THE INTERPRETATION OF QUANTIFIERS:
SEMANTICS & PROCESSING

A Dissertation Presented
by
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dissertation, and always being able to help me smile, and to Kai for constant love and support in
all things, linguistic and otherwise.
The primary goal of this study is to develop a theory of the processing of doubly-quantified sentences such as *A squirrel picked up every nut*, particularly how the scope ambiguity in such sentences is resolved. The research departs from most psycholinguistic work in drawing upon current linguistic theories of LF, the syntax-semantics interface, and formal semantics.

First, I investigate the issue of how structural factors affect quantifier scope preferences. I argue that the processor takes an economic stance towards scope assignment. The preferred relative scoping of two quantified phrases is computed from the ‘required’ LF structure— the LF constructed from required grammatical operations acting on S-structure. Furthermore, I contend that when *every* has scope over *a*, the processor does not commit to how many entities the *a*-phrase represents.

Next, I present an analysis of the semantic differences between *each* and *every* with respect to event distributivity, in preparation for considering the scope behavior of these quantifiers. I demonstrate that a sentence containing *each* can only be true of an event which has a totally distributive event structure, where each individual object in the restrictor set of the quantified phrase is associated with its own subevent, and all the subevents are differentiated on some relevant dimension. *Every* is subject to the weaker requirement that there be at least two different subevents.
Finally, I apply the semantic analysis of *each* and *every* to the question of how individual quantifiers affect scope preferences. *Each* has often been said to have a stronger preference for wide scope than *every*. I argue that this observation arises from cases where *each* takes wide scope in order to fulfill its condition requiring total event distributivity and differentiation of subevents. Otherwise the scope behavior of *each* and *every* is quite similar; they preferentially take wide scope only when that is the scoping computed off the required LF structure. More generally, I hypothesize that a quantifier’s scope behavior is driven by the lexical condition(s) which are part of its meaning.

Experimental evidence is presented in support of each of these claims.
# Table of Contents

<table>
<thead>
<tr>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
</tr>
<tr>
<td>ABSTRACT</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
</tr>
<tr>
<td>1. OVERVIEW</td>
</tr>
<tr>
<td>2. BACKGROUND</td>
</tr>
<tr>
<td>2.1 Basics</td>
</tr>
<tr>
<td>2.2 Relative Scope</td>
</tr>
<tr>
<td>2.2.1 Event Readings</td>
</tr>
<tr>
<td>2.2.2 One Scope Reading May Entail the Other</td>
</tr>
<tr>
<td>2.3 Semantic Properties of Quantifiers</td>
</tr>
<tr>
<td>2.3.1 Monotonicity</td>
</tr>
<tr>
<td>2.3.2 Weak/Strong</td>
</tr>
<tr>
<td>2.3.3 Distributivity</td>
</tr>
<tr>
<td>2.4 The Syntax of Quantifier Scope</td>
</tr>
<tr>
<td>2.4.1 Quantifier Raising</td>
</tr>
<tr>
<td>2.4.2 Clause Boundedness</td>
</tr>
<tr>
<td>2.4.3 Minimalism and Economy</td>
</tr>
<tr>
<td>2.4.4 Structural Determinants of Quantifier Interpretation</td>
</tr>
<tr>
<td>2.5 Quantifiers and Quantifier Scope in Psychology and Psycholinguistics</td>
</tr>
<tr>
<td>2.5.1 Non-scope Studies</td>
</tr>
<tr>
<td>2.5.2 Psycholinguistic Studies of Scope Preferences</td>
</tr>
<tr>
<td>2.5.2.1 Ioup (1975)</td>
</tr>
<tr>
<td>2.5.2.2 Gil (1982)</td>
</tr>
<tr>
<td>2.5.2.3 VanLehn (1978)</td>
</tr>
<tr>
<td>2.5.2.4 Catlin &amp; Micham (1975)</td>
</tr>
<tr>
<td>2.5.2.5 Micham et al. (1980)</td>
</tr>
<tr>
<td>2.5.2.6 Fodor (1982)</td>
</tr>
<tr>
<td>2.5.2.7 Gillen (1991)</td>
</tr>
<tr>
<td>2.5.2.8 Kurtzman &amp; MacDonald (1993)</td>
</tr>
<tr>
<td>Section</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>4.3</td>
</tr>
<tr>
<td>4.3.1</td>
</tr>
<tr>
<td>4.3.2</td>
</tr>
<tr>
<td>4.3.2.1</td>
</tr>
<tr>
<td>4.3.2.2</td>
</tr>
<tr>
<td>4.3.2.3</td>
</tr>
<tr>
<td>4.3.3</td>
</tr>
<tr>
<td>4.4</td>
</tr>
<tr>
<td>4.5</td>
</tr>
<tr>
<td>4.6</td>
</tr>
<tr>
<td>4.6.1</td>
</tr>
<tr>
<td>4.6.2</td>
</tr>
<tr>
<td>4.7</td>
</tr>
<tr>
<td>5.1</td>
</tr>
<tr>
<td>5.2</td>
</tr>
<tr>
<td>5.2.1</td>
</tr>
<tr>
<td>5.2.2</td>
</tr>
<tr>
<td>5.2.3</td>
</tr>
<tr>
<td>5.2.4</td>
</tr>
<tr>
<td>5.2.5</td>
</tr>
<tr>
<td>5.3</td>
</tr>
<tr>
<td>5.4</td>
</tr>
<tr>
<td>5.4.1</td>
</tr>
<tr>
<td>5.4.2</td>
</tr>
<tr>
<td>5.5</td>
</tr>
<tr>
<td>5.5.1</td>
</tr>
<tr>
<td>5.5.2</td>
</tr>
<tr>
<td>5.5.3</td>
</tr>
<tr>
<td>5.5.4</td>
</tr>
<tr>
<td>5.6</td>
</tr>
<tr>
<td>5.6.1</td>
</tr>
<tr>
<td>5.6.2</td>
</tr>
<tr>
<td>5.6.3</td>
</tr>
<tr>
<td>5.7</td>
</tr>
<tr>
<td>5.8</td>
</tr>
<tr>
<td>5.9</td>
</tr>
</tbody>
</table>
5.10 Concluding Remarks................................................................. 167

APPENDICES

A. EXPERIMENT 1 RAW READING TIMES .........................................171
B. EXPERIMENT 3 ADDITIONAL ANOVAS ......................................172
C. EXPERIMENTAL MATERIALS.......................................................173

BIBLIOGRAPHY ..............................................................................176
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Total Number and Percentage of Sentences Rejected at or after the Subject Noun in S2 in Experiment 1</td>
<td>69</td>
</tr>
<tr>
<td>3.2</td>
<td>Standard Deviations for Residual Reading Times at the Critical Region in S2 (Subject + Aux/Verb) by Participants in Experiment 1 (by Items in parentheses)</td>
<td>73</td>
</tr>
<tr>
<td>4.1</td>
<td>Number of Times <em>Each</em> and <em>Every</em> Were Chosen per Condition in Experiment 2</td>
<td>119</td>
</tr>
<tr>
<td>A.1</td>
<td>Raw Reading Times for Each Region in Experiment 1 (msec./word) (Residual Reading Times in Parentheses)</td>
<td>171</td>
</tr>
<tr>
<td>B.1</td>
<td>Percentage of Cases Where <em>each, every</em> &gt; <em>a</em> Scope was Preferred for All Items in Experiment 3</td>
<td>172</td>
</tr>
<tr>
<td>B.2</td>
<td>Percentage of Cases Where <em>each, every</em> &gt; <em>a</em> Scope was Preferred for the First Nine Items a Participant Saw in Experiment 3</td>
<td>172</td>
</tr>
</tbody>
</table>
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Length-adjusted reading times for each analysis region in Experiment 1 (given as deviations from predicted)</td>
<td>67</td>
</tr>
<tr>
<td>3.2</td>
<td>Raw reading times for S2 in attempted replication of Kurtzman &amp; MacDonald's Experiment 1</td>
<td>77</td>
</tr>
<tr>
<td>5.1</td>
<td>Percentage of cases where the preferred scope was <em>each, every &gt; a</em> in Pilot Experiment 1</td>
<td>139</td>
</tr>
<tr>
<td>5.2</td>
<td>Percentage of cases where the preferred scope was <em>each, every &gt; a</em> in Experiment 3, for the first nine items vs. the second nine items that a participant saw</td>
<td>145</td>
</tr>
</tbody>
</table>
Quantifiers such as every, some, a, and many are used frequently in day to day language. Hence, a theory of human language comprehension ought to include a theory of how quantifiers are interpreted. The primary goal of this study is to develop a theory of the processing of doubly-quantified sentences such as A squirrel picked up every nut. A major part of this problem is how the scope ambiguity in such sentences is resolved. The previous example can mean either that one squirrel picked up all the nuts and it was the same squirrel each time; or it can mean that for every nut there was some squirrel or other that picked it up, with the possibility of there being a number of different squirrels involved. Which reading is obtained depends on the relative position of the quantifier phrases a squirrel and every nut at LF (the level of representation from which semantic structures are built). How scope ambiguities are resolved thus depends in part on how LF structures are constructed. Yet, the building of LF has not been a prevalent topic of study in psycholinguistics. Moreover, while syntactic theory has been drawn on repeatedly in the study of the construction of S-structures, semantic theory has largely been ignored. The research described here departs from that vein, drawing upon current linguistic theories of LF, the syntax-semantics interface, and formal semantics.

