate. Because adults prefer nonisomorphic interpretations, there will be ample positive evidence. From a learnability perspective, it is clearly advantageous for learners to initially assign linguistic representations that are dispreferred by the sentence-parsing mechanism.<sup>17</sup>

This brings us to what we called a mistaken generalization. We found that young children assigned an isomorphic interpretation to sentences like *The detective didn't find someone*, incorrectly interpreting *someone* within the scope of clausemate negation. From a learnability perspective, mistaken generalizations are more problematic than undergeneralizations. Not only do children have to learn that sentences like *The detective didn't find someone* can receive a nonisomorphic interpretation; they must also learn that such sentences CANNOT receive an isomorphic interpretation. In other words, children need to "unlearn" their initial interpretive hypothesis. On the assumption that children do not have access to (direct) negative evidence, we are faced with a potential learnability problem.<sup>18</sup>



One solution to this problem would be to assume that children have access to indirect negative evidence. That is, after hearing enough sentences like *NP didn't V some N* in wide-scope contexts (i.e. some > not) but never in narrow-scope contexts (not > some) children may be able to infer that such sentences cannot be used in narrow-scope contexts. Another possibility is that positive evidence leads children to abandon their initial hypothesis that sentences like *The detective didn't find someone* can mean *The detective didn't find anyone*. This is in fact what we want to argue.

Following Musolino (1998a, 1998b), we propose that there exists positive evidence that, once encountered by children, has the effect of compelling them to expunge from their grammar the (incorrect) initial assumption that *some* can be interpreted in the scope of clausemate negation. Based on the evidence, children are forced to interpret *some* outside the scope of clausemate negation, as in the adult grammar. Specifically, we contend that what children need to learn is that *some* and *any* are allomorphs, that is, different morphological realizations of the same abstract lexeme. The argument proceeds as follows. First, we present independent evidence suggesting that *some* and *any* should be treated as allomorphs in the adult grammar. Second, we show that this property can be learned and we point to what we take to be the specific triggering data. Finally, we show that learning that *some* and *any* are allomorphs has the desired effect, in the sense that it effectively resolves the learnability problem.

The view that *some* and *any* are different morphological realizations of the same underlying element was originally proposed by Klima (1964) as part of a more elaborate theory of polarity licensing. The essence of Klima's proposal is that the licensing condition on the distribution of NPI/PPI pairs like *some/any* can be expressed as a syntactic transformation (Klima's rule of indefinite incorporation). It was later argued, however, in particular by Ladusaw (1979), that the licensing condition on NPIs and PPIs must be semantic in nature and cannot be syntactic. To quote Ladusaw (1979: 1), "This dissertation formulates and defends the thesis that the principles which account for the limited distribution of PSI's [polarity-sensitive items] are semantic and not syntactic." If Ladusaw's view is correct, does it entail that we should abandon the idea that *some* and *any* are morphological variants of one another? We believe that the answer is "no." We can only conclude from Ladusaw's position that if we were to treat *some* and *any* as allomorphs then the alternation between these two forms cannot be regulated by SYNTACTIC factors (i.e. a syntactic transformation such as Klima's rule of indefinite incorporation). Since the claim that *some* and *any* are allomorphs does

not entail that one should also adhere to Klima's syntactic version of the licensing condition, it should therefore be immune from Ladusaw's criticism. In what follows, we will therefore argue that there are reasons to believe that *some* and *any* are allomorphs, regardless of the precise nature of the licensing condition on PSIs (for a view similar to our own, see Krifka 1994).

The evidence regarding the special morphological status of *some* and *any* comes from the behavior of the pair in VP-elliptical contexts. The examples below suggest that VP ellipsis can ignore certain features like the presence or absence of negation, since *some* and *any*, in (13) and (14), can serve as antecedents for one another, indicating that some form of sloppy identity may be at work there.

- (13) John didn't eat any soup but I did  
       John didn't eat any soup but I did\*eat any soup/eat some soup  
 (14) John ate some soup but I didn't  
       John ate some soup but I didn't\* eat some soup/eat any soup

If so, we should expect other negative polarity items, such as *budge an inch* or *give a red cent*, for example, to behave in the same fashion under VP ellipsis. Surprisingly, however, (16), which is parallel to (13), is unacceptable. The fact that *budge an inch* and *give a red cent* are NPIs is illustrated in (15).

- (15) a. John didn't budge an inch/give a red cent to charity.  
       b. \*John budged an inch/gave a red cent to charity.  
 (16) \*John didn't budge an inch/give a red cent to charity but  
       Mary did budge an inch/give a red cent to charity.

On the morphological approach advocated here, this puzzling set of facts receives a natural explanation. On this view the perceptible difference between *some* and *any* is a phonetic illusion. Underlyingly (i.e. before spell-out), *some* and *any* are the same morpheme, which we will call  $\alpha$ . On the analysis we propose, the derivation of (13) proceeds as follows.

*Pre-spell-out:*

- Step 1: John didn't eat  $\alpha$  soup but I did eat  $\alpha$  soup.  
 Step 2: John didn't eat  $\alpha$  soup but I did.

*Post-spell-out:*

- Step 3: John didn't eat any soup but I did.

