

# On the quantificational status of indefinites: the view from child language

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## 1 Introduction

The study of indefinites in natural language semantics has focused on two properties which suggest that indefinites have a different character from other quantificational expressions. The first property is that of quantificational variability (Lewis 1975), whereby indefinites seem to have a different quantificational force depending on their syntactic and semantic context. This suggests that indefinites have no quantificational force of their own and hence that indefinite determiners are not really quantifiers. The second property is their island-free scope behavior. Although prototypical quantificational NPs can take scope only within a single clause, indefinites can take unbounded scope, even appearing to take scope out of syntactic islands. This latter fact also suggests that indefinites are non-quantificational. Together these properties lead to the possibility that indefinites are never quantificational. In this paper we consider and reject this possibility on the basis of data from child language. We show that the most explanatory account of children's interpretations of sentences containing numerally quantified indefinites is one that treats them quantificationally. While we do not deny that indefinites have properties that require them to be given multiple representations in the adult grammar, the child data shows unequivocally that a quantificational representation

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<sup>1</sup> The authors are engaged in a continuing collaboration in which the order of names alternates from one paper to the next. The authors contributed equally to the work reported here. Thanks to the Central Institute of Indian Languages (Mysore), especially Udaya Narayana Singh, B. Mallikarjun, and B. K. Suvarna Devi, without whom this research would not have been possible. Thanks to Ken Drozd and two anonymous reviewers for helpful comments on a previous version of the paper. This work was supported in part by a grant from the National Science Foundation (BCS-0418309).

must be included among these. Indeed, our research seems to show that the non-quantificational representations are actually dispreferred by children, suggesting that future research on the acquisition of semantics should address just how children come to acquire or access these non-quantificational representations. On a more general level, we hope to add support to the idea that work in linguistic theory does not reach its full explanatory force until the models proposed face the challenges posed by the need to explain language acquisition (Chomsky, 1965; Hornstein and Lightfoot, 1981). The primary aim of generative linguistics is the construction of an explanatory model that captures both the state of knowledge achieved by adults and the initial state of the learner. In the present context, we show that that research on the acquisition of syntax and semantics can place limits on the construction of such a model.

## **2 The theoretical context**

### *2.1 Quantificational variability and the free variable analysis*

The study of indefinites within the generative paradigm begins with Kamp 1981 and Heim 1982, who introduced the possibility that indefinites (including NPs with numeral determiners) are non-quantificational. The idea that indefinites do not carry existential force of their own grows out of the observation that the quantificational force of an indefinite varies depending on its surrounding context (Lewis 1975):

- (1) a. A psychologist usually ignores syntactic theory.
- b. A psychologist rarely ignores syntactic theory.

In, (1a), we interpret the indefinite as referring to most psychologists whereas in (1b), we interpret it as referring to few psychologists. In other words, indefinites do not simply

introduce their own quantificational force but rather can also take their quantificational force from other elements in the sentence (such as adverbs like *usually* and *rarely*). Kamp and Heim took these observations as evidence that indefinites are not quantificational, but rather are best treated as free variables that come to be bound by other quantificational elements in the sentence. For example, the sentences in (1) would have semantic representations like (2) in which the indefinite is treated as the restrictor of the quantificational adverb.

- (2) a. usually(x) [[psychologist(x)] → [x ignores syntactic theory]]  
 b. rarely(x) [[psychologist(x)] → [x ignores syntactic theory]].

In these examples, the interpretation of the variable introduced by the indefinite depends on the choice of adverbial. Further, in the absence of other quantificational elements, indefinites are bound by an existential quantifier inserted by a default operation of existential closure (Kamp 1981, Heim 1982, Diesing 1992).

- (3) a. A psychologist ignores syntax  
 b. psychologist(x) & x ignores syntax (variables unbound)  
 c.  $\exists x$  [psychologist(x) & x ignores syntax] (variables bound by  $\exists$  closure)

In the original Kamp/Heim formulation, the existential closure operation applied at the text level, unselectively binding all free variables, as shown in (c). However, subsequent research showed that existential closure could not be a text-level operation (Diesing 1992, Kadmon 1987, Kratzer 1995). This conclusion was derived from two arguments.

First, bare plural subjects of individual level predicates, such as *tall*, cannot be interpreted existentially.

- (4) Firemen are tall

= firemen are generally tall  
≠ some firemen are tall

Since bare plurals also show the quantificational variability effect, and hence are also treated as variables, we expect that if there were a text-level existential closure operation, they could receive an existential interpretation in these contexts.<sup>2</sup> But they do not. Hence, we can conclude that existential closure does not apply at the text level.

Second, pronouns that are not c-commanded by their antecedents are interpreted differently from how text-level existential closure would predict:

(5) Oscar owns sheep. Otto vaccinates them.

Existential closure applied to the text would yield a representation like (6):

(6)  $\exists x$  [x is a sheep & Oscar owns x & Otto vaccinates x]

The problem is that the text in (5) means that Otto vaccinates all of the sheep that Oscar owns, but the representation says only that there are some sheep that Oscar owns and Otto vaccinates. Therefore, we can conclude that there is no text-level existential closure and free pronouns are interpreted in some other way, most likely taking an E-type strategy (Evans 1977).

Diesing (1992) went on to argue that existential closure does exist, accounting for the existential interpretation of indefinites, but that it is restricted to applying within VP. This argument was based, in part, on the difference between stage-level and individual-level predicates. Unlike with individual-level predicates, indefinite subjects of stage-level predicates can have an existential interpretation, as shown in (7):

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<sup>2</sup> The fact that indefinite subjects of individual level predicates can receive an existential interpretation argues that indefinites, unlike bare plurals, must also have a quantificational representation, as we will see below.

(i) A fireman is tall

- (7) a. Firemen are available (ok  $\exists$ )  
 b. Firemen are tall (\*  $\exists$ )

The difference between stage-level and individual-level predicates, Diesing argues, is that only the former have a VP-internal subject position. Consequently, the variable introduced by an indefinite or bare plural subject of a stage-level predicate can be bound by VP-internal existential closure after it reconstructs to its base position. Since there is no such position for individual-level predicates, an indefinite subject cannot occur inside VP at LF and consequently cannot be bound by existential closure.

A second argument in favor of VP-internal existential closure is provided by the interpretation of German bare plurals. Diesing shows that the S-structure position of bare plural subjects in German determines their interpretation. Outside of VP, a bare plural is interpreted generically, whereas inside VP, a bare plural is interpreted existentially.

- (8) a. ... weil ja doch Kinder auf der Straße spielen (Diesing 1992, p. 37)  
 ... since indeed children in the street play  
 ‘...since there are children playing in the street.’  
 b) ... weil Kinder ja doch auf der Straße spielen  
 ... since children indeed in the street play  
 ‘...since generally children play in the street.’

This data suggests that the properties displayed on the surface in German are indicative of the general relation between structure and interpretation. English simply does at LF what German does on the surface. That is, existential readings of bare plurals are derived by interpreting them inside VP, where they are inside the scope of existential closure.

Generic readings are derived by interpreting bare plurals outside of VP (where they can be bound by an invisible generic operator).

In contrast to the variable analysis presented so far, Diesing also argues that that

indefinites, unlike bare plurals, are ambiguous between a variable-introducing representation and a quantificational representation. The argument proceeds along the following lines. If existential closure is restricted to applying inside VP and if indefinites only introduce free variables, then we predict that indefinites outside of VP in sentences with no other quantificational source should be ungrammatical. But they aren't, so something has to give.