Chapter 2 presents the linguistic and psycholinguistic background for the study. The semantic properties of quantifiers and the syntax of quantifier scope are considered. Previous research in psychology and psycholinguistics on the interpretation of quantifiers and quantifier scope is also reviewed. The chapter raises the question of what factors influence the resolution of scope ambiguities. Two factors are readily identified: (some aspect of) syntactic structure and choice of quantifier. Yet identifying these two main factors does not get us very far. What we
really would like to know is how and why they matter, and how they interact. I offer answers to these questions in the following chapters.

The issue of how structural factors affect quantifier scope preferences is investigated in Chapter 3. According to my theory, the processor takes an economic stance towards scope assignment. The preferred relative scoping of two quantified phrases is computed from the ‘required’ LF structure—the LF constructed from required grammatical operations acting on S-structure. Furthermore, I argue that when every has scope over a, the processor does not commit to how many entities the a-phrase represents (one or more than one). The theory is supported by an experiment on scope preferences in dative sentences such as Kelly showed a photo to every critic last night and what is known about scope preferences in other constructions.

In Chapter 4 I present an analysis of the semantic differences between each and every with respect to event distributivity, in preparation for considering the influence that individual quantifiers may have in determining scope preferences. I demonstrate that whether a sentence containing each or every can be truthfully asserted about an event depends on how the parts of that event, the subevents, are associated with the members of the quantifier’s restrictor set. Each and every differ with respect to the conditions they place on this association. Each requires total event distributivity, where each individual object in the restrictor set of the quantified phrase is associated with its own subevent, and all the subevents are differentiated on some relevant dimension. Every is subject to the weaker requirement that there be at least two different subevents. Evidence for these claims comes from examining the kinds of sentences and contexts in which each and every can and cannot occur and from an experiment in which participants chose whether each or every was more appropriate in describing a particular scenario.

Finally, in Chapter 5, I apply the semantic analysis of each and every developed in Chapter 4 to the question of how individual quantifiers affect scope preferences. Each has often been said to have a stronger preference for wide scope than every. I argue that this observation arises from cases where each takes wide scope in order to fulfill its condition requiring total event distributivity and differentiation of subevents. Otherwise the scope behavior of each and every is quite
similar; they preferentially take wide scope only when that is the scoping computed off the required LF structure. More generally, I hypothesize that a quantifier’s scope behavior is driven by the lexical condition(s) which are part of its meaning. These claims are supported by informant responses and two questionnaire studies investigating scope preferences in sentences containing each and every.

Overall, the dissertation provides insight into how semantic ambiguity is handled by the language processor.
Chapter 2

Background

The goal of this study is to develop a theory of how scope ambiguities are resolved. A sentence such as (1) has two interpretations. It can mean that there is some book that Marina showed to each of the children, and it was the same book each time. Or it can mean that for every child there was some book that Marina showed her/him, with the possibility that it was a different book in each case.

(1) Marina showed a book to every child.

Investigating quantifier scope preferences involves consideration of the semantic properties of quantifiers and the syntax of quantifier scope. Essential concepts in these areas are presented in sections 2.1–2.4. Existing work on quantifiers and quantifier scope in psychology and psycholinguistics is reviewed in §2.5.

2.1 Basics

Two major types of quantification have been identified in the literature: determiner quantification, as in (2), where the quantifier (e.g. some, every, few) heads a determiner phrase; and adverbial quantification, as in (3), where the quantifier (e.g. always, usually, seldom) modifies a clausal projection:

(2) Every child smiled.

(3) The cat usually sleeps during the daytime.

The present study is primarily limited to determiner quantification.

A quantified determined phrase (QP) has the syntactic structure in (4):

\[
\text{Every \ child \ smiled.}
\]

\[
\text{The \ cat \ usually \ sleeps \ during \ the \ daytime.}
\]
In the literature on quantification, the term ‘quantifier’ is sometimes used to refer to the
determiner within the QP (every in the example) and sometimes to the entire QP (every child), in
part because some properties are best ascribed to just the determiner while others are best
attributed to the whole phrase. I will reserve the term ‘quantifier’ for the determiner and use
‘quantified phrase’ or ‘QP’ for the entire phrase.

The ‘scope’ of a quantified phrase is what it c-commands.1 A QP ‘scopes over’ all the
expressions that occur in its scope. In (4), every child scopes over smiled.

Semantically, quantifiers are said to occupy the operator position in a tripartite structure, as
in (5) (Kamp 1981; Heim 1982). From this position they bind variables in the two other parts of
the structure.

The restrictive clause identifies the restriction on the quantifier, the set to which the quantifier
applies. At the very least, the restriction consists of the common noun in the QP. Additional
content often comes from context. If (2) were uttered after (6), for example, then the set of
children would be readily understood as the children in the room, rather than the children in the
whole world.

---

1 A phrase X c-commands a phrase Y if and only if neither of X or Y dominates the other and
the first branching node dominating X dominates Y. in (4), NP c-commands Det but does not c-
command VP.
Janetta skipped into the classroom.

The nuclear scope contains the remainder of the sentence. It corresponds to what is being ascribed to the quantified set. Both the restrictive clause and the nuclear scope can be thought of as identifying sets, with the quantifier characterizing a particular relation between them. In (2), for instance, the quantifier serves to define a relation between the set of children and the set of smilers, saying that all members of the first set belong to the second set, i.e. that the first set is a subset of the second set. Different quantifiers correspond to different relations between sets. In *Most children smiled*, the quantifier *most* says that more than half of the members of the set of children belong to the set of smilers.

Since quantifiers correspond to relations between sets, the semantic type\(^2\) of QPs is different from that of DPs such as *Vanessa* and *Pedro* which simply refer to individuals and are of type \(e\); QPs have the higher semantic type \(<<e,t>,t>\). Because of this, there are some syntactic positions in which QPs are not interpretable unless some sort of special operation, such as Quantifier Raising (QR), is performed. These operations, as well as the ones which take place at the syntax-semantics interface to create the semantic structure in (5) are discussed in §2.4.

### 2.2 Relative Scope

Scope ambiguities arise when there are two (or more) quantifiers or operators in a domain at S-structure (such as a single clause\(^3\)) and one QP c-commands the other. When the semantic representation is constructed, one quantifier will be in the nuclear scope of the other, as sketched below:

---

\(^2\)Every word and phrase has a semantic type, corresponding to the kind of semantic value it expresses. There are two basic semantic types: \(e\), which is the type of expressions which refer to entities (e.g. *Pedro*), and \(t\), which is the type of expressions which refer to truth values (full sentences are of this type). Other, more complicated types are built from these basic two. For example, an expression of type \(<<e,t>,t>\) (such as the predicate *sleeps*) is one which when applied to a type \(e\) expression results in a type \(t\) expression. When *sleeps* combines with *Pedro*, the sentence *Pedro sleeps* of type \(t\) results.