At step 1, the underlying form of *some* and *any*,  $\alpha$ , appears in both VPs. At step 2, VP ellipsis can take place under identity:<sup>19</sup> the upper VP [eat  $\alpha$  soup] serves as the antecedent for the lower VP, [eat  $\alpha$  soup]. At the

point of spell-out, where the elements must be phonetically realized (step 3), the question arises as to how  $\alpha$  will surface. There are two options: *some* or *any*. In this case,  $\alpha$  occurs in the scope of negation where it can be licensed as *any*, as in step 3.

The second part of the argument is to show how children could learn that *some* and *any* are allomorphs. Musolino (1998b) observes that children may learn this fact on the basis of simple questions like the ones in (17).

- (17) a. Do you want some juice?  
b. Do you want any juice?

The assumption is that children's word learning is guided by a principle of contrast according to which a difference in form reflects a difference in meaning (i.e. different words mean different things) as argued by Clark (1987, 1993). Then the lack of contrast in meaning between the two questions in (17), in spite of the difference in form (i.e. *some* vs. *any*), should lead children to assume that *some* and *any* cannot be two separate words. This, in turn, leads children to the conclusion that *some* and *any* must be different morphological realizations of the same lexical element.<sup>20</sup> Thus, the existence of questions like (17) in the PLD, in conjunction with knowledge of the principle of contrast, leads children to deduce that *some* and *any* are allomorphs.

The next step in the argument is to show how learning that *some* and *any* are allomorphs suffices to force children to abandon their incorrect initial hypothesis that *some* can be interpreted in the scope of clausemate negation. The crucial observation is that allomorphs are subject to the condition of mutual exclusivity. In the case at hand, this means that if one of two allomorphs, that is, *any*, must be interpreted in the scope of clausemate negation (by virtue of its NPI status) then the other allomorph, *some*, cannot also be interpreted in the scope of clausemate negation; rather it must be interpreted OUTSIDE the scope of clausemate negation. So although *some* and *any* have the same lexical meaning, that is, they are both existential determiners, these two allomorphs contrast, in the sense that one must be interpreted within the scope of clausemate negation (i.e. *any*) while the other must be interpreted outside the scope of clausemate negation (i.e. *some*). In this case, therefore, mutual exclusivity translates as a ban against a similar scope reading with respect to a logical operator such as negation. On this view, therefore, the "positive" behavior of *some* (i.e. the fact that it can't be interpreted in the scope of clausemate negation) is a consequence of its special morphological relation to *any* (for a similar view, see Krifka 1994). In short, learning that

*some* and *any* are allomorphs induces a blocking effect à la Pinker (1986).<sup>21</sup>

To summarize, the observation that children undergeneralize with respect to their interpretation of sentences like *Every horse didn't jump over the fence* and that they form a mistaken generalization in the case of sentences like *The detective didn't find someone* does not raise a serious learnability problem. We have argued that in both cases, children have access to positive evidence from the input that leads them to the correct generalizations and, hence, guides them in their passage to adulthood.

#### 4.2. *The roots of isomorphism*

In this section we consider the following question: what prevents children from assigning nonisomorphic interpretations? Specifically, we consider two hypotheses regarding children's inability to assign nonisomorphic interpretations. The first is that children fail to assign nonisomorphic interpretations because their grammar does not yet generate such interpretations. On this view, children and adults assign different formal representations to sentences such as *Every horse didn't jump over the fence* or *The detective didn't find someone*. We call this the "grammatical" hypothesis. A second hypothesis is that children can assign such sentences formal representations corresponding to nonisomorphic interpretations; however, in the course of language comprehension, they fail to access such representations. We call this the "parsing" hypothesis. The available evidence favors the grammatical hypothesis, in our view. We argue, moreover, that isomorphism can be derived from the interaction of a learning principle, the subset principle, along with fundamental properties of UG; thereby making the case that the acquisition of semantic knowledge is driven and constrained by universal principles of grammar as well as universal principles of learning. Before we present the argument, however, we consider the parsing hypothesis in more detail and explain why we think that the grammatical explanation is more adequate.

On the parsing hypothesis, the difference between children and adults may be assumed to lie in their respective ability to revise their initial interpretations of sentences containing negation and quantified NPs. The initial interpretations, in turn, correspond to isomorphic interpretations since sentences are incrementally parsed from left to right. In order to arrive at a nonisomorphic interpretation, however, the initial order imposed by the parser must be revised. Hence, nonisomorphic interpretations are computationally more costly than isomorphic ones. On the assumption that children lack the computational resources (i.e. work-

ing memory) necessary to revise their initial interpretations, they are stuck with isomorphic interpretations. On this view, children who failed to access nonisomorphic readings would be, metaphorically, trapped by the parser. As children grow older and mature, the story would go, so does their processing capacity, and at some point, like adults, they become capable of revising their initial interpretations and eventually manage to access nonisomorphic interpretations.