Recall that surface structure position determines interpretation in German. Existential readings of bare plurals are restricted to VP-internal position. Thus, inside VP, a variable can be bound by existential closure, but outside of VP it cannot. The indefinite in (9), which is outside of VP, as indicated by its position to the left of the adverbial *ja doch*, has an existential interpretation. Since this interpretation could not have come about from existential closure, Diesing concludes that indefinites also have a quantificational representation.

- (9) ...weil zwei Kinder ja doch auf der Straße spielen (Diesing 1992, p. 58)  
... since two children indeed in the street play.  
'... since there are two children playing in the street.'

In the next section, we consider whether this conclusion is warranted by considering an independent problem associated with indefinites.

## 2.2 *Wide-scope indefinites*

A second problem associated with indefinites concerns their scope. If it is true that indefinites have a quantificational representation (in addition to a representation as variables), then we would expect them to have the same scopal options as other quantificational expressions. However, as observed by Fodor and Sag (1982), this expectation is not met. Consider the following.

10) Every professor rewarded every student who read a book I had reviewed.

11) Readings:

a)  $\forall \text{professor} \gg \forall \text{student} \gg \exists \text{book}$

b)  $\exists \text{book} \gg \forall \text{professor} \gg \forall \text{student}$

c)  $?\forall \text{professor} \gg \exists \text{book} \gg \forall \text{student}$ <sup>3</sup>

(10) allows at least two “scope” readings for the indefinite *a book*. This NP can be interpreted inside the scope of both universal quantifiers as in (11a). On this reading, as long as a student read some book or other that I had reviewed, then that student was rewarded. Alternatively, we can interpret the indefinite with the widest scope, as in (11b). On this reading, there is one particular book that I reviewed such that every professor rewarded every student who read that book. The availability of this reading is surprising on a view that takes non-surface scope readings to be due to a covert operation of quantifier raising (QR). The surprise is due to the fact that the indefinite is contained in a relative clause, an island for movement. Compare the ungrammaticality of ((12a-b):

(12) a. \* Which book did every professor reward every student who read t?

b. \* The book that every professor rewarded every student who read t

If QR is syntactic movement, then we should expect it to be subject to the same constraints as overt movement and so the wide scope reading of (10) should be impossible.

Reinhart (1997) and Kratzer (1998) account for the problem raised by Fodor and Sag by proposing that indefinites are optionally interpreted as choice functions. On this view, an indefinite NP can be interpreted as specific without scoping.

A choice function is a function from a set of individuals to a member of that set. Because a choice function picks out an individual we can get a specific reading of an

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<sup>3</sup> The presence of the intermediate scope reading has been the subject of considerable debate, largely beyond the scope of this article. See Reinhart 1997 for discussion.

indefinite without making reference to syntactic scope. To illustrate what a choice function is, we can contrast a choice function with a superlative function, like “oldest,” which takes a set and returns a new set containing only the member of the original set with the relevant property (in this case, the property of being the oldest member of that set). Let us say that we have the set of books given in (13a):

- (13) a. book = {Huck Finn, Gravity’s Rainbow, War and Peace}  
 b. oldest(book) = {War and Peace}

The function “oldest” applied to that set will return a singleton set containing the oldest book, namely War and Peace. If we were to apply the same function to a different set, say the set of living presidents given in (14a), then it would return a singleton set containing the oldest member of that set, namely Ford.

- (14) a. living\_president = {Ford, Carter, Bush I, Clinton, Bush II}  
 b. oldest(living\_president) = {Ford}

A choice function, rather than mapping to a singleton set, maps directly to an individual member. So, in a sentence like (10), repeated here, the apparent wide scope reading is due to the indefinite “a book” being interpreted as a choice function as in (15).

- (10) Every professor rewarded every student who read a book I reviewed

- (15)  $\exists f \forall y [\text{professor}(y) \wedge \forall x[(\text{student}(x) \wedge \text{read}(x, f(\text{book}))) \rightarrow \text{reward}(y, x)]]$

(15) says that there is a function such that every professor will reward every student who reads the book selected by that function, say Gravity’s Rainbow. The appearance of wide scope is not due to QR, but rather to the fact that the function picks out a particular book.

### 2.3 *How many representations for indefinites?*

Let us now take stock. The quantificational variability of indefinites leads to a theory of indefinites whereby these NPs have two possible semantic representations.

They can either be free variables that get their existential interpretation from a default operation of existential closure, or else they can be quantificational. The wide scope behavior of indefinites leads to a theory whereby these NPs can be assigned a third representation under which they introduce a function variable, bound by a root-level existential closure operation over function variables. That's a lot of representations for one type of NP, bringing up the question of whether any of these can be eliminated.

At first estimation, it seems as if the quantificational representation is dispensable because the set of readings that it generates can all be accounted for under the choice-function analysis. That is, the quantificational representation treats the indefinite like any other case of restricted quantification. The quantifier introduces a restriction (represented by the head N) and a scope (represented by its LF c-command domain). Importantly, the restrictor on the quantification is taken as a presupposition on the domain of quantification. This presupposition essentially gives a specific interpretation for the quantified NP. However, the specific interpretation that comes from treating indefinites quantificationally can also arise through the use of choice functions, suggesting that this reading may only be derived in the latter fashion. That is, the existence of a choice-function representation may eliminate the need for a quantificational representation.<sup>4</sup> Indeed, several theories of indefinites have precisely this character. Winter 1997 argues that indefinites are only choice-functional, with the different readings derived from the variable locations of existential closure (see Matthewson 1999 and Lidz, in press for cross-linguistic arguments against this view). Chung and Ladusaw 2004 also argue that

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<sup>4</sup> If this is right, then it follows that bare plurals, unlike indefinites, cannot introduce function variables since bare plurals are restricted to existential interpretations inside VP, as shown by Diesing 1992.

indefinites are never quantificational. Instead, on their view, indefinites are either predicates (cf. van Geenhoven 1995) or choice functions.

In the remainder of the paper, we will argue that the possibility of eliminating the quantificational representation of indefinites runs aground when we consider children's interpretations of indefinites. Taking advantage of children's limitations in the interpretations of quantificational NPs generally, we will show that children's interpretations of indefinites are limited in exactly the same ways as their interpretations of true quantificational expressions. This parallelism between unambiguously quantificational NPs and indefinites is best captured by a theory in which indefinites do have a quantificational representation. Indeed, the limitations that children show with indefinites may even suggest that the nonquantificational representations involving existential closure may actually be the ones that children have difficulty with. Before making these arguments, however, we must first review some literature on children's quantificational interpretations, which establishes an independent generalization that we will use to assess children's behavior with indefinites.

### 3 The Isomorphism Effect

In order to investigate the syntax and semantics of quantification in children, Musolino, Crain and Thornton (2000) (based on Musolino, 1998) tested children and adults' interpretation of sentences like (16) and (17) using the Truth Value Judgment Task methodology (Crain and Thornton 1998).

- (16) Every horse didn't jump over the fence.  
a.  $\forall x$  [horse(x)  $\rightarrow$   $\neg$  jump (x, over the fence)] (none)  
b.  $\neg \forall x$  [horse(x)  $\rightarrow$  jump (x, over the fence)] (not all)
- (17) The smurf didn't buy every orange.  
a.  $\neg \forall x$  [orange(x)  $\rightarrow$  buy (smurf, x)] (not all)

Sentences like (16) are ambiguous between a “none” and a “not all” reading (16a and 16b, respectively). By contrast, (17) is unambiguous, allowing only the “not all” interpretation. Musolino et al. found that children, unlike adults, displayed a strong preference for the “none” interpretation of sentences like (16), i.e. (16a). In addition, Musolino et al. were able to tell that this effect was not conceptual in nature because the “not all” reading which was rejected in sentences like (16) was accepted in sentences like (17), where it is the only possible reading. In sum, when the quantificational expression was in subject position, children rejected the reading in which negation took scope over the QP. When the QP was in object position, however, they accepted this reading.