\(^3\)Quantifier scope does not seem to be always clause-bounded. See §2.4.2.
The ‘relative scope’ of the two quantifiers refers to which quantifier occupies which operator position. In (7), \( Q_1 \) scopes over \( Q_2 \); \( Q_1 \) is said to have ‘wide’ scope, and \( Q_2 \) is said to have ‘narrow’ scope (when these terms are used in reference to syntactic LF structures, they are defined on QPs rather than quantifiers). The syntactic processes by which the relative scope of two QPs is determined are discussed in §2.4.

Of primary interest to us are scope ambiguities involving two QPs headed by quantificational determiners. (8), repeated from (1), has two interpretations, depending on the relative scope of the QPs *a book* and *every child*. For the interpretation in (8a), *a book* has scope over *every child*; for (b), *every child* has scope over *a book*.

(8) *Marina showed a book to every child.*

a. There is some book that Marina showed to all of the children; it was the same book each time. \( a \text{ book} > \text{every child} \)

b. For each child there is some book that Marina showed her/him; it was possibly a different book in each case. \( \text{every child} > a \text{ book} \)

The term ‘forward’ scoping is used when the first (left-most) quantifier encountered in a sentence takes wide scope, as in (8a). ‘Reverse,’ or ‘inverse,’ scoping is when the second quantifier has wide scope, i.e. the scoping is the inverse of the linear order of the quantifiers, as in (8b).

A number of other kinds of scope ambiguities exist, such as those involving the relative scope of a determiner-headed QP and a quantificational adverb (9), a QP and clausal negation (10), a QP and a wh-phrase (11), and a QP and an intensional verb (12):
(9)  Ronny quickly made all the beds.
    a. Ronny completed the task of making the beds in a short amount of time.  
       \(\text{quickly} \rightarrow \text{all the beds}\)
    b. Ronny made each of the beds in a short amount of time, but it took a while to complete the whole task.  
       \(\text{all the beds} \rightarrow \text{quickly}\)

(10) Every duck did not cross the road.
    a. None of the ducks crossed the road.  
       \(\text{every duck} \rightarrow \text{not}\)
    b. Some of the ducks crossed the road but some did not.  
       \(\text{not} \rightarrow \text{every duck}\)

(11) Which person did every dog lick?
    a. There is a single person that all the dogs licked; who is it?  
       \(\text{which person} \rightarrow \text{every dog}\)
    b. For each dog, there is a person that dog licked; who is the person for dog\(_1\)?, who is the person for dog\(_2\)?…  
       \(\text{every dog} \rightarrow \text{which person}\)

(12) Sophie thinks a friend will come by tomorrow.
    a. Sophie thinks some friend or other will come by.  
       \(\text{think} \rightarrow \text{a friend}\)
    b. There is a particular friend, say Emma, that Sophie thinks will come by.  
       \(\text{a friend} \rightarrow \text{think}\)

I have nothing further to say about the ambiguities in (9-12). To my knowledge, little if any rigorous work has been done on scope preferences in these constructions.

2.2.1 Event Readings

An additional dimension is sometimes considered in studying scope ambiguities. (13) can be said to have three readings, not just the two generated by the two possible relative scopings of the quantifiers all and a:

(13)  All the comrades sang a victory song.  
      Ioup (1975b:33-4)

First, it can mean that all the comrades sang the same song \((a \rightarrow \text{all})\) and that the singing occurred as one event, i.e. all the comrades sang at the same time. Second, the same song could be sung by all the comrades \((a \rightarrow \text{all})\) but different comrades could sing the song at different times, resulting in many singing events. Third, different songs could be sung by different comrades at different
times \((all > a)\), again yielding many singing events. If (13) is changed to include only one quantifier-- \(All \text{ the comrades sang the victory song}\)-- there is still the possibility of one singing event vs. many singing events. Beghelli & Stowell (1997) derived readings such as these by positing a covert event quantifier which interacts scopally with other quantifiers in the sentence. Event readings are considered in greater detail in Chapter 4.

2.2.2 One Scope Reading May Entail the Other

With many determiner quantifiers, one scope reading is entailed by (follows logically from) the other. For example, in (8) the reading in which the \(a\)-phrase has scope over the \(every\)-phrase, (8a), entails the reading in which the \(every\)-phrase has scope over the \(a\)-phrase, (8b). If the context is such that (8) is true with reading (8a)– e.g. Marina showed \(The \text{ Cat in the Hat}\) to every child– then it must also be true under reading (8b). The latter reading allows the possibility of their being a different book per child, but does not require it.

On the other hand, the reverse entailment does not obtain. The reading in (8b) does not entail the reading in (8a). A context can be found in which (8) is true under reading (8b) but not under reading (8a)– e.g. Marina showed \(The \text{ Cat in the Hat}\) to Emma, \(Green \text{ Eggs and Ham}\) to Jasper, and \(The \text{ Lorax}\) to Orestes.

A number of authors, including Reinhart (1976) and Cooper (1979), argue that because of these entailment properties sentences like (8) are not ambiguous between two readings but vague– one reading is just a more specific instance of the other. One of the (many) situations under which (8b) is true is the specific situation under which (8a) is true. These authors contend that only the more general \(every > a\) scoping (8b) need be syntactically generated for (8). The pragmatics/context can restrict the meaning to the equivalent of the \(a > every\) scoping.

However, one reading entailing the other does not hold with all choices of quantifiers. When \(every\) in (8) is replaced by a non-monotone quantifier such as \(exactly \text{ half}\) neither reading entails the other (Fodor & Sag 1982; Ruys 1992):
(14) Marina showed a book to exactly half the children.

   a. There is some book that Marina showed to half the children; it was the same book each time.
      \[ a \text{ book} > \text{exactly half the children} \]

   b. For half the children, there is some book that Marina showed her/him; it was possibly a different book in each case.
      \[ \text{exactly half the children} > a \text{ book} \]

If exactly half were like every, then (14a) would entail (14b). But consider a situation in which there are four children, Emma, Jasper, Orestes, and Chloe. Marina shows The Cat in the Hat to Emma and Chloe, and Green Eggs and Ham to Jasper, but no book to Orestes. Then (14) is true on the reading in (a): there is a single book that was shown to half the kids (The Cat in the Hat); but it is false on the reading in (b), since more than half the kids (three, in fact) were shown some book or other. Thus, at least when certain quantifiers are involved, both scope readings must be derived syntactically.

Many researchers maintain that all doubly quantified sentences are ambiguous and both readings need to be constructed in the syntax. This is the position I adopt. Still, the fact that the every > a scoping is vague as to whether it was the same indefinite in each case is an important point, which will resurface later. For an comprehensive review of the ambiguity/vagueness debate see Ruys (1992).

2.3 Semantic Properties of Quantifiers

A number of the semantic properties which have been ascribed to quantifiers are potentially relevant to the question of how quantifiers are processed during natural language comprehension.

2.3.1 Monotonicity

For one, quantifiers fall into different sets according to their ‘monotonicity,’ that is, the kind of inferencing pattern they exhibit. Two separate inferencing patterns are relevant.

Left monotone increasing quantifiers, such as several, a few, both, at least two, and not all,
generalize from a more restrictive nominal, such as *children with brown eyes*, to a less restrictive nominal, such as *children* (i.e. they generalize from a subset to a set), as shown in (15a), while left monotone decreasing quantifiers, such as *every, neither, no, at most two* and *few*, generalize from a set to a subset, as exemplified in (15b):

(15)  
   a. left monotone increasing  
      
      If several children with brown eyes smiled, then several children smiled.  
   
   b. left monotone decreasing  
      
      If every child smiled, then every child with brown eyes smiled.  