Although attractive, the parsing approach faces a number of empirical difficulties. First, it has been shown by Crain et al. (1996) that children between the ages of 3;5 and 5;10 were perfectly capable of accessing inverse-scope relations for sentences like *Every dwarf ate a pizza*. In other words, children overwhelmingly accepted such sentences (i.e. 92% of the time) in contexts where every dwarf ate the same pizza; that is, a pizza was eaten by every dwarf ( $a > \text{every}$ ), which corresponds to a nonisomorphic reading. If it is the case that children fail to access nonisomorphic readings for sentences containing negation and quantified NPs because these readings are somehow harder to access than isomorphic readings (for the reasons discussed above), it remains mysterious why children can access nonisomorphic readings for sentences like *Every dwarf ate a pizza*. Also, on this view, it is hard to explain why adults have a strong preference for the allegedly more difficult interpretation of sentences like *Every horse didn't jump over the fence*, that is, the nonisomorphic interpretation.

Second, we have seen that sentences like *The detective didn't find someone* are problematic for children in both comprehension and production. Children incorrectly interpret such sentences on a narrow-scope reading and they also produce them in narrow-scope contexts, that is, in contexts where adults would use *any* instead of *some*. If children's difficulty with sentences like *The detective didn't find someone* has to do with the parser, it is mysterious why this problem should also surface in production. On the grammatical view, however, this parallelism between comprehension and production is what one should expect. That is, if children incorrectly assign sentences like *The detective didn't find someone* a formal representation corresponding to a narrow-scope reading, it comes as no surprise that they should experience difficulty in both comprehension and production. We now turn to the grammatical hypothesis.

Let us reconsider children's interpretation of sentences like *Every horse didn't jump over the fence*. Recall that in the adult grammar such sentences are ambiguous between an isomorphic ( $\text{every} > \text{not}$ ) and a nonisomorphic reading ( $\text{not} > \text{every}$ ). However, in languages like Chinese, for example, such sentences are not ambiguous — they permit only an isomorphic

reading. The example in (18) illustrates this property (the judgments are from James Huang, personal communication).

- (18) Mei-pi ma dou mei tiao-guo langan  
 ‘Every horse didn’t jump over the fence’  
 $\forall(x) [\text{horse}(x) \rightarrow \neg \text{jump over the fence}(x)]$  (every > not)

Thus, the possibility of assigning nonisomorphic readings to sentences like *Every horse didn’t jump over the fence* (i.e. not > every) appears to be subject to parametric variation across different languages. Suppose then that there exists a binary parameter of UG, which distinguishes languages like English from language like Chinese in the following way: on one value of the parameter, sentences like *Every horse didn’t jump over the fence* only allow an isomorphic interpretation (e.g. Chinese). On the other value of the parameter, both isomorphic and nonisomorphic interpretations are possible (e.g. English). Notice now that these two values create a subset/superset configuration. That is, the Chinese value of the parameter allows a subset of the options that are possible on the English value (isomorphic interpretation vs. isomorphic and nonisomorphic interpretation). In order to avoid the kind of learnability problem that would follow from initially choosing the superset value of a parameter, it is conceivable that learners initially opt for the subset value of the parameter, in accordance with the logic of the subset condition (see Crain et al. 1994 for a precise statement of this condition). This scenario is in fact compatible with the experimental findings. Recall that English-speaking children are initially restricted to isomorphic interpretations of sentences like *Every horse didn’t jump over the fence*, which is equivalent to having initially opted for the Chinese value of the parameter discussed above.

Thus, in the case of children’s interpretation of sentences like *Every horse didn’t jump over the fence*, the observation of isomorphism can be derived from the application of the subset condition. A natural question to ask, therefore, is whether children’s (incorrect) isomorphic interpretation of sentences like *The detective didn’t find some guys* can also follow from the application of the subset condition. We believe that the answer is affirmative. Before presenting our argument, however, we need to look into the theoretical underpinnings of the scope interaction between quantified NPs and negation. This, in turn, will give us necessary insight into the structure of UG and it will pave the way for a derivation of isomorphism in terms of the subset condition.

The relevant theoretical observations were made by Hornstein (1984, 1995) and Reinhart (1995, 1997). They observed that the scope interactions between negation and quantified NPs do not seem to arise from

a grammatical mechanism involving (covert) movement (such as QR for example). Thus, there are (at least) two separate mechanisms whereby a quantified expression can take scope. One mechanism involves movement operations and the other doesn't. Let us illustrate this point using the examples in (19), from Hornstein (1995).

- (19) a. Someone expects every Republican to win re-election  
 b. Someone expects every Republican will win re-election

As Hornstein observes, whereas *every Republican* can take wide scope over *someone* in (19a) that is, a different person expects each of the Republicans to win re-election (every > some), the same is not true in (19b). Example (19b) must mean that a single individual (someone) is such that she expects every Republican to win re-election (some > every). According to Hornstein, the unavailability of a wide-scope reading of *every Republican* in (19b) is due to the fact that moving this phrase out of the embedded subject of a tensed clause would create a locality violation.<sup>22</sup> This option, however, is possible when the embedded clause is not tensed, as in (19a). The contrast in interpretation between (19a) and (19b), therefore, shows that the wide-scope reading of *every* over *some* is subject to locality constraints, a characteristic signature of operations induced by syntactic movement.