Musolino et al., described this phenomenon as an isomorphism effect: the scope of quantificational elements with respect to negation is determined by surface position. However, these results are consistent either with the possibility that surface position is defined in terms of precedence relations or with the possibility that surface position is defined in terms of hierarchical structure. On the former view, if the quantificational expression precedes negation, then it takes scope over negation; and, if the linear order is reversed, then so are the scopal relations (Johnson-Laird 1969, Kroch 1974, Ioup 1975, Fodor 1982, Bunt 1985, Kurtzman and MacDonald 1993). On the latter view, semantic scope is determined by syntactic command relations (Lasnik 1972, Jackendoff 1972, May 1977, Hornstein 1984, Aoun and Li 1989, Hornstein 1995). If the quantificational expression c-commands negation, then it takes scope over negation; if negation c-commands the quantificational expression, then negation takes wider scope.

In addition, Musolino et al.’s hypothesis was built on only partial data. From the observation that children rejected the inverse scope reading of (16), Musolino et al.

concluded that the surface scope reading was available. However, they were unable to test the surface reading directly due to the truth-conditions of the two propositions. This is because the interpretation of a universal quantifier outside the scope of negation (16a) entails the interpretation in which negation takes wider scope (16b). That is, every situation that makes (16a) true also makes (16b) true. If it is true that none of the horses jumped over the fence, (8a), it necessarily follows that not all of the horses jumped over the fence, (8b); but not vice versa. Hence, Musolino et al., could test only the former directly. These entailment patterns are shown below.

- (18)            a.         $\forall x[\neg P(x)] \rightarrow \neg[\forall x [P(x)]]$             none  $\rightarrow$  not all  
                   b.         $\neg[\forall x[P(x)]] \not\rightarrow \forall x[\neg P(x)]$             not all  $\not\rightarrow$  none

To deal with these problems, Lidz and Musolino (2002) examined the scope of negation with respect to numerally quantified NPs in object position in English and Kannada. The use of numerally quantified NPs averts the entailment problem. The two readings of ambiguous sentences involving the scope of negation with respect to a numerally quantified NP do not stand in an entailment relation to each other.<sup>5</sup> For each reading it is possible to construct scenarios that make that reading true and the other false (see Lidz and Musolino, 2002). Consequently, both the surface and inverse scope readings could be tested directly.

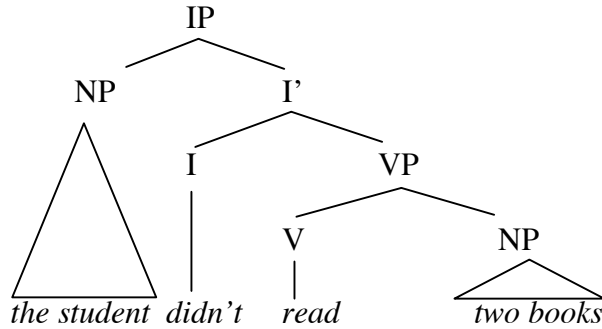
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<sup>5</sup> Consider for example the sentence *The student didn't read two books* which can either mean that it is not the case that the student in question read two books (i.e. not > two) or that there are two specific books that the student didn't read (i.e. two > not). In a situation in which the student has four books, reads two and fails to read the other two, the wide scope reading of the numeral is true (i.e. there are indeed two books that the student didn't read) while the narrow scope reading is false (i.e. it is false that it is not the case that the student read two books since s/he read exactly two books). Conversely, in a situation in which the student has two books, reads one and fails to read the other one, the wide scope reading of the numeral is false (since there is now only one book that the student didn't read – and not two) while the narrow scope reading is now true since it is indeed not the case that the student read two books; i.e. s/he only read one. Thus, since the two readings can be true or false independently of each other, no entailment relation holds between them.

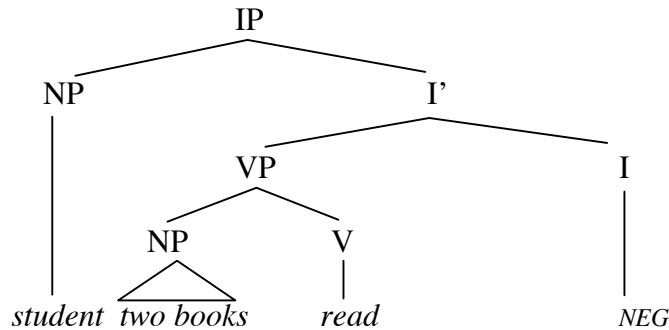
With respect to the cause of isomorphism, the two languages tested by Lidz and Musolino enabled them to distinguish a linear interpretation of the effect from a hierarchical interpretation of it. English and Kannada are alike in that negation c-commands the object position at S-structure in both languages; however, these languages differ in terms of linear order. In English, negation precedes the object NP whereas in Kannada, negation follows the object NP. This state of affairs is illustrated in (19) and (20).

- (19) a. The student didn't read two books  
 b. vidyaarathi eraDu pustaka ooD-al-illa (Kannada)  
 student two book read-INF-NEG  
 'The student didn't read two books.'

- (20) a. English



- b. Kannada



Because English and Kannada exhibit the same hierarchical relations with a different word order, a comparison of children's behavior in the two languages enabled Lidz and Musolino to distinguish the linear interpretation of isomorphism from the hierarchical interpretation. If the isomorphism effect is due to a one-to-one mapping from precedence to scope, then Kannada children were predicted to show a preference for the wide scope reading of *two cookies*. By contrast, if the effect is due to a one-to-one mapping from c-command to scope, then Kannada children were predicted to display a preference for the narrow scope reading.

As expected, adults in both languages were equally likely to accept the two interpretations of sentences like (19). Four-year-olds, on the other hand, displayed a significant preference for the narrow scope reading of the numeral, independent of language. In both languages, children accepted the reading in which negation took scope over the object significantly more often than they accepted the inverse scope interpretation. Lidz and Musolino concluded on the basis of these studies that the isomorphism effect is a consequence of hierarchical structure rather than linear order. Children's interpretations of scopally ambiguous sentences are determined by the surface c-command relations that hold between the two scope bearing elements. For children, a scope bearing element takes scope over everything that it c-commands on the surface. Thus, children differ from adults not in the principles used to map syntactic structure to semantic structure but only in their willingness to apply covert displacement operations. Both children and adults compute scope on the basis of the c-command relation.

Children, however, strongly prefer the pronunciation position and the interpretation position to coincide.<sup>6</sup>

Now, one might object to this characterization of Lidz and Musolino's results on the basis of the theory of indefinites. Because Lidz and Musolino tested indefinites, it is possible that their results do not inform us about how children compute scope relations *per se*. This possibility arises out of the idea discussed above that indefinites (including NPs with numeral determiners) are non-quantificational (Kamp 1981, Heim 1982, Fodor and Sag 1982, Kratzer 1995, Diesing 1992, van Geenhoven 1995, Chung and Ladusaw 2004). As noted above, it is quite possible that indefinites are never quantificational. On such an analysis, then, children's narrow scope readings of indefinites in Lidz and Musolino's study would not result from a preference to avoid covert movement, but from a preference to treat them as individual variables bound by VP-internal existential closure.