Right monotone increasing quantifiers, such as *several, a few, both, at least two*, and *every*, generalize from a more restrictive predicate to a less restrictive predicate (16a), while right monotone decreasing quantifiers, such as *not all, neither, no, at most two* and *few*, generalize from a less restrictive predicate to a more restrictive one (16b):

(16)  
   a. right monotone increasing  
      
      If every child smiled at lunchtime, then every child smiled.  
   
   b. right monotone decreasing  
      
      If no child smiled, then no child smiled at lunchtime.  

Note that *every* and *not all* (and their synonyms) are the only quantifiers for which leftward and rightward monotonicity do not match (they are increasing in one case, and decreasing in the other).

Some quantifiers, such as *exactly half* are non-monotone, obeying neither inference in (15) and neither in (16):

(17)  
   a. *If exactly half the children with brown eyes smiled, then exactly half the children smiled.  
   
   b. *If exactly half the children smiled, then exactly half the children with brown eyes smiled.*

(18)  
   a. *If exactly half the children smiled at lunchtime, then exactly half the children smiled.*  
   
   b. *If exactly half the children smiled, then exactly half the children smiled at lunchtime.*

Linguistically, monotonicity is relevant in a number of constructions. It is only monotone decreasing quantifiers, for instance, which license negative polarity items such as *any* and *ever*
(Ladusaw 1979):

(19)  a. No child who has ever seen Claude has smiled at him.
     b. Every child who has ever seen Claude has smiled at him.
     c. *Several children who have ever seen Claude have smiled at him.

(20)  a. No child has ever smiled at Claude.
     b. *Every child has ever smiled at Claude.
     c. *Several children have ever smiled at Claude.

Since it is monotone decreasing only on the nominal, every licenses ever when ever occurs as part of the nominal (19b) but not when it occurs within the predicate (20b).

Psycholinguistically, (rightward) monotonicity has been proposed to affect which set invoked by a quantifier is “in focus” and therefore which set can be felicitously referred to by a pronoun in a later sentence (Sanford, Moxey, & Paterson 1996; Paterson, Sanford, Moxey, & Dawydiak 1998; see §2.5.1 for a review).

It is hard to see what effect monotonicity might have on scope preferences.

2.3.2 Weak/Strong

Quantificational determiners are also divided into categories according to whether they can occur in the environment in (21).

(21) There is/are ___ caterpillars in the garden.

Quantifiers which can appear here, such as few, several, a and two, are called ‘weak’ quantifiers, and quantifiers which cannot, such as most and every, are called ‘strong’ quantifiers (Milsark 1977).

But the terms ‘weak’ and ‘strong’ are not quite as simple as this distributional test might suggest. Milsark (1977), Diesing (1992), and numerous other researchers hold that weak quantifiers are ambiguous between a weak and a strong interpretation, with only the weak interpretation coming through in existential there-sentences. (22) can mean either that a lot of caterpillars are in the garden (weak reading) or that a large proportion of the set of caterpillars is
in the garden, while a small proportion of the set is elsewhere (strong reading) (c.f. Partee 1988). (23) lacks the latter reading.

(22) Many caterpillars are in the garden.

(23) There are many caterpillars in the garden.

On their strong interpretation weak quantifiers behave like strong quantifiers, defining a relation between sets (the strong reading of (22) could be given as “a large proportion of the set of caterpillars belongs to the set of things that are in the garden”).

Furthermore, weak/strong is not only a property of the determiner but also of the entire QP. When of the is inserted into the QP in (23), making it an overt partitive, the resulting sentence is ungrammatical:

(24) *There are many of the caterpillars in the garden.

(24) shows that overt partitives have only strong readings. In fact, overt partitives are often used to paraphrase strong readings.⁴

QPs headed by weak quantifiers are often referred to as ‘indefinites’ since on their weak reading they refer to an entity or set of entities which is new to the domain of discourse. Strong QPs are ‘presuppositional’ in that they presuppose the existence of the set of entities which they are applied to. Moreover, this set is generally already known or given in the discourse. A speaker uttering (25) is assuming that the hearer knows about a particular set of caterpillars:

(25) Many of the caterpillars are in the garden.

While many (but not all) scholars maintain that indefinites are ambiguous, how the various interpretations are defined differs from researcher to researcher. Much work has yet to be done in this area. I have presented the particular position on weak/strong readings advocated for by Diesing (1992) since I adopt some of her syntactic proposals below.

The weak/strong distinction is an important one because whether a QP is interpreted as

⁴VanLehn (1978:24-5) reported a dialect split with partitives, however. Some of his informants consistently accepted examples like (24). Based on this, he argued that partitives have strong interpretations in some dialects but not others.
weak or strong can affect its position at LF, the level at which scope is determined, and therefore which elements in the structure it scopes over (see §2.4.4).

One other kind of reading that deserves mention is the ‘specific’ reading of an indefinite. In (26), a new couch can refer to the type of object that Vera wants, in which case the (a) continuation is appropriate, or to a particular, unique object that Vera wants– a specific couch– in which case continuation (b) is appropriate:

(26) Vera wants a new couch.
    a. She will buy one tomorrow.
    b. She will buy it tomorrow.

Specific indefinites are sometimes explicitly indicated by specificity markers like a certain. How specific readings align with other readings that indefinites exhibit is a matter of much debate. I will have little to say about specific indefinites.

2.3.3 Distributivity

Some quantifiers (each, every, both) are distributive. When a quantified phrase headed by a distributive quantifier is combined with a predicate, the predicate is understood as applying to each individual member in the quantified set rather than to the set as a whole. For example, suppose the set of girls consists of Emma, Essie, and Ali. (27a) is understood as Emma picking up the box by herself, Essie picking up the box by herself, and Ali doing it by herself. On the other hand, all in (b) invites a collective interpretation: Emma, Essie, and Ali lifted the box together.

(27) a. Each girl picked up the box.
    b. All the girls picked up the box.

Distributivity is a central topic of Chapters 4 and 5, where the differences between the distributive quantifiers each and every are investigated.
2.4 The Syntax of Quantifier Scope

In this section I will describe how different relative scopings are generated in the syntax and how weak vs. strong interpretations of indefinites are obtained. I begin with a little history.

2.4.1 Quantifier Raising

It has long been said that QPs are not interpreted in their surface positions, at least not all the time. Chomsky (1976) and May (1977) argued for the rule of Quantifier Raising (QR) which adjoined QPs to S-nodes. This rule operates at LF in English, generating representations like the following:

\[ S \quad QP_1 \quad every \quad blanket \quad S \quad DP \quad the \quad girl \quad VP \quad V \quad folded \quad t_1 \]

For all intents and purposes, QR as it was originally proposed was obligatory. It was forced to apply because QPs in their surface position violated constraints on the interpretation of LFs. QPs were not of the right semantic type to combine with their sister nodes (e.g. every blanket could not combine with folded), but they could combine with S-nodes.

Under the QR approach, the two readings of (29) are obtained by adjoining the QPs to S in different orders. For the forward scope interpretation, where the subject QP (a girl) has scope over the object QP (every blanket), the subject is adjoined above the adjunction site of the object, as shown in (30a). For the inverse scope interpretation, where the object QP has wide scope, the subject is adjoined below the adjunction site of the object, as shown in (30b):

\[ QP \quad every \quad blanket \quad S \quad DP \quad the \quad girl \quad VP \quad V \quad folded \quad t_1 \]

\[ S \quad QP_1 \quad every \quad blanket \quad S \quad DP \quad the \quad girl \quad VP \quad V \quad folded \quad t_1 \]

Alternatives to QR which achieve similar results are Cooper storage (Cooper 1983) and Quantifying-in (Montague 1973).
(29) A girl folded every blanket.