In contrast, the example in (20), from Reinhart (1995), shows that a quantifier like *some politician* seems to be immune from such locality restrictions since a wide-scope reading easily obtains in the example in spite of the fact that *some politician* also occurs in subject position of an embedded tensed clause. That is, the sentence in (20) can mean that some politician exists such that Max did not consider the possibility that the politician is corrupt (some > not). Reinhart concludes that the wide-scope reading of *some politicians* cannot therefore be induced by syntactic movement, which supports the conclusion, originally arrived at by Hornstein (1984), that there exist two different scope mechanisms; one based on syntactic movement and the other not.

- (20) Max did not consider the possibility that some politician is corrupt

Consider again the contrast between (21a) and (21b), that is, the fact that a quantifier like *some problems* can take wide scope over negation but a quantifier like *every problem* cannot. This contrast suggests that the non-movement-based scope mechanism described by Reinhart is not available for every quantifier (see Reinhart 1997 for a more detailed discussion). Accordingly, Hornstein (1984) splits quantifiers into two classes, one class of quantifiers that take scope via movement operations, like *every N*, and a second class that take scope via a non-movement-

based mechanism, like *some N*. The key generalization is that quantifiers that take scope via covert movement typically cannot take wide scope over negation (e.g. *every N*, *any N*) and are, therefore, interpreted isomorphically. By contrast, quantifiers that can take scope via the kind of mechanism described by Reinhart (e.g., *some N*, *two N*) can take wide scope over negation and, therefore, induce nonisomorphic interpretations.

- (21) a. The detective didn't find some guys (some > not)  
 b. The detective didn't find every guy (not > every)

To summarize the discussion so far, we followed Hornstein (1984) and Reinhart (1995, 1997) in arguing that there are two types of quantified NPs. Some QNPs are assigned scope via movement operations and yield isomorphic readings with respect to negation, as illustrated by (21b). Other QNPs are assigned scope via a mechanism that does not involve movement operations (e.g. choice functions, as in Reinhart 1995, 1997). Such QNPs typically give rise to nonisomorphic interpretations with respect to negation, as illustrated by (20) and (21a). Let us call the first class of QNPs type 1 QNPs and the second class type 2 QNPs. The diagram below illustrates this point.

- (22) QNPs  $\begin{cases} \nearrow \text{Type 1 } \textit{option a} = \textit{scope induced by movement} \\ \searrow \text{Type 2 } \textit{option a} = \textit{scope induced by movement} \\ \qquad \qquad \qquad \textit{option b} = \textit{scope induced by non-movement-} \\ \qquad \qquad \qquad \qquad \qquad \qquad \textit{based mechanism} \end{cases}$

The observation of isomorphism can now be rephrased as follows: children initially treat *some N* as though it were a type 1 quantifier, that is, one that cannot take scope over negation but instead must be interpreted isomorphically. The reason for this, we believe, involves the subset condition. As the diagram in (22) illustrates, type 1 quantifiers have a subset of the interpretive options available to type 2 quantifiers, that is, the single option, a, versus both options, a and b. Consequently, a child faced with deciding whether a given quantifier is of type 1 or type 2 must initially hypothesize that the quantifier in question is of type 1, in accordance with the subset condition. If this initial hypothesis turns out to be incorrect, however, there are further implications for children's grammars. One possibility is that children will misfire, as in the case of *some N*. In this case, children initially assume that *some N* must receive an isomorphic interpretation with respect to clausemate negation whereas, in fact, it must receive a nonisomorphic interpretation in the adult system. Even in this case, no learnability problem arises, since UG provides



learners the means to expunge their incorrect grammatical hypothesis, as noted earlier.

The present account makes an interesting prediction with respect to children's interpretation of sentences like *Cookie monster didn't eat two slices of pizza*, which are ambiguous between an isomorphic reading (not > two) and a nonisomorphic reading (two > not). This means that a quantifier like *two N* must be of type 2. However, we argued that children, following the subset condition, initially hypothesize quantifiers to be of type 1, which can only receive an isomorphic interpretation with respect to negation. The prediction then is that children should initially reject sentences like *Cookie Monster didn't eat two slices of pizza* on a wide-scope, nonisomorphic interpretation (i.e. two > not). Musolino (1998b) tested children's comprehension of such sentences using the truth-value judgment methodology and found that this prediction is largely borne out. Out of 20 children in the Musolino study, nine rejected the nonisomorphic interpretation of sentences like *Cookie Monster didn't eat two slices of pizza* 94% of the time.

In sum, children's undergeneralization and mistaken generalization in interpreting sentences like *Every horse didn't jump over the fence* and *The detective didn't find some guys* can be derived from the application of the subset condition. In the first case, children's isomorphic interpretation follows from their initial setting of a parameter distinguishing languages like Chinese and English. In the second case, children's isomorphic interpretation follows from the application of the subset condition in conjunction with a universally encoded dichotomy partitioning the class of quantified NPs.<sup>23</sup> In both cases, a universal learning principle conspires with principles of UG to guide and constrain children's hypotheses regarding the interpretation of negation and quantified NPs.