We can summarize the problem for Lidz and Musolino's account of children's scope interpretations in the following way: the fact that children in English and Kannada strongly preferred the narrow scope reading of the indefinite could be a consequence of either of two factors. First, as proposed by Lidz and Musolino, it could be the case that the children treated the indefinite quantificationally but are strongly biased towards interpreting relative scope on the basis of relative c-command relations at S-structure. Alternatively, it could be the case that the children do not have access to the

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<sup>6</sup> A number of studies have shown that under certain discourse circumstances, children's preference for isomorphic interpretations can be overcome (Gualmini, in press; Musolino and Lidz, in press). What this suggests is that children's isomorphic behavior reflects a strong preference that adults do not share. Children and adults do not differ in their grammar's ability to generate nonisomorphic readings. See also Lidz, et al., 2004, for arguments that children can apply QR in sentences lacking negation.

quantificational representation of indefinites, if this even exists, and so treated them as free variables.<sup>7</sup> If children do not have access to the quantificational representation of indefinites, then any conclusions about the syntax of quantifier scope in children based on indefinites must be invalid.

Now, if we could show that children's isomorphic behavior in Lidz and Musolino's experiment was due to them treating the indefinites quantificationally, then we would have evidence that indefinites do indeed have a quantificational representation. In principle, we ought to be able to design an experiment which determines whether the quantificational representation is available for children. To the extent that such a representation is available for children, we can conclude that this representation is also available for adults. Although it is in principle possible that children have a quantificational representation for indefinites and that adults do not, such an analysis would require us to determine what properties of language development cause the quantificational representation to disappear.

Returning now to the question of whether indefinites are quantificational for children, consider the following sentence:

(21) Two butterflies didn't go to the city

This sentence is ambiguous in exactly the same way as the sentences we have tested on children so far. It can have either of the two possible readings given informally in (22):

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<sup>7</sup> See Krämer, 2000 for a proposal along these lines that specifically rejects an account of isomorphism based on surface syntactic position, contra Musolino, 1998 and Lidz and Musolino, 2002. In particular, Krämer found that Dutch children allowed singular indefinites to take scope underneath negation even when they occurred in a position higher than negation at S-structure. To the extent that Krämer's results differ from what we report here, one will have to examine the nature of the particular determiners involved in the various languages. Our suspicion is that the variable-only analysis may be right for children's singular indefinites but not for indefinites with cardinal determiners.

- (22) a. there are two butterflies who didn't go to the city  
b. it's not the case that two butterflies went to the city.

We can now consider how these readings could be derived. First, suppose that, for children, indefinites only introduce free variables and that these variables can be bound by existential closure applying at the VP level. This analysis would predict that only the narrow scope reading is available. That is, since existential closure applies at the VP-level and since VP occurs below negation, it follows that the individual variable would have to reconstruct into VP to be appropriately bound. Taking this derivation, since the existential is necessarily below negation, we derive only the narrow scope reading (22b).

Since the wide scope reading is also available (indeed, it is the preferred reading for adults, see Musolino and Lidz 2003), we must consider how it is derived. There are two options. One possibility is to follow Diesing and say that indefinites are sometimes quantificational, which would allow us to interpret the indefinite with its own existential quantifier outside of VP, and hence above negation. Alternatively, we could say that indefinites sometimes introduce function variables (rather than individual variables), which can be bound by root-level existential closure over choice functions. Because a choice function picks out an individual, we would get the appearance of wide scope for the indefinite. It is important to note at this point that the position of the indefinite at LF plays no role in its interpretation as a choice function. Either inside or outside of VP, a choice function would get a specific interpretation (see Lidz, to appear).

We are now in a position to use children's interpretations of indefinites as a test for the proper treatment of indefinites. Recall that children in both English and Kannada interpreted indefinites in object position as having narrow scope with respect to negation.

As noted above, this effect could have been due to children lacking whatever representation gives rise to wide scope readings (i.e., either the choice function representation or the quantificational representation). Given this analysis we would expect children to also show only narrow scope interpretation for indefinites in subject position as well. Alternatively, the narrow scope finding for objects could have been due to children treating indefinites quantificationally and to the strong bias for quantificational NPs to be interpreted in their surface positions in child language (as proposed by Musolino et al. 2001, and Lidz and Musolino 2002). On this view, we would expect children to assign wide scope to an indefinite in subject position. By testing children on sentences such as (22), we can determine which of these accounts is correct. If it turns out that children’s limitations are best explained by a quantificational analysis of indefinites, then we can conclude that indefinites in adult language also have such an analysis.

### **5. Experiment 1: Subject indefinites**

The experiment we now report on was conducted in the United States and in India where we tested English and Kannada-speaking 4-year-olds on their interpretation of ambiguous sentences involving a numerally quantified subject NP and negation, as illustrated in (23).

- (23) a. Two butterflies didn’t go to the city
- b. eraDu chitte paTNa-kke hoog-al-illa  
two butterfly city-DAT go-INF-NEG  
‘Two butterflies didn’t go to the city.’

The isomorphic reading of (23), given in (24a), can be paraphrased as “there are two butterflies that did not go to the city.” The non-isomorphic reading, given in (24b), can be paraphrased as “it is not the case that two butterflies went to the city.”

- (24) a.  $\exists_2 x$  [butterfly(x)] &  $\neg$ [x go to the city]  
b.  $\neg \exists_2 x$  [butterfly(x)] & [x go to the city]

As discussed above, testing children's interpretation of sentences like (19) allows us to determine whether the isomorphic behavior for indefinites found in Lidz and Musolino is due to their lacking a quantificational interpretation or to their preference to interpret quantificational expressions in their surface positions.

### 3.1 Method

#### *Subjects*

We tested 20 Kannada-speaking children between the ages of 4;0 and 4;11 (mean 4;5) and 20 English speaking children between the ages of 4;0 and 4;11 (mean 4;6). We chose 4-year-olds because previous studies, i.e. Lidz and Musolino (2002), showed that children of this age displayed a strong preference for the isomorphic interpretations of sentences with negation and quantificational objects. The Kannada-speaking children were selected from the Pushkarini and Swami Vivekananda preschools in Mysore, India. English-speaking children were tested in the language acquisition laboratory at Northwestern University.

#### *Procedure*

As in Lidz and Musolino's study, we tested our subjects using the Truth Value Judgment Task methodology (TVJT) (Crain and Thornton 1998). The TVJT involves two experimenters. The first experimenter acts out short stories in front of the subjects using small toys and props. The second experimenter plays the role of a puppet who watches the stories alongside the puppet. At the end of the story, the puppet makes a statement about what he thinks happened in the story. The subjects' role is to decide whether the

puppet's statement is "right" or "wrong". Finally, subjects are asked to justify their answers by explaining why they think the puppet was right or wrong. For a more detailed description of the TVJT, see Crain and Thornton 1998 and Lidz and Musolino, 2002.

The Kannada-speaking children were first introduced to the task as a group and then tested individually in a quiet room away from the class. English-speaking children were introduced to the task when they arrived at the laboratory. Each child, independent of language, received two pretest stories and if the child could answer those appropriately, including appropriate justifications, they would then hear seven more stories: four test stories and three control stories, administered in a pseudorandom order.