(30) a. 

\[
\begin{array}{c}
\text{S} \\
\text{QP}_{i} \quad \text{S} \\
\quad \text{a girl} \\
\quad \text{every blanket} \\
\quad \text{t}_{i} \\
\text{VP} \\
\quad \text{V} \\
\quad \text{folded} \\
\text{t}_{j}
\end{array}
\]

forward scope:
\( a \text{ girl} > every \text{ blanket} \)

b. 

\[
\begin{array}{c}
\text{S} \\
\text{QP}_{j} \quad \text{S} \\
\quad \text{every blanket} \\
\quad \text{a girl} \\
\quad \text{t}_{i} \\
\text{VP} \\
\quad \text{V} \\
\quad \text{folded} \\
\text{t}_{j}
\end{array}
\]

inverse scope:
\( every \text{ blanket} > a \text{ girl} \)

In later syntactic work, adjunction sites other than \( S \) were proposed to be not only possible, but necessary.

2.4.2 Clause Boundedness

QR is thought to be generally clause-bounded (at least for strong quantifiers): (31), (32), and (33) only have the forward scope reading. The second QP cannot raise to a position above the first QP.

(31) A private detective acknowledged the fact that every worker was suspicion.

a. There was one private detective who acknowledged that all of the workers were under suspicion. \( a > every \)

b. *For each worker, there was a possibly different private detective who acknowledged that that worker was under suspicion. \( *every > a \)
Sarit wrote down a song which most of the children sang.

a. There was one song which Sarit wrote down and most of the children sang that song.

b. *For most of the children, Sarit wrote down one song which that child sang (possibly a different song for each child).

Someone believes that every politician is corrupt. (Reinhart 1997:349)

Yet there are other examples where it seems the clause-boundedness constraint on QR is relaxed, where it is easier to get the inverse scope reading. For example, in (34) it can be a different doctor for each patient, and in (35) it can be a different test for each drug:

A doctor will make sure that we give every new patient a tranquilizer. (Reinhart 1997:350)

A quick test confirmed that each drug was psychoactive. (VanLehn 1978:8)

The exact conditions under which QR can apply across a clause boundary have yet to be delineated. I will be using single clause examples in the following chapter, but clause boundedness becomes a potential issue for certain examples discussed in Chapter 5.

2.4.3 Minimalism and Economy

The aim of the minimalist program of Chomsky (1995) was to develop an economical syntactic theory which did not contain any elements that were not needed conceptually. Many operations were trimmed down or abandoned. In this framework, the role of QR has come under scrutiny.

Reinhart has taken an economy view of determining scope preferences. In early work (Reinhart 1976; 1983) she argued that surface c-command relations are critical in determining whether a doubly-quantified sentence is ambiguous or not. She claimed that when there is mutual c-command between the quantified NPs or PPs, the sentence is ambiguous, but when one QP asymmetrically c-commands the other, only the commanding can have wide scope. More recently, she abandoned the no ambiguity approach and used surface c-command to determine the preferred scope interpretation (Reinhart 1983, Chapter 9; 1995; 1997). The C-command
Principle in (36) has been derived from this view:

(36) The C-command Principle

In a doubly-quantified sentence where QP$_1$ c-command QP$_2$ at S-structure, the preferred scoping is QP$_1 >$ QP$_2$.

According to Reinhart, all QPs can be interpreted in their surface positions. QR is needed only to generate scopings which do not correspond to surface c-command relations. It is an extra operation. As such, it exacts some cost and the readings generated with it are less economical and thus more marked. They are only available under certain circumstances.

Coming from a more psychological perspective, Pritchett & Whitman (1995) proposed that the representational complexity of LF structures determines the preferred interpretation of sentences which are unambiguous at S-structure but have more than one possible LF. They used doubly-quantified sentences to demonstrate their theory: the preferred reading of such a sentence is the one associated with the less complex (more economical) LF, where complexity is measured by the number of chain links in the structure. For example, the forward scope reading is preferred in *Someone loves everyone* because it involves one fewer chain link than the inverse scope reading (the LF for the latter is identical to the LF for the former, except that *everyone* take a further movement step to adjoin above *someone*). The theory also accounts for graded preferences. When the second QP is an embedded subject, as in *Some professor hopes every student fails*, inverse scope is harder to obtain because it requires an LF with more chain link than the LF for inverse scope in the previous subject/object case.

Hornstein (1995) argued that within a minimalist LF, a separate rule of QR is completely unnecessary. In his theory, DPs move to [Spec,AGRP] positions for Case-checking before LF. QPs can take scope at LF from these positions or their base positions, as long as Diesing’s (1992) Mapping Hypothesis (see below) is obeyed. QPs which are interpreted as strong/presuppositional must take scope from outside of VP, in their Case positions.

Hornstein maintained that while *Someone kissed everyone* is structurally ambiguous (with either the LF in (37a) or (b)), *Everyone kissed someone* is not ambiguous but vague, having only the
LF in (38a). This LF corresponds to the everyone>someone scoping. Recall from §2.2.2 that this reading entails the someone>everyone reading.

\[(37)\]
\[
\begin{array}{l}
\text{a. } [\text{AGRsP } \text{someone}_s [\text{AGRoP } \text{everyone}_o [\text{VP } \text{t}s [\text{kissed } \text{t}_0 ]]]] \\
\text{b. } [\text{AGRsP } [\text{AGRoP } \text{everyone}_o [\text{VP } \text{someone}_s [\text{kissed } \text{t}_0 ]]]]
\end{array}
\]

\[(38)\]
\[
\begin{array}{l}
\text{a. } [\text{AGRsP } \text{everyone}_s [\text{AGRoP } \text{someone}_o [\text{VP } \text{t}s [\text{kissed } \text{t}_0 ]]]] \\
\text{b. } * [\text{AGRsP } [\text{AGRoP } \text{someone}_o [\text{VP } \text{everyone}_s [\text{kissed } \text{t}_0 ]]]]
\end{array}
\]

The LF in (38b) is unavailable because everyone, being a strong QP, must be interpreted out of VP. In other words, when there is a strong QP as subject and indefinite as object, the inverse scoping of object > subject cannot be generated.

Pica & Snyder (1995) presented a theory of quantifier scope in a minimalist framework as well. Like Reinhart but unlike Hornstein (and most other researchers before him in various frameworks), they offered an account of quantifier scope preferences. According to them, a scope reading which is dispreferred should not be considered to be entirely grammatical.

The syntax of quantifier scope which Pica & Snyder propose is very similar to Hornstein’s. They also have no separate rule of QR. The specifier positions of agreement phrases (AGRP), as well as the VP-internal subject position, are positions from which QPs can take scope. QPs move to [Spec,AGRP] positions for Case-checking, so an independent rule of QR is not needed.

Relative quantifier scope is determined by the LF c-command relation between the QPs.

The favored LF position of DPs and argument PPs—i.e. the position in which they are preferentially interpreted—is their Case-checking positions (whether quantified or not). This is [Spec,AGRsP] for subjects, [Spec,AGRoP] for objects, and a position somewhere between Tense

---

6. Two early exceptions were Lakoff (1971) and Kroch (1974). Lakoff held that ‘command’ (a precursor to c-command) is most important—QP1 preferentially receives wide scope if it commands QP2— with linear order playing a role if the QPs command each other—QP1 preferentially receives wide scope if it precedes QP2. For Kroch, surface syntactic order was primary. He believed that the forward scope reading is always available and is the preferred scoping unless overridden by the preferences and requirements of the particular quantifiers used. He also felt that in spoken language intonation plays a role in determining which scoping is preferred.
and VP for arguments PPs. The preferred scoping of a sentence corresponds to the scoping obtained when the QPs are in these positions. A subject can be interpreted in [Spec,VP], but this is more costly in some way, perhaps because it depends on incorporation, and results in a dispreferred interpretation.

For example, the preferred interpretation of (39), with wide scope on the subject *someone*, follows directly from [Spec,AGRsP] c-commanding [Spec,AGRoP].