## 5. Conclusion

At the outset we asked how children manage to navigate through the maze of semantic interactions between negation and quantified NPs and, in particular, the extent to which they assign the relevant adult interpretations to sentences containing these elements. The findings from the present experiments show that children display early mastery of a complex array of facts pertaining to quantification and negation, as witnessed by their ability to assign the relevant adult interpretations to sentences containing these elements, for the most part. In two instances, however, we found children's interpretations to differ from those of adults. The remarkable feature of children's nonadult interpretations is that they

differ from those of adults in a systematic way, suggesting that children's nonadult behavior is nonetheless governed by principles of UG. Indeed, we found children to systematically interpret sentences containing negation and QNPs on the basis of the position that these elements occupy in overt syntax. The acquisition of semantic knowledge in this domain is therefore constrained by syntactic factors. The fact that children's semantic knowledge appears to differ from that of adults has sometimes led to the conclusion that children lack access to certain semantic principles that characterize adult linguistic systems (e.g. Philip 1995; Drozd and Philip 1993). We would draw a different conclusion. On the basis of our findings, we contend that children and adults have access to the same universal linguistic principles. On our account, the only difference between children and adults is that children, as learners, are sensitive to the demands of learnability and therefore cannot hypothesize the full adult system at once. Rather, they need to make a more restricted set of initial hypotheses and await subsequent positive evidence to expand their knowledge. Specifically, we argued that children's interpretations of sentences containing negation and quantified NPs arise from the interplay between a universally encoded dichotomy partitioning the class of QNPs and the basic demands of learnability. In the same spirit, we showed that children can move from their system of interpretation to the adult system solely on the basis of positive evidence. Therefore, the observation that children differ from adults does not create any learnability problems. In sum, we view children's knowledge as incomplete rather than inaccurate. Finally, we take the present investigation to emphasize the role of universal grammar and language learnability in helping us understand the course of language development.

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## Notes

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1. See Crain et al. (1996) for a criticism of this view.
  2. In all the examples used in this paper, “Y occurs in the scope of X” can either be read as “Y occurs in the c-command domain of X” or “Y occurs to the right of X.” In order to tease these two definitions apart, we would need cases where the c-command relations between the QNPs and negation do not systematically coincide with their linear arrangement.
  3. Here, we are concerned with the relation between overt position and relative interpretation. An interpretation is said to be isomorphic if the two coincide and nonisomorphic if they don’t. In the context of the present article, we do not intend the notion of isomorphism to describe the relation between the (possible) covert position of quantifiers (i.e. their position at LF) and their interpretation. Whether isomorphism holds between the position of logical elements at LF and their relative interpretation is a question that need not concern us here.
  4. In addition to its NPI reading, (i) *any* also has what is known as a “free choice” (FC) reading, (ii).
    - (i) (NPI)  
I don’t have any money.
    - (ii) (FC)  
Any linguist could tell you that.
- It has been argued that while NPI *any* is best analyzed as existential, in particular by Ladusaw (1979) and Horn (1972), FC *any*, on the other hand, has universal force (Carlson 1981). For the purpose of our study, we will only consider *any* in its NPI use.
5. Since NPI *any* occurs outside the scope of negation in the example in (3a), *Did any of the turtles not buy an apple?*, one may wonder how its licensing can take place. In this case, it is reasonable to assume that what licenses NPI *any*, if not negation, is the fact that (3a) is a question. Indeed, questions are another environment where NPIs are allowed to occur, e.g. *Do you have any money?*
  6. It is conceivable in these cases that children are using a form of negation known as metalinguistic negation (Horn 1989) in their responses. This form of negation is typically used to deny an utterance previously encountered, as in the following example: Speaker A: *John had some beans*. Speaker B: *John didn’t have some beans. He had some rice*. The fact that in cases of type 3 children were asked to respond to utterances containing *some* or *something* would be compatible with the use of metalinguistic negation. This account, however, is incompatible with the results from our comprehension experiment, where children (incorrectly) interpret *some* in the scope of clausemate negation (see experiment 1).
  7. The stories witnessed by our control group of adults were a videotaped version of the experimental stimulus. They were therefore identical — modulo the medium of presentation — to the stories witnessed by the children.
  8. The test sentences were
    - (i) The detective didn’t find someone/some guys
    - (ii) The Troll didn’t find something/some marbles
    - (iii) The Cheetah didn’t eat something/some food
    - (iv) The old man didn’t hurt someone/some guys