### *Materials*

We placed subjects in an experimental situation in which both scope readings of sentences like (23) are relevant in the context of the stories. The stories were constructed in such a way as to make one of the readings false and the other reading true. Answers of YES or NO to the puppet's statements (along with appropriate justifications) were therefore taken as a measure of subjects' ability to access one reading or the other.<sup>8</sup>

As in Lidz and Musolino's study, two versions of each story were constructed. In the first one, the wide scope reading of the numerally quantified NP in sentences like (23) was true (abbreviated Wt) and the narrow scope reading of this NP was false (abbreviated Nf). In the second version, the wide scope reading of the numerally quantified NP was false (abbreviated Wf) and the narrow scope reading was true (abbreviated Nt). Recall that what we call here the wide scope reading of the NP corresponds to an isomorphic interpretation, since this NP occurs in subject position and therefore c-commands

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<sup>8</sup> Answers in which the subject said that the puppet spoke truthfully are coded as YES and answers in which the subject said that the puppet didn't say the right thing are coded as NO.

negation. What we are calling the narrow scope reading of the NP corresponds to a non-isomorphic interpretation. Thus, if subjects accept the puppet's statement in the Wt/Nf condition, then we conclude that they are able to access the isomorphic interpretation. If subjects accept the puppet's statement in the Wf/Nt condition, then we conclude that they are capable of accessing the non-isomorphic interpretation.

In the Wt/Nf version of the story corresponding to example (23), four butterflies are flying around on a summer day and decide to go somewhere together. The forest is in sight and so they all fly there. They are all happy because it is nice and cool in the forest. After a while, two of the butterflies complain that it is boring in the forest and decide to go on to the city because there are interesting tall buildings there. But the other two butterflies are worried that it will be too hot in the city and decide to stay. At the end of the story, the puppet says: "I know what happened. Two butterflies didn't go to the city.<sup>9</sup> Am I right?" In this case, the wide scope (isomorphic) reading of the numeral is true because there are two butterflies who decided not to go to the city. The narrow scope (non-isomorphic) reading is false because two butterflies did go to the city.

In the Wf/Nt version of the story, two butterflies are flying around on a summer day and decide to go somewhere together. The forest is in sight and so they both fly there. They are happy because it is nice and cool in the forest. After a while, one of the butterflies complains that it is boring in the forest and decides to go on to the city because there are interesting tall buildings there. But the other butterfly is worried that it will be too hot in the city and decides to stay. At the end of the story, the puppet says: "I know

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<sup>9</sup> Kannada speaking subjects, of course, heard the Kannada version of the story with the utterance in (i) at the end.

(i) eraDu chitte paTNa-kke hoog-al-illa  
two butterfly city-DAT go-INF-NEG  
'two butterflies didn't go to the city.'

what happened. Two butterflies didn't go to the city. Am I right?" In this case, the wide scope (isomorphic) reading of the numeral is false because only one butterfly decided against going to the city. The narrow scope (non-isomorphic) reading is true because only one butterfly did go to the city.

The statements made by the puppet on each of the four test trials are given in each of the two languages in Table 1.

<b>English</b>	
Test story 1	Two butterflies didn't go to the city
Test story 2	Two frogs didn't jump over the rock
Test story 3	Two lions didn't buy a cookie
Test story 4	Two dinosaurs didn't eat fish
<b>Kannada</b>	
Test story 1	eraDu chitte paTNakke hoogalilla two butterfly city-dat go-inf-neg 'Two butterflies didn't go to the city.'
Test story 2	eraDu kappe baNDe meeLe negeyalilla two frog rock over jump-inf-neg 'Two frogs didn't jump over the rock.'
Test story 3	eraDu simba biskitannu karedisalilla two lion cookie-acc buy-inf-neg 'Two lion's didn't buy a cookie.'
Test story 4	eraDu moSaLe miinuvannu tinnalilla two dinosaur fish-acc eat-inf-neg 'Two dinosaurs didn't eat fish.'

**Table 1: Puppet's statements in test stories in each language**

When making these statements, the experimenter playing the role of the puppet was instructed to say the sentences in a way that is most naturally compatible with the sentence being true. This step was taken to ensure that if there are any prosodic cues associated with the different readings, they would be provided to the child subjects.<sup>10</sup>

In addition to the test stories, each subject also witnessed three control stories. Unlike the test items, the statements made by the puppet on the control stories were not

<sup>10</sup> Also see McMahan, Lidz and Pierrehumbert (2004) for evidence that adult speakers do not normally use prosody or intonation to indicate the scope of a quantificational subject with respect to negation.

ambiguous. The purpose of these stories was to control for children’s knowledge of the meaning of the separate linguistic elements involved in the scope ambiguities discussed above (i.e., negation and NPs of the form *two N*.) The experimenter holding the puppet had a choice between two different statements for each of the control stories. One statement was true in the context of the story and the other was false. If the child had answered YES to a given test story, the experimenter holding the puppet was instructed to pick the statement for the following control story corresponding to a NO answer, and vice-versa. This ensured that the number of YES and NO responses was balanced. Another precaution that was taken to ensure that children knew the meaning of the word *two* was to have each subject count the number of toys or characters in each of the stories as they were being laid out on the table. The list of statements made by the puppet in the control stories in each language is given in table 2.

<b>English</b>	
Control story 1	The hippos didn’t drink milk (true) Two hippos drank milk (false)
Control story 2	Two snakes climbed onto the book (true) Four snakes climbed onto the book (false)
Control story 3	Two frogs danced with bugs (true) The frogs didn’t dance (false)
<b>Kannada</b>	
Control story 1	neeraanegaLu haaLu kuDalilla water-elephant-pl milk drink-inf-neg ‘The hippos didn’t drink milk.’  eraDu neeraane haaLu kuDitu two water-elephant milk drink-pst-3sn ‘Two hippos drank milk.’
Control story 2	eraDu haavu pustaka meeLe hattitu two snake book onto climb-pst-3sn ‘Two snakes climbed onto the book.’  muru haavu pustaka meeLe hattitu two snake book onto climb-pst-3sn ‘Two snakes climbed onto the book.’
Control story 3	eraDu kappe tigiNeygaLoDane kuNitu two frog bug-pl-with dance-pst-3sn ‘Two frogs danced with bugs.’

	kappegaLu kuNiyalilla frog-pl dance-inf-neg 'The frogs didn't dance.'
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**Table 2: Puppet statements in control stories in each language**

Finally, the 40 subjects (20 English and 20 Kannada) were randomly assigned to each condition (Wt/Nf and Wf/Nt) thus giving rise to a 2x2 design with scope condition and language as between subjects factors with 10 subjects per cell (Table 3).

	Wide True / Narrow False	Wide False / Narrow True
English 4-year-olds (n)	10	10
Kannada 4-year-olds (n)	10	10

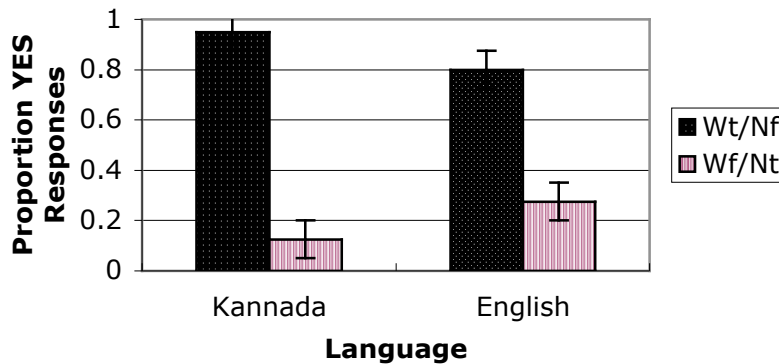
**Table 3: 2x2 design**

Since the puppet's statements on critical trials are ambiguous, we chose to treat scope condition as a between subjects factor, instead of a within subjects factor, in order to avoid potential contaminating effects between the two possible readings. That is, once children become aware of one of the possible interpretations of the ambiguous statements, they may find it difficult to later assign a different interpretation to a similar statement. In other words, the initial interpretation that children assign to statements of the form *Two N didn't VP* may influence the way they interpret subsequent statements of the same form.