(39) *Someone likes everyone.*

The reading in which *everyone* receives wide scope is obtained by interpreting *someone* in the VP-internal subject position, which is below AGRoP. This reading is dispreferred because interpreting *someone* VP-Internally is less economical. The same process is needed, and thus the same cost is incurred, in interpreting the ‘weak crossover’ sentence in (40) (the intended meaning of which is Jake’s mother like Jake, Bruno’s mother likes Bruno, etc.):

(40) ??*His mother likes everyone.*

In general, the acceptability of weak crossover sentences containing a QP correlates with the acceptability of the inverse scope reading in corresponding sentences with two QPs (experimental evidence for this claim was reported in Snyder, 1994).

According to Pica & Snyder, in quantified dative sentences like (41) both scope readings are possible but neither is preferred. They account for this by allowing the *to*-phrase to be checked in a position either above or below AGRoP, so the direct object can c-command the *to*-phrase or vice versa.

(41) *Mary gave something to everyone.*

In other cases involving quantified PPs, the choice of preposition plays a role in determining which scopings are available and what the scope preferences are. For example, *Mary presented someone with everything* seems not to allow the reading in which *everything* has wide scope.

Pica & Snyder observe that their theory provides a straightforward account of why S-structure c-command relations seem to play a role in determining scope preferences (Huang 1982; Reinhart 1983). In most cases, the S-structure position of a QP corresponds to its preferred
The theory of quantifier scope preferences which I develop in Chapter 3 has an explanation in the same vein.

The economy approaches to quantifier scope reviewed in this section have in common the idea that certain relative scopings are costly to obtain. In addition, they maintain that QR is an expensive operation which should be eliminated or scaled back. I will take a similar stance in Chapter 3. Moreover, I will make the association that some of these researchers do between economy and scope preferences. The preferred scoping of a sentence is the one which is more economical.

2.4.4 Structural Determinants of Quantifier Interpretation

Some researchers have proposed that QPs must be in certain positions at LF in order to be interpreted. These proposals have repercussions for when QR is necessary and for which relative scopings should be preferred.

Beghelli (1995) and Beghelli & Stowell (1997) argued for a very articulated LF structure, with numerous functional categories. Different kinds of QPs– e.g. QPs headed by each or every vs. QPs headed by decreasing quantifiers like few vs. indefinites– go to different functional projections to check their features. Some QPs can have various interpretations; these have an option about where to go at LF. Quantifier scope is determined by LF c-command. QR is to the targeted site for a given QP, rather than adjunction to any phrase of right type. Because QPs are constrained as to where they can move at LF, all QPs do not have the same scope possibilities. The tendency for each and every to take wide scope, for example, is captured by their LF position being relatively high in the tree. Beghelli & Stowell’s proposals will be considered in more detail in Chapters 4 and 5, where the differences between each and every are investigated.

A second proposal associating certain LF positions with particular interpretations comes from Diesing (1992). Her theory specified how an LF representation is translated into a tripartite semantic structure.

Recall from §2.3.2 that indefinites (QPs headed by weak quantifiers such as a, some, one, two,
many) can have either of two interpretations: a weak reading or a strong/presuppositional
reading. The weak interpretation of (42), for instance, is roughly “there was one caterpillar in the
garden,” and its strong interpretation is something like “one of the caterpillars was in the
garden.”

(42) One caterpillar was in the garden.

Diesing argued that the weak reading arises when an indefinite is in a VP-internal position at
LF, while the strong/presuppositional reading arises when an indefinite is in a VP-external
position at LF. From its LF position, an indefinite gets mapped by a ‘tree splitting’ procedure
called the Mapping Hypothesis into the corresponding part of the tripartite structure:

(43) Mapping Hypothesis

Material within VP is mapped into the nuclear scope of the tripartite structure.
Material outside of VP is mapped into the restrictive clause of the tripartite structure.

The S-structure for (42) is given in (44a). In order for one caterpillar to receive a weak
interpretation, it must lower back into the VP-internal subject position at LF, as shown in (44b)
(for simplicity, verb movement is not shown in these structures). Following the Mapping
Hypothesis, it is then mapped into the nuclear scope of the tripartite representation (45).

(44) a. [IP One caterpillar [VP t was in the garden ]] S-structure
b. [IP t [VP One caterpillar was in the garden ]] LF for weak reading

(45)

Indefinites in the nuclear scope are bound by the existential closure operator (∃). Such indefinites
introduce the existence of an entity or set of entities into the discourse. Accordingly, weak
readings are also called ‘existential’ readings.

For one caterpillar to receive a strong interpretation, it does not need to move at LF. From its
S-structure position in [Spec,IP] it is mapped into the restrictive clause of the tripartite structure. The quantificational determiner then raises further to serve as a quantificational operator; see (46). Strong/presuppositional readings are thus also called ‘quantificational’ readings.

\[
\text{Operator} \quad | \quad \text{Restrictive Clause} \quad | \quad \text{Nuclear Scope}
\]

\[
\text{one}_x \quad | \quad \text{caterpillar}(x) \quad | \quad x \text{ was in the garden}
\]

In contrast to indefinites, QPs headed by strong quantifiers such as *every* are always mapped into the restrictive clause. Because of their presuppositional nature, they require a restrictive clause for their interpretation. As such, they must always be outside of VP at LF, so that the Mapping Hypothesis maps them into the correct part of the tripartite structure. (An alternative reason why strong QPs have to move out of VP is that there is a semantic-type mismatch—strong QPs are of type \(<<e,t>,t>\), but their base position is type \(e\)—they must be sister to a clausal projection (a phrase of type \(t\)) in order to be interpreted. Diesing & Jelinek, 1995, take this approach.)

In Diesing’s theory, Quantifier Raising is obligatory for all QPs which receive a strong/presuppositional/quantificational interpretation and are in VP at S-structure, whether they are headed by strong or weak quantifiers. It does not apply to indefinites which receive a weak/existential interpretation. In this system, strong QPs are predicted to always have scope over weak QPs.

I will adopt the Mapping Hypothesis in Chapter 3, along with the view that QR operates on only some QPs (strong QPs which are in VP at S-structure).

### 2.5 Quantifiers and Quantifier Scope in Psychology and Psycholinguistics

In this section I review the research that has been conducted in psychology and psycholinguistics on the interpretation of quantifiers and quantifier scope.
It should be clear from the above discussion that both syntax and semantics should be considered in studying the processing of quantifiers. Surface syntactic representations have been considered in psycholinguistics since its inception. Underlying, or deep, structure has also sometimes played a role, e.g. in the Derivational Theory of Complexity (Fodor, Bever, & Garrett 1974). However, LF representations, semantic representations, and formal semantic properties of words and constructions have been largely ignored in the field until fairly recently. In this section, I will very briefly review some of the work that has been done in this area.

Crain & Steedman (1985) and Altmann & Steedman (1988) spawned a line of psycholinguistic research concerned with how the building of a discourse representation can affect the processing of sentences containing referential phrases like \textit{a psychologist} and \textit{the psychologist}. Within that framework, Ni & Crain and colleagues (Crain, Ni, Shankweiler, Conway, & Braze 1996; Ni, Crain, & Shankweiler 1996) considered the semantic/discourse needs of \textit{only}. Portner (1989) followed up some of Crain & Steedman’s studies, formalizing the notion of discourse representation based on the semantic work on discourse structure by Kamp (1981) and Heim (1982). Percus (1995) reinterpreted Portner’s work and other related results, also informed by semantic research.

In other domains, Dwivedi (1991) looked at the processing of modal auxiliaries like \textit{could} and \textit{might} in discourse, drawing on semantic work of Roberts (1987b). Trueswell & Tanenhaus used the semantics of tense to make predictions about syntactic processing in various contexts. Radó (1997) examined the effect of syntactically marked topic and contrastive focus on the interpretation of Hungarian sentences.

\textbf{2.5.1 Non-scope Studies}

A number of studies in the psychological and psycholinguistic literature focus on individual quantifiers but are not concerned with scope issues. I turn to these now, then move on to a review of scope studies themselves.