9. Note that since the isomorphic interpretation (every > not) entails the nonisomorphic one (not > every), it would have been impossible to design a story where the isomorphic interpretation was true and the nonisomorphic one false.
10. The test sentences were
  - (i) Every horse didn't jump over the fence
  - (ii) Every boy didn't pet the polar bear
  - (iii) Every caveman didn't ride on the giant turtle
  - (iv) Every girl didn't ride on the merry-go-round
11. In fact, adults display a strong preference for the nonisomorphic interpretation of sentences of the form *Every N didn't VP*. We present data to support this claim in section 4.
12. As in the previous experiment, the entailment relation between the *none* and the *not all* reading (i.e. *none* entails *not all*, but not vice-versa) dictated that we make the wide-scope reading false and the narrow-scope reading true in the context of our stories.
13. The test sentences were
  - (i) The Smurf didn't buy every orange
  - (ii) The Smurf didn't eat every potato chip
  - (iii) The boy didn't clean every space robot
  - (iv) The farmer didn't feed every horse
14. Note here that the children who accepted the *not every* interpretation of sentences like *The Smurf didn't buy every orange* are younger than those who rejected the *not every* interpretation of sentences like *Every horse didn't jump over the fence* (mean 4;10 vs. mean 5;11). What this shows is that children do not have a problem with *not every* readings in general, since younger children can assign it to sentences like *the Smurf didn't buy every orange*. Rather it means that until a certain age, children cannot assign sentences like *Every horse didn't jump over the fence* a nonisomorphic interpretation.
15. It is important to keep in mind that in the present context, isomorphism is simply an OBSERVATION. That is, we are NOT claiming that there exists a general principle of isomorphism in the grammar of young children that predicts that any sequence of quantificational elements will be interpreted on the basis of their overt position.
16. It is also worth noting that in spontaneous speech by adults, sentences of the form *Every N didn't VP* are almost exclusively used to mean that not every N did so-and-so, a nonisomorphic interpretation. Indeed, in the corpus of spontaneous speech collected by Musolino, not more than two of the 30 examples were uses of the *Every N/All the Ns didn't VP* construction with an intended "nobody VPed" meaning. For a similar observation, see Horn (1989).
17. For a more detailed version of this argument, see Crain et al. (1994) and Crain and Thornton (1998).
18. On the view that PPIs like *some* behave like pronominal elements with respect to negation and hence that they are subject to a general version of principle B of the binding theory, as argued in Progovac (1994), children's problem with the interpretation of *some* is reminiscent of their difficulty with the interpretation of pronouns such as *him* or *her* (Chien and Wexler 1990; Thornton and Wexler 1999). For a parallel treatment of these two problems, see O'Leary (1994). Note also that using the approach developed in Progovac (1994), O'Leary is unable to resolve the learnability problem raised by children's incorrect use of *some*. One possibility not considered by O'Leary, though, is that in order to resolve the learnability problem, Progovac's

approach regarding the status of *some* may need to be abandoned. This is in fact what we are implicitly proposing here.

19. We are assuming a PF-deletion theory of ellipsis merely for simplicity of exposition. As far as we can tell, our proposal is neutral between a PF-deletion and an LF-copying approach.
20. For a similar argument applied to English plural morphology, see Clark (1993).
21. Indeed, our approach is reminiscent of Pinker's (1986) in the domain of the acquisition of verbal morphology. Pinker argues that children can recover from their overgeneralization of the past tense rule, as for example in *goed* instead of *went*, when they realize that *went* and *goed* compete for the same cell in the verbal paradigm, i.e. [Go + past]. Pinker invokes a version of the uniqueness principle (Wexler and Culicover 1980) according to which there can only be one lexical realization of [Go + past] and it must be *went*, since it is what children encounter in the input. Thus, Pinker argues, knowledge of uniqueness in conjunction with the presence of *went* in the input induces a blocking effect and allows children to expunge the incorrect form *goed* from their grammar.
22. Specifically, Hornstein argues that moving *every Republican* out of the subject position of an embedded tensed clause would be an ECP violation. The ECP (empty-category principle of Chomsky 1981, 1986; see also Rizzi 1990, among others) is a condition that states that traces left by movement must be properly governed. In government-binding-style frameworks the ECP typically interacts with the general rule move-alpha so as to constrain its application and account for the local behavior of movement-based grammatical dependencies.
23. For additional cross-linguistic evidence of the classification proposed by Hornstein (1984) and its role in the acquisition of quantification, see Lee (1996).

## References

- Aoun, Joseph; and Li, Audrey (1989). Scope and constituency. *Linguistic Inquiry* 20(2), 141–172.
- ; and Li, Audrey (1993). *Syntax of Scope*. Cambridge, MA: MIT Press
- Aronoff, Mark (1976) *Word Formation in Generative Grammar*. Cambridge, MA: MIT Press.
- Baker, Carol (1970). Double negatives. *Linguistic Inquiry* 1(2), 169–186.
- (1979). Syntactic theory and the projection problem. *Linguistic Inquiry* 10, 533–581.
- Bellugi, Ursula (1967). The acquisition of the system of negation in children's speech. Unpublished Ph.D. dissertation, Harvard University.
- Brooks, Patricia; and Braine, Martin (1996). What do children know about the universal quantifiers *all* and *each*? *Cognition* 60, 235–268.
- Bucci, Wilma (1978). The interpretation of universal affirmative propositions: a developmental study. *Cognition* 6, 55–77.
- Chien, Yu-Chin (1994). Structural determinants of quantifier scope: an experimental study of Chinese first language acquisition. In *Syntactic Theory and First Language Acquisition: Cross-Linguistic Perspectives*, vol. 2: *Binding, Dependencies and Learnability*, B. Lust, G. Hermon, and J. Kornfilt (eds.). Hillsdale, NJ: Erlbaum.
- ; and Wexler, Kenneth (1989). Children's knowledge of relative scope in Chinese. *Papers and Reports in Child Language Development* 28, 72–80.
- ; and Wexler, Kenneth (1990). Children's knowledge of locality conditions in binding as evidence for the modularity of syntax and pragmatics. *Language Acquisition* 1, 225–295.