## Results

In the analysis below, our dependent measure was the proportion of YES responses to the puppet's statements. Beginning with subjects' responses to the test items (Figure 1), we found that subjects in both languages accepted the puppet's statements reliably more often in the WtNf condition, as compared to the WfNt condition (87.5% vs. 20%, respectively ( $t(38) = -8.516, p < .0001$ ). The proportions of YES responses were entered

into an analysis of variance (ANOVA) with two factors: language (English, Kannada) and condition (WtNf, WfNt). The analysis revealed a significant main effect of condition ( $F(1,36) = 75.85, p < .0001$ , no reliable effect of language ( $F(1,36) = 0, p = 1$ ) and no reliable interaction between language and condition ( $F(1,36) = 3.75, p > .06$ ).<sup>11</sup>



**Figure 1: Proportion of YES responses to test trials for Kannada- and English-speaking children in each of the two conditions**

On the control items, the children gave correct answers 94% of the time in both conditions. An ANOVA with two factors (language and condition) was performed on the proportion of correct responses to the control items. We found no reliable effect of language ( $F(1,36) = 0.439, p > .51$ ), no reliable effect of condition ( $F(1,36) = 0, p = 1$ ) and no interaction between language and condition ( $F(1,36) = 0.439, p > .51$ ).

## Discussion

First, it is important to note that the results presented above replicate the effect reported in earlier studies (Musolino, Crain and Thornton, 2000; Lidz and Musolino, 2002;

<sup>11</sup> The interaction does approach significance. This is not a consequence of a qualitative difference in preferences across the languages but rather the magnitude of these preferences. The Kannada speaking children were slightly more likely to accept the isomorphic interpretation than the English speaking children and they were slightly less likely to accept the nonisomorphic interpretation than the English speaking children.

Musolino and Lidz, in press). That is, children display a reliable preference for one of the two interpretations of scopally ambiguous sentences. Furthermore, children's near perfect performance on control items, also found in previous studies, demonstrates that they did not experience any difficulty with the task. The TVJT has by now been used successfully to test children's interpretation of a wide range of linguistic constructions in languages such as English (Crain and Thornton, 1998), Italian (Guasti and Chierchia, 1999), Kannada (Lidz and Musolino, 2002), Greek (Papafragou and Musolino, 2003) and Korean (Han, Lidz and Musolino, 2003) with children as young as 3 and a half. It has also been clearly demonstrated that children in that age range are perfectly capable of dealing with complex sentences involving negation and quantificational expressions. That is, not only has it been shown that children know the individual meanings of these expressions (Lidz and Musolino, 2002; Papafragou and Musolino, 2003) but children are also perfectly capable of repeating the complex sentences they hear on these tasks (*ibid*) and provide justifications for their answers which only make sense if children have in fact parsed all the elements in these sentences.

The real question then, concerns the nature of the isomorphism effect, observed in previous studies, and replicated in the present one. What we found here is that 4-year-old speakers of English and Kannada display a strong preference for the interpretation of sentences of the form *Two N didn't VP* on which the subject NP takes scope over negation, i.e. Subj > neg, regardless of language.

These results are most compatible with an explanation of children's behavior that treats indefinites as quantificational expressions whose scope is determined by the surface c-command relations between a quantificational expression and negation. If the

numeral indefinites are treated quantificationally, the fact that children assign them only surface scope is automatically explained by whatever explains the isomorphism effect with universals and existentials (Musolino 1998). Other accounts run into serious difficulty.

First, consider the possibility that the isomorphism effect found in Lidz and Musolino was due to children treating the indefinites as variables. Such an account would predict that the indefinites in subject position should not show isomorphic behavior but rather nonisomorphic behavior. Assuming that the domain of existential closure is the VP, the free variable introduced by an indefinite will be bound by existential closure only if it occurs within VP. A free variable outside of VP will be unbound and thus will fail to receive an interpretation. Such a variable would be forced to reconstruct back into VP in order to be interpreted. Thus, if children have only the non-quantificational interpretation of indefinites, then we would expect them to exhibit obligatory reconstruction of indefinite subjects and hence inverse scope with respect to negation.<sup>12</sup> This prediction is not borne out. Rather, we find a subject-object asymmetry in children's interpretations. In object position an indefinite with a numeral determiner takes narrow scope with respect to negation but in subject position it takes wide scope with respect to negation.

Next, consider the possibility that the results in the present experiment are not due to children treating indefinites as quantifiers or as individual variables but as function variables. That is, the interpretation in which the subject appears to take scope over

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<sup>12</sup> Note however that the results of Musolino et al. (2000) demonstrate that children typically fail to access to the reading provided by reconstructing the subject into VP. If this is true, then children who fail to treat indefinites quantificationally should find sentences with indefinite subjects ungrammatical across the board.

negation could be due to their treating indefinites as choice functions. This approach is problematic, however, because it fails to explain why this interpretation is available only to subject NPs. That is, if the referential/specific interpretation is available to subject NPs, then we would also expect it to be available to object NPs, leading to the appearance of nonisomorphic interpretations for objects. But, as Lidz and Musolino's (2002) original data show, children do not accept such interpretations. Thus, the most explanatory account of children's behavior is one in which children are just like adults in allowing indefinites to be quantificational, but differ from adults in requiring surface scope.

A further prediction of the hypothesis that children do not treat indefinites as choice functions is that NPs obligatorily interpreted as referential in the adult grammar will fail to be interpreted as such. Kannada allows us to test this prediction directly.

#### 4 **Experiment 2: The choice-function interpretation in Kannada children**

In Kannada, inanimate direct objects are optionally marked with accusative case. Lidz (1999, in press) argues that the case-marked inanimates are best treated as denoting choice functions. The evidence for this position comes from the scope relations exhibited by these NPs. First, whereas noncasemarked objects can take scope either above or below negation and intensional predicates, casemarked objects must take scope above such elements (cf. deHoop 1996 for similar data in other languages):

- (25) a. naanu **pustaka** huDuk-utt-idd-eene  
 I-NOM book look.for-NPST-be-1S  
 'I am looking for a particular book.'  
 OR 'I am looking for something to read.'
- b. naanu **pustaka-vannu** huDuk-utt-idd-eene  
 I-NOM book-ACC look.for-NPST-be-1S  
 'I am looking for a particular book.'  
 ≠ 'I am looking for something to read.'

- (26) a. naanu **pustaka** ood-al-illa  
 I-NOM book read-INF-NEG  
 'I didn't read any books.'  
 OR 'There is a book that I didn't read.'
- b. naanu **pustaka-vannu** ood-al-illa  
 I-NOM book-ACC read-INF-NEG  
 'There is a book that I didn't read.'  
 ≠ 'I didn't read any books.'

If the casemarked objects are treated as choice-function variables bound by a root-level existential closure operation, it follows that they will have the appearance of scope over any VP-level operators like intentional predicates or negation.

Second, only casemarked NPs can take scope out of syntactic islands. This is illustrated for relative clause islands in (27), though the phenomenon is completely general.