Two main lines of research on quantifiers exist in the psychological literature. First, Johnson-
Laird (1969; 1983) has looked at syllogistic reasoning with quantifiers (primarily logical ∀ and ∃) in his work on mental models. In more recent research he has considered doubly-quantified sentences (Johnson-Laird, Byrne, & Tabossi 1989; c.f. Greene 1992; Johnson-Laird, Byrne, & Tabossi 1992), yet still from a deductive reasoning perspective rather than a language processing one. Gillen (1991) has applied some of their ideas in her studies on scope preferences (see below).

Second, various researchers have studied how numbers and proportions are assigned to quantifiers like many and few in various contexts (e.g. for Many kids are sleeping, what number or proportion of kids is intended, fifteen, two-thirds, etc.) and whether quantifiers are mapped onto mental scales (e.g. Parducci 1968; Pepper 1981; Newstead & Collis 1987; see Moxey & Sanford 1993 for a thorough review). This research is not relevant to the syntactic and (formal) semantic processing of quantifiers.

Moxey and Sanford and colleagues conducted a few of the small number of on-line reading experiments involving quantifiers that have been conducted. They investigated which set possibly invoked by a quantifier can be felicitously referred to by a pronoun in a later sentence. For example, the second sentence in (47b,c) are intuitively incompatible with the previous quantified sentence:

(47) **Context sentence:** Local MPs were invited to take part in a public inquiry about proposals to build a new nuclear power station.

```
(a) A few of the MPs attended the meeting. Their presence helped the meeting to run more smoothly.
(b) A few of the MPs attended the meeting. #Their absence helped the meeting to run more smoothly.
(c) Few of the MPs attended the meeting. #?Their presence helped the meeting to run more smoothly.
(d) Few of the MPs attended the meeting. Their absence helped the meeting to run more smoothly.
```

Using self-paced sentence-by-sentence reading (Sanford et al. 1996) and eye-tracking (Sanford, Moxey, & Paterson 1994; Paterson et al. 1998), the researchers found slower reading times in the second sentence in (47b,c) vs. (a,d), in line with intuitions. Their account of these results is based on the claim that a pronoun following a QP can only refer to the set which the quantifier “puts
into focus” (directs the attention of the reader/listener to). A few focuses the ‘reference set’: those MPs who attended the meeting; thus their presence is appropriate. Few focuses the ‘complement set’: those MPs who did not attend the meeting; thus their absence is appropriate. Quantifiers which focus the complement set can marginally refer to the reference set, but quantifiers which focus the reference set have no access to the complement set. Thus, the continuation in (c) is not quite as bad as the continuation in (b). Sanford et al. (1994) suggested that the quantifiers which focus the complement set are those which are (right) monotone decreasing.

Percus, Gibson, & Tunstall (1997) conducted a follow-up study using a wider range of quantifiers. They argued that the complement set is never made available for reference by any quantifier and that the differences between quantifiers with respect to anaphora should not be traced back to monotonicity. Rather, the data can be accounted for by considering the conditions under which a property can be ascribed to a group. One of the considerations is the number of exceptions which are permitted, i.e. how many members of the group are allowed not to have the property while the group as a whole is still said to have the property. This varies from quantifier to quantifier.

2.5.2 Psycholinguistic Studies of Scope Preferences

Scope preferences have been the topic of a number of psycholinguistic studies in child and adult language. I will review the adult research presently. Although the acquisition studies often used adult controls, because the goals of these studies are different than those of adult studies, the adult results reported in them are not particularly informative. Few connections have yet been made between the adult and child literature.

Also of note are computational linguistic approaches to the resolution of quantifier scope ambiguities. In contrast to earlier work (Schubert & Pelletier 1982; Allen 1987), Poesio (1994) considered psycholinguistic results in constructing his system. He argued for a discourse-based theory of quantifier scope interpretation and preferences, using underspecified representations. Perhaps in the future this area will have something to offer psycholinguistics as well.
The adult studies into scope preferences fall into three groups. Ioup (1975a,b), VanLehn (1978), and Gil (1982) gathered intuitive judgements. Catlin & Micham (1975) and Micham et al. (1980) used more controlled experimental settings but the tasks they used invited problem solving by the participants. Gillen (1991) and Kurtzman & MacDonald (1993) employed tasks which more closely mirrored normal reading and comprehension, though they still involved a judgement component. I will review each of these studies in turn.

2.5.2.1 Ioup (1975)

Ioup (1975a,b) is well-known for her view that the intrinsic character of the individual quantifiers is a prime factor in determining scope preferences. She constructed a hierarchy of the tendency of (unstressed) quantifiers to take wide scope (from greatest to lowest tendency):

(48) Ioup’s Quantifier Hierarchy

\[ each > every > all > most > many > several > some_{pl} > a_{few} \]

This hierarchy only includes quantifiers over plural sets. From it, Ioup derived the following generalization: the larger the set defined by the quantifier, the greater tendency for wide scope. She noted that the quantifiers over singular sets, \( some_{sg} \) and \( a \), are apparent exceptions to this generalization. They seem to fit in between \( every \) and \( all \) on the hierarchy, but Ioup felt she lacked conclusive evidence to place them there.

The Quantifier Hierarchy was constructed from examples like the following (Ioup 1975b:73-4). Ioup claimed that in (49) \( each/every \) are preferentially (if not obligatorily) given wide scope over \( a \), but when \( each/every \) are replaced by \( all \) in (50) the sentences are very ambiguous and the indefinite preferentially receives wide scope.

(49)  
\[ a. \quad I\text{ saw a picture of each child.} \]
\[ b. \quad She\text{ knows a solution to every problem.} \]
\[ c. \quad Ethel\text{ has a dress for every occasion.} \]
(50)  a.  *I saw a picture of all the children.*
    b.  *She knows a solution to all problems.*
    c.  *Ethel has a dress for all occasions.*

More quantifiers were compared in (51) (Ioup 1975b:75). Ioup observed that with the quantifier *some* in (a), the total number of handouts is a few (i.e. the scope is *a few > some*), while with *all* and *every* in (d,e), each pedestrian got a few handouts (*all, every > a few*). The intervening cases are said to offer less strong judgements towards one scope or the other.

(51)  a.  *Joan gave a few handouts to some pedestrians.*
    b.  *Joan gave a few handouts to several pedestrians.*
    c.  *Joan gave a few handouts to many pedestrians.*
    d.  *Joan gave a few handouts to all pedestrian.*
    e.  *Joan gave a few handouts to every pedestrian.*

Ioup argued against linear order playing a role in determining scope preferences. After the inherent properties of the quantifiers themselves, she believed the grammatical functions of the quantified phrases to be the critical secondary factor. A QP in a position higher on the hierarchy in (52) will have a greater tendency to take wide scope than one lower on the hierarchy:

(52)  Ioup’s Grammatical Function Hierarchy

    topic > deep and surface subject > deep subject or surface subject > prepositional object
    > indirect object (IO) > direct object (DO)

Ioup’s conclusions were based on intuitions she gathered from informants in numerous languages. For English items, participants indicated the reading they obtained for a sentence by selecting a point on a scale of interpretations: 1. unambiguous “collective” interpretation (= wide-scope indefinite), 2. ambiguous with preference for collective interpretation, 3. ambiguous with no preference, 4. ambiguous with preference for “individual” interpretation (= wide-scope universal), 5. unambiguous individual interpretation. The scale was used in order to make the task easier on the informants and because Ioup believed that ambiguity should be viewed as a continuum. Ioup reported that any indecision by participants was always between adjacent
points on the scale, and that no two informants in the same language gave judgements more than
two levels away from each other. It is unclear how many informants she had. For English
sentences it seems that sometimes she presented simply her own intuitions.

Among the comparisons she made in English to support the Grammatical Function
Hierarchy were those below (loup 1975b:78-81):

(53)  Support for deep and surface subject > deep subject or surface subject
       a. Every girl took a chemistry course. every > a only
       b. A chemistry course was taken by every girl. every > a preferred
       c. Every chemistry course was taken by a girl. every > a preferred
       d. A girl took every chemistry course. a > every preferred

(54)  Support for Prep O > DO
       a. I had many conversations with a friend. a > many only
       b. I had a conversation with many friends. ambiguous, no pref.
       c. Freddy hit many balls with a bat. a > many only
       d. Freddy hit a ball with many bats. ambiguous, no pref.