- Carlson, Gregory (1981). Distribution of free-choice *any*. In *Papers from the Seventeenth Regional Meeting of the Chicago Linguistic Society*, Hendrick, Masek, and Miller (eds.). Chicago: CLS.
- Chomsky, Noam (1976). Conditions on rules of grammar. *Linguistic Analysis* 2, 303–351.
- (1981). *Lectures on Government and Binding*. Dordrecht: Foris.
- (1986). *Knowledge of Language: Its Nature, Origin, and Use*. New York: Praeger.
- (1995). *The Minimalist Program*. Cambridge, MA: MIT Press.
- Clark, Eve V. (1987). The principle of contrast: a constraint on language acquisition. In *Mechanisms of Language Acquisition*, B. McWhinney (ed.). Hillsdale, NJ: Erlbaum.
- (1993). *The Lexicon in Acquisition*. Cambridge: Cambridge University Press.
- Crain, Stephen; and McKee, Cecile (1985). The acquisition of structural restrictions on anaphora. In *Proceedings of the Northeastern Linguistic Society*, S. Berman, J.-W. Choe, and J. McDonough (eds). Amherst, MA: GLSA.
- ; Ni, Weijia; and Conway, Laura (1994). Learning, parsing, and modularity. In *Perspectives on Sentence Processing*, C. Clifton, L. Frazier, and K. Rayner (eds.). Hillsdale, NJ: Erlbaum.
- ; and Thornton, Rosalind (1998). *Investigations in Universal Grammar: A Guide to Research on the Acquisition of Syntax and Semantics*. Cambridge, MA: MIT Press.
- ; Thornton, Rosalind; Boster, Carol; Conway, Laura; Lillo-Martin, Dianne; and Woodams, Elaine (1996). Quantification without qualification. *Language Acquisition* 5(2), 83–153.
- ; and Wexler, Kenneth (1999). Methodology in the study of language acquisition: a modular approach. In *Handbook of Language Acquisition*, W. Ritchie and T. Bhatia (eds.). New York: Academic Press.
- Donaldson, Margaret; and Lloyd, Peter (1974). Sentences and situations: children's judgments of match and mismatch. In *Problèmes actuels en psycholinguistique*, F. Bresson (ed.). Paris: Centre National de Recherche Scientifique.
- Drozd, Kenneth; and Philip, William (1993). Event quantification in preschoolers' comprehension of negation. In *Proceedings of the 24th Annual Child Language Research Forum*, E. V. Clark (ed.). Stanford, CA: Center for the Study of Language and Information.
- ; and van Loosbroek, Erik (n.d.). The effect of context on children's interpretations of universally quantified sentences. Unpublished manuscript.
- Fodor, Janet, D.; and Crain, Stephen (1987). Simplicity and generality rules in language acquisition. In *Mechanisms of Language Acquisition*, B. MacWhinney (ed.). Hillsdale, NJ: Erlbaum.
- Grice, H. Paul (1989). *Studies in the Way of Words*. Cambridge, MA: Harvard University Press.
- Guasti, Maria T.; Thornton, Rosalind; and Wexler, Kenneth (1993). Children's negative questions: the case of English. In *Proceedings of the Boston University Conference on Child Language Development*, 19. Boston: Cascadilla.
- Horn, Laurence (1972). On the semantic properties of logical operators in English. Unpublished Ph.D. dissertation, UCLA. (Reproduced [1976]. Bloomington, IN: IULC.)
- (1989). *A Natural History of Negation*. Chicago: University of Chicago Press.
- Hornstein, Norbert (1984). *Logic as Grammar*. Cambridge, MA: MIT Press.
- (1995). *LF: The Grammar of Logical Form from GB to Minimalism*. Oxford: Blackwell.
- Huang, James (1982). Logical relations in Chinese and the theory of grammar. Unpublished doctoral dissertation, MIT.
- Inhelder, Bärbel; and Piaget, Jean (1964). *The Early Growth of Logic in the Child: Classification and Seriation*. London: Routledge and Kegan Paul.