- (27) a. Hari pustakav-annu oodida vidyaarthiy-annu hudukuttiddaane  
 Hari book-ACC read-PST-RP student-ACC look.for-PROG-be-3SM  
 'Hari is looking for the student who read a (certain) book.'  
 (There is a particular book such that Hari is looking for the student who read that book)
- b. Hari pustaka oodida vidyaarthiy-annu hudukuttiddaane  
 Hari book read-PST-RP student-ACC look.for-PROG-be-3SM  
 'Hari is looking for the student who read a book.'  
 (\*There is a particular book such that Hari is looking for the student who read that book)

If casemarked objects are treated as choice functions, it follows that they can take scope out of syntactic islands.

Given that the referential interpretation is morphologically marked in Kannada, we can test directly whether children have this interpretation of indefinite NPs generally.

In our second experiment, we examined Kannada speaking children’s ability to access the reading in which an object indefinite takes scope over negation in sentences like (28).

- (28) a.     avanu biskit-annu tinn-al-illa  
          he     cookie-ACC eat-INF-NEG  
          ‘He didn’t eat a cookie.’
- b.     avanu biskit tinn-al-illa  
          he     cookie eat-INF-NEG  
          ‘He didn’t eat a cookie.’

As discussed above, the presence of morphological case forces a wide-scope reading of the object in the adult grammar while the lack of case is compatible with either scope interpretation. Hence, we expect adults to be able to access the wide-scope reading independent of whether the object is morphologically casemarked. For children, the question is whether the presence of morphological case will also yield a wide-scope interpretation. As we have seen, the wide scope interpretation of an object NP is difficult for children to access in general. Experiment 1 indicated that children do allow an wide scope interpretation of subject indefinites and we argued that this result is best explained by a theory in which indefinites are treated as quantifiers and not as choice functions. So, in cases where the choice-function interpretation is forced in the adult grammar, we predict that children will still fail to access this interpretation, erroneously treating the indefinite as quantificational.

#### *4.1 Method*

##### *Subjects*

We tested 24 Kannada-speaking children between the ages of 4;0 and 4;11 (mean 4;5) and 24 Kannada-speaking adults. The children were selected from the Pushkarini and

Swami Vivekananda preschools in Mysore, India. Adults were students and staff at the University of Mysore.

### *Procedure*

The procedure was identical to experiment 1.

### *Materials*

We placed subjects in an experimental situation in which both scope readings of sentences like (28) are relevant in the context of the stories. The stories were constructed in such a way as to make the narrow scope reading of the object NP false and the wide scope reading true. Answers of YES or NO to the puppet's statements (along with appropriate justifications) were therefore taken as a measure of subjects' ability to access the wide scope reading. We presented the sentences only in contexts in which the inverse scope reading was true in order to determine whether morphological marking would affect children's abilities to access this interpretation.

In the story corresponding to the examples in (28), participants heard a story in which Cookie Monster has two cookies and is considering eating them. He is very hungry. He eats the first cookie. When he comes to the second cookie, however, he sees that it is shaped like a heart, not a cookie and so even though it has frosting that looks good to eat, he decides not to eat it.

The statements made by the puppet on each of the four test trials are given in Table 4. The stories were the same in the two conditions, with the test sentences differing only by the presence or absence of accusative casemarking on the object NP.

<b>Kannada</b>	
Test story 1	Anoop kaaru-(vannu) toley-al-illa Anoop car-(ACC) wash-INF-NEG 'Anoop didn't wash a car'
Test story 2	Rashmi kekku-ge moTTe-(yannu) hak-al-illa Rashmi cake-DAT egg-(ACC) put-INF-NEG 'Rashmi didn't put an egg into the cake.'
Test story 3	Huduganu ungra-(vannu) karedis-al-illa boy ring-(ACC) buy-INF-NEG 'The boy didn't buy a ring.'
Test story 4	avanu biskit-(annu) tinn-al-illa he cookie-(ACC) eat-INF-NEG 'He didn't eat a cookie.'

**Table 4: Puppet's statements in test stories**

When making these statements, the experimenter playing the role of the puppet was instructed to say the sentences in a way that is most naturally compatible with the sentence being true. This step was taken to ensure that if there are any prosodic cues associated with the different readings, they would be provided to the child subjects.

In addition to the test stories, each subject also witnessed three control stories. Unlike the test items, the statements made by the puppet on the control stories were not ambiguous. The purpose of these stories was to ensure that participants could appropriately respond to sentences that were true as well as sentences that were false. The experimenter holding the puppet had a choice between two different statements for each of the control stories. One statement was true in the context of the story and the other was false. If the child had answered YES to a given test story, the experimenter holding the puppet was instructed to pick the statement for the following control story corresponding to a NO answer, and vice-versa. This ensured that the number of YES and NO responses was balanced. The list of statements made by the puppet in the control stories is given in table 5.

<b>Kannada</b>	
Control story 1	Simha muru haavu hiD-i-tu (FALSE) 'The lion found three snakes'  Simha eradu haavu hiD-i-tu (TRUE) 'The lion found two snakes'
Control story 2	Ha manushya ella baNDe ett-id-a (FALSE) 'That man lifted all the rocks'  Ha manushya eradu baNDe ett-id-a (TRUE) 'That man lifted two rocks'
Control story 3	Ella kappe maney-a meeLe haar-i-tu (FALSE) 'All the frogs jumped over the house'  Eradu kappe maney-a meeLe haar-i-tu (TRUE) 'Two frogs jumped over the house'

**Table 5: Puppet statements in control stories**

Finally, participants in each age group were randomly assigned to each condition (morphology vs no morphology) thus giving rise to a 2x2 design with scope condition and language as between subjects factors with 12 subjects per cell (Table 6).

	Morphology	No Morphology
Kannada 4-year-olds (n)	12	12
Kannada adults (n)	12	12

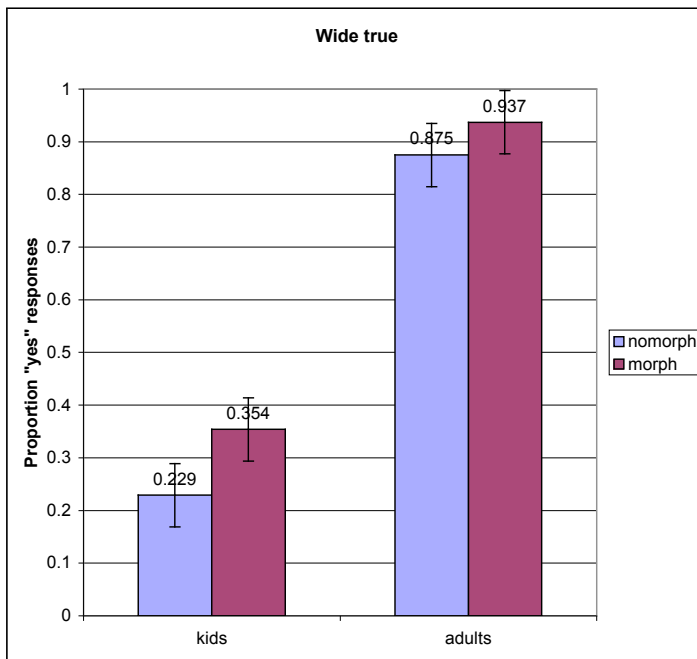
**Table 6: 2x2 design**

As in experiment 1, we chose to treat morphology as a between subjects factor in order to avoid potential contaminating effects between the conditions.

## Results

The mean proportions of YES responses by age and condition are given in figure 2. In the analysis below, our dependent measure was the proportion of YES responses to the puppet's statements. The proportions of YES responses were entered into an analysis of variance (ANOVA) with two factors: age (Adult, Child) and condition (Morphology, No morphology). The analysis revealed a significant main effect of age ( $F(1,44) = 50.58, p < 0.0001$ ), no reliable effect of condition ( $F(1,44) = 1.17, p > 0.28$ ) and no reliable interaction between age and condition ( $F(1,44) = 0.13, p > 0.79$ ).

On control items, we found that adults gave correct answers 94% of the time in both conditions. Children gave correct responses to control items 97% of the time in the morphology condition and 100% of the time in the no morphology condition. The proportion of correct responses to control items were entered into a analysis of variance (ANOVA) with two factors, age and condition, and we found no reliable effect of age ( $F(1,44) = 1.94, p = 0.17$ ), no reliable effect of condition ( $F(1,44) = 0.21, p = 0.64$ ) and no reliable interaction between age and condition ( $F(1,44) = 0.21, p = 0.64$ ).



**Figure 2: Mean proportion of "YES" responses by age and condition.**

#### 4.2 Discussion

The results of experiment 2 indicate that children do not assign a wide scope reading to an indefinite object NP even when that NP is morphologically marked for Case. Even though morphological case enforces a specific reading on indefinites in object position in the adult grammar, 4-year-old children are unable to access that reading. This result is

important in the context of the current paper for the following reason. The wide scope reading of an indefinite object NP is forced by morphological case because the case marker is an indication that that NP should be treated as a choice function. Thus, to the extent that children fail on these sentences, we have evidence that they do not have (or do not access) the choice function interpretation. Consequently, children's behavior in experiment 1 cannot be taken as evidence that the wide scope reading of an indefinite subject NP derives from treating that NP as a choice function. We can therefore conclude that children represent indefinites quantificationally.

Of course, it is possible that children do have a choice-function interpretation for indefinites but that they are unaware that this interpretation is forced by morphological case. To the extent that this is true, however, it adds support for the claims in this paper that children treat indefinites quantificationally. As noted above, there is a kind of subject-object asymmetry with respect to children's interpretations of indefinites in sentences containing negation. When the indefinite is in subject position, children treat it as taking wide scope over negation and when it is in object position, children treat it as taking scope inside negation. This semantic asymmetry is best explained on a theory in which indefinites are treated quantificationally and children are only able to access surface scope interpretations. We find no evidence that children have access to a choice function representation. Such a representation would predict wide scope, independent of syntactic position. Moreover, if children had such a representation, we would expect it to be visible when that interpretation is required by the adult language. But we find no such evidence. Thus, if children do have the choice-function representation, we have found no evidence that they are able to access it in understanding.

## 5 Conclusions

One of the central goals of modern linguistic theory is to construct models of grammar which aim at explanatory adequacy, i.e. models that are responsive to the demands of language acquisition (Chomsky, 1965). Hornstein and Lightfoot (1981) define the problem as follows: “We shall try to justify our explanations on the basis of the following three criteria:

- (a) Coverage of empirical data, showing that a class of facts follows from the principles we hypothesize.
- (b) Standards of simplicity and elegance, showing that the principles meet the usual general requirements of scientific theorizing.
- (c) A demonstration that the principles contribute insight on the central problem of acquisition.” (p.14-15)

Hornstein and Lightfoot further explain that “Criterion (c), that explanatory principles should illuminate the nature of the acquisition process, has fundamental importance ... One might postulate a simple, elegant principle entailing a significant range of facts, which makes no psychological sense in terms of language acquisition” (p.16).

The main thrust of the argument presented in this paper has been to show that explanatory adequacy can indeed be achieved and thus that data from child language can be brought to bear on the formulation of grammatical theory. Specifically, we have used the limitations found on children’s quantificational interpretations as evidence for the proper treatment of indefinites. It has been independently established that children show a massive preference for surface scope in sentences containing a quantificational NP and negation (Musolino 1998, Musolino, Crain and Thornton 2000, Lidz and Musolino 2002). To the extent that they show the same preference in sentences containing indefinites, we have evidence that indefinites have a quantificational representation. Indeed, we found exactly that preference. In fact, we found the preference for surface

scope even in sentences that require inverse scope in the adult grammar, suggesting that the mechanisms for inverse scope, whether they are quantifier raising, reconstruction or the use of choice functions, are extremely difficult for children to access.

Indefinites in natural language pose an exceptionally interesting problem for learners because a single form can apparently map onto a wide range of representations. The current state of the theory of indefinites treats them as multiply ambiguous, being associated with representations as individual variables and function variables as well as a quantificational representation. To date, we seem to find evidence only for the quantificational representation in 4-year-old children. Future work on the acquisition of indefinites should therefore focus on determining whether these other representations are ever available and under what conditions, if any, learners can access such representations.

Finally, although this is not the primary focus of this paper, we can ask what is responsible for children's isomorphism preference. One thing that is clear is that this preference does not derive from a grammatical deficiency. Under certain discourse conditions, children of this age show an improved ability to access nonisomorphic interpretations (Gualmini, in press; Musolino and Lidz, in press). Moreover, in sentences requiring quantifier raising that are unambiguous and do not contain negation, children perform at adult-like levels (Lidz, et al 2004). In other work, we have suggested that the isomorphism preference may derive from parsing principles (Musolino and Lidz, in press; Viau, Lidz and Musolino 2005). In particular, we have argued that the child reaches an isomorphic parse first, because such a parse involves identity between the LF and the S-structure, and have difficulty revising this parse. This hypothesis is supported by several facts. First, in addition to using discourse factors to alleviate the isomorphism

preference in children, Musolino and Lidz (2003) have shown that it is possible to use discourse factors to induce an isomorphism effect in adults, suggesting an extragrammatical basis for this effect. Second, Trueswell et al. (1999) have shown that children have difficulty revising parsing decisions in general and thus garden-path more easily than adults. Third, Anderson (2004) shows that adults have an overall parsing preference for isomorphic interpretations of multiply quantified sentences, showing slowed reading times for sentences involving inverted scope, even when materials are biased in favor of this interpretation. Finally, Viau, Lidz and Musolino (2005) show that experience with nonisomorphic readings can be syntactically primed. Together these results suggest that the isomorphism effect has a basis in differences between the parsing systems of children and adults.

The latter result is especially important in the current context for the following reason. One possible explanation of children's isomorphic preference might have to do with limitations in children's ability to compute information-structure representations. An anonymous reviewer suggests that inverse scope usually involves contrastive discourse relations and that the interpretation of referential indefinites requires the listener to make inferences about the epistemic state of the speaker. Children may therefore have difficulty in understanding these sentences because of impoverished information-structural abilities (see Hulsey et al., in press, for a similar suggestion). This suggestion makes a lot of sense, especially given the findings that children have difficulty computing certain Gricean inferences (Noveck 2001, Chierchia, et al. 2001, Papafragou and Musolino 2003, Musolino and Lidz, in press). However, the fact that inverse scope can be primed, leading to improved access to nonisomorphic readings in the absence of

contextual support (Viau, Lidz and Musolino 2005), suggests that it is not discourse properties alone that are responsible for children's isomorphic behavior with indefinites or more generally. That information packaging considerations play a role in children's interpretations of scopally ambiguous sentences is a serious hypothesis that must be examined more closely, and perhaps, in concert with a theory of LF-parsing, will ultimately contribute to a complete understanding of children's interpretive limitations in this domain. In the context of the current paper, however, these limitations provide us with a valuable probe into the syntactic and semantic representation of indefinites in both children and adults.

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