- Jackendoff, Ray (1972). *Semantic Interpretation in Generative Grammar*. Cambridge, MA: MIT Press.
- Kadmon, Nirit; and Landman, Fred (1993). Any. *Linguistics and Philosophy* 16, 353–422.
- Klima, Edward S. (1964). Negation in English. In *The Structure of Language*, J. A. Fodor and J. J. Katz (eds.). Englewood Cliffs, NJ: Prentice Hall.
- Krämer, Irene (1998). Indefinite subject noun phrases and negation in the interpretation of Dutch children. In *Proceedings of the Center for Language Studies Opening of the Academic Year 1998–1999*, 51–81. Tilburg: CLS.
- (forthcoming). Who are you talking about? Children’s interpretation of sentence initial indefinite subjects in sentences containing negation. In *Linguistics in the Netherlands 1999*, R. Kager and R. Van Bezooijen (eds.). Amsterdam: Benjamins.
- Krifka, Manfred (1994). Semantics and pragmatics of polarity items. Unpublished manuscript, Department of Linguistics, University of Texas at Austin.
- Ladusaw, William A. (1979). Polarity sensitivity as inherent scope relations. Unpublished Ph.D. dissertation, University of Texas at Austin.
- Lasnik, Howard (1972). Analyses of negation in English. Unpublished doctoral dissertation, MIT.
- (1994). Syntactic structures meets the minimalist program. Unpublished manuscript, University of Connecticut.
- Lee, Thomas (1991). Linearity as a scope principle for Chinese: the evidence from first language acquisition. In *Bridges Between Psychology and Linguistics*, D. Napoli and J. Kelg (eds.). Hillsdale, NJ: Erlbaum.
- (1997). Scope and distributivity in child Mandarin. In *Proceedings of the 28th Annual Child Language Research Forum*. Stanford: Center for the Study of Language and Information.
- Linebarger, Marcia (1980). The grammar of negative polarity. Unpublished Ph.D. dissertation, MIT.
- May, Robert (1985). *Logical Form: Its Structure and Derivation*. Cambridge, MA: MIT Press.
- Musolino, Julien (1998a). Not any child can deal with *some*. In *Proceedings of the 1997 Boston University Conference on Language Development*. Somerville, MA: Cascadilla.
- (1998b). Universal grammar and the acquisition of semantic knowledge: an experimental investigation into the acquisition of quantifier–negation interaction in English. Unpublished doctoral dissertation, University of Maryland at College Park.
- (1999). What every child doesn’t know. In *Proceedings of the 1998 Boston University Conference on Language Development*. Somerville, MA: Cascadilla.
- (forthcoming). Negation, quantification and isomorphism in child English. In *Proceedings of the Stanford Child Language Research Forum*. Stanford: Center for the Study of Language and Information.
- O’Leary, Carrie (1994). Children’s awareness of polarity sensitivity. Unpublished M.A. thesis, University of Connecticut.
- ; and Crain, Stephen (1994). Negative polarity items (a positive result) positive polarity items (a negative result). Paper presented at the 1994 Boston University Conference on Language Development.
- Philip, William (1991). Quantification over events in early universal quantification. Paper presented at the 16th annual Boston University Conference on Language Development, Boston, MA.
- (1992). Event quantification and the symmetrical interpretation of universal quantifiers in child language. In *Semantic Issues*, K. von Stechow and H. Rullman (eds.). University of Massachusetts Occasional Papers in Linguistics. Amherst, MA: GLSA.

- (1995). Event quantification in the acquisition of universal quantification. Unpublished doctoral dissertation, University of Massachusetts, Amherst.
- ; and Aurelio, S. (1991). Quantified spreading: pilot study of preschooler's "every." In *Papers in the Acquisition of WH: Proceedings of the UMass Roundtable, May 1990*, T. Maxfield and B. Plunkett (eds.). Amherst, MA: GLSA.
- Pinker, Stephen (1984). *Language Learnability and Language Development*. Cambridge, MA: Harvard University Press.
- (1986). Productivity and conservatism in language acquisition. In *Language Learning and Concept Acquisition: Foundational Issues*, W. Demopoulos and A. Marras (eds.), 54–79. London, Canada: University of Western Ontario.
- (1989). *Learnability and Cognition*. Cambridge, MA: MIT Press.
- Progovac, L. (1994). *Negative and Positive Polarity. A Binding Approach*. Cambridge: Cambridge University Press.
- Reinhart, Tanya (1995). *Interface Strategies*. OTS Working Papers, TL-95-002. Utrecht: University of Utrecht.
- (1997). Quantifier scope: how labor is divided between QR and choice functions. *Linguistics and Philosophy* 20, 335–397.
- Rizzi, Luigi (1990). *Relativized Minimality*. Cambridge, MA: MIT Press.
- Roeper, Thomas; and de Villiers, Jill (1991). The emergence of bound variable structures. In *Papers in the Acquisition of WH*, T. Maxfield and B. Plunkett (eds.), 267–282. University of Massachusetts Occasional Papers. Amherst, MA: GLSA.
- ; and Matthei, E. (1975). *On the Acquisition of All and Some*. Papers and Reports on Child Language Development 9. Stanford: Stanford University Press.
- Takahashi, Mari (1991). Children's interpretations of sentences containing *every*. In *Papers in the Acquisition of WH: Proceedings of the UMass Roundtable, May 1990*, T. Maxfield and B. Plunkett (eds.). Amherst, MA: GLSA.
- Thornton, Rosalind (1995). Children's negative questions: a production/comprehension asymmetry. In *Proceedings of ESCOL*, J. Fuller, H. Han, and D. Parkinson (eds.). Ithaca, NY: Cornell University.
- ; and Wexler, Kenneth (1999). *Principle B, VP Ellipsis, and Interpretation in Child Grammar*. Cambridge, MA: MIT Press.
- Van der Wal, Sjoukje (1996). *Negative Polarity Items and Negation, Tandem Acquisition*. Groningen Dissertations in Linguistics 17. Groningen: Grodil.
- Wexler, Kenneth; and Culicover, Peter (1980). *Formal Principles of Language Acquisition*. Cambridge, MA: MIT Press.