(55)  Support for IO > DO
       a. I told every child a story. every > a preferred
       b. I told a story to every child. every > a preferred
       c. I told every story to a child. a > every preferred
       d. I told a child every story. a > every preferred

(56)  Support for Prep O > IO
       a. Joan told someone the story at every intersection. every > some preferred
       b. Joan told everyone the story at an intersection. a > every preferred

It is unclear whether loup looked at other examples within each category to further corroborate
her findings on these examples.

In looking at other languages, loup compared the scope preferences of the equivalent of three
plural English quantifiers: some_{pl} (or a few), all, and each. In each item, one of these quantifiers was
paired with the quantifier corresponding to a. She had informants translate six sentences into their native language and then asked them questions about its interpretation. She also asked whether the sentence could be expressed with another word order and how that affected its interpretation. In all six sentences, the singular QP was the direct object. The results of this research supported the positioning of each above all and some on the Quantifier Hierarchy and the relative rankings of subject, indirect object, and direct object on the Grammatical Function Hierarchy.

The predictions of Ioup’s Quantifier Hierarchy and Grammatical Function Hierarchy were tested in some of the studies reported below. I will further discuss the Quantifier Hierarchy in Chapter 5, where the influence of individual quantifiers on scope preferences is investigated.

2.5.2.2 Gil (1982)

Like Ioup, Gil (1982) examined quantifier scope preferences cross-linguistically. He used sentences with numerical quantifiers, like Three boys saw two girls. Data was gathered from informants in three languages by asking them whether the sentences were true relative to diagrams that depicted particular interpretations. Gil found that this kind of doubly-quantified sentence has at least four different types of readings, depending in part on whether the verb is related to the whole group of boys (or girls) or to each individual boy (or girl) in the group. For instance, the readings for the example above include (i) each of the three boys seeing each of the two girls; and (ii) each of the three boys seeing one girl, with the total number of girls that were seen adding up to two. In contrast to Ioup (who used different kinds of sentences), Gil found “widespread” disagreement about judgements within a homogeneous speech community, variation within subjects, and cross-linguistic variation. Yet there were non-random patterns in his data, which correlated with grammatical relations in various ways. He presented three semantic/pragmatic models which could account for his findings. I know of no other studies which examined the types of sentences Gil used, though there is a fair amount of research on them in the semantics literature.
2.5.2.3 VanLehn (1978)

VanLehn (1978) gathered data in two ways. First, he conducted a corpus analysis, selecting doubly-quantified sentences from technical reports on Artificial Intelligence research. For each sentence he determined the intended scoping, sometimes using the context in which the sentence had occurred to help him and sometimes asking assistance from the author of the sentence.

Second, he asked informants for scope judgements on a set of sentences that he constructed which controlled for lexical content and surface structure (since by its nature the corpus study did not control for such factors). The items were typed individually on cards and given to participants to read. The informants were first asked to paraphrase the sentence. If it was unclear from the paraphrase which reading they had arrived at, then VanLehn asked them clarifying questions. For the sentence *Every guy kissed a girl*, for instance, the questions were like: *Did they all kiss the same girl? If there are 5 guys, how many girls does this imply got kissed? Is there a different girl per guy?* The scope judgements were described using the relations ‘different/per’ (equivalent to wide-scope universal) and ‘same/per’ (equivalent to wide-scope indefinite). E.g., a different girl per guy vs. the same girl per guy (note that the noun associated with the universal quantifier is the “object” of the per relation in both cases). For the examples he discussed in the text, the percentage of different/per responses was reported.

It is unclear how many items VanLehn gathered judgements on and how many participants judged each item. He reports collecting more than 1500 total judgements, but also states (p. 23) that “the addition of another couple of judgements sometimes made the percentages swing up or down by 5 or 10 percentage points, but rarely more than that,” suggesting a small number of informants for a given item.

VanLehn’s position was that quantifier scope preferences are “epiphenomena” and do not correspond to any syntactically real processes. He claimed (p. 9) “the informant must ‘misuse’ one of the real processes to disambiguate Q scope,” saying that the difficulty that informants had in coming up with paraphrases for and answering questions about doubly-quantified sentences supported his position. Drawing on both the corpus data and the judgement data, he examined
the effects of three factors on scope preferences: quantifier choice, embedding, and linear
order/c-command relations.

In terms of individual quantifiers, VanLehn constructed a hierarchy of how likely quantifiers
are to occur as the object in the different/per relation as opposed to the same/per relation, i.e.
how likely quantifiers are to take wide scope. Only strong quantifiers (or weak quantifiers with
strong readings) were included. A position higher on the hierarchy corresponds to a greater
tendency for wide scope (p. 23).

(57) VanLehn’s Quantifier Hierarchy

\[ \text{each} > \text{every} > \text{all of the} > \text{all the} > \text{other plurals (e.g. many of the)} \]

This hierarchy is consistent with that of loup, although it does not incorporate as many
quantifiers.

VanLehn looked at the effect of the syntactic position of QPs from two standpoints. For one,
he examined scope preferences in sentences where the QPs were in different clauses, varying the
embedded positions used. Recall from §2.4.2 that QR is considered to be generally clause-
bounded, though there are some examples which challenge this idea. VanLehn found further
exceptions. He observed that the difficulty of scoping out of a relative clause depends on whether
the wh-operator was overt or not and on the choice of quantifier (p. 31):

(58) a. At the conference yesterday, I managed to talk to a guy who is
representing each/every raw rubber producer from Brazil.
0% each > a
0% every > a

b. At the conference yesterday, I managed to talk to a guy representing
each/every raw rubber producer from Brazil.
50% each > a
0% every > a

These findings suggest that a purely grammatical account of clause-boundedness phenomena
would likely be inadequate. VanLehn himself argued that it should not be grammatically based
at all.

Syntactic position effects were also examined for sentences in which the QPs were in the
same clause. The linear order of the QPs and the c-command relation between were considered.
In evaluating the role of c-command, he defined the C-command Hierarchy as follows (a
refinement of a similar hierarchy proposed by Reinhart, 1976):

(59) VanLehn’s C-command Hierarchy

preposed PP & topicalized NP > subject > sentential PP & adverbial NP >
verb phrase PP > object

Only the last three positions on the hierarchy differ when linear order is used to construct it rather than c-command: object > verb phrase PP > sentential PP & adverbial NP. The hierarchies predict scope preferences in the same way: If the universal QP is higher on the hierarchy than the indefinite then a wide-scope universal reading is predicted, and if the indefinite is higher then a wide-scope indefinite reading is predicted. If the QPs are at the same level (e.g. both verb phrase PPs), then no preference is predicted. VanLehn found that both linear order and c-command correlated well with his scope preference data. As mentioned above, c-command will play an important role in the theory of scope preferences which I develop in Chapter 3.

2.5.2.4 Catlin & Micham (1975)

Catlin & Micham (1975) used three different off-line measures to determine which quantifier (every or some) was assigned wide scope in active and passive subject-object sentences like those in (60). Subject quantifier was crossed with voice, to yield four conditions.

(60) Every man knew some woman.

Some woman was known by every man.

For each of four items, participants were asked: (i) which noun category the sentence was “about,” (ii) which noun category the person would want to examine, one member at a time, in order to determine whether the sentence was true or false, and (iii) how the person would choose to negate or deny the sentence. For question (iii), two choices were given; (61) gives the choices for the sentences in (60):

(61) Some man did not know any woman.

No woman was known by every man.

The researchers believed that the noun which was the subject of the denial that was chosen in question (iii), and the noun given as the answer to questions (i) and (ii), would correspond to the
noun in the quantified phrase which was given wide scope in the target sentence.

The three measures were found to be highly correlated; on 85% of the items the same noun was chosen as the answer to all three questions. The results from the trials where all three measures agreed indicated that the (surface) subject of the sentence was given wide scope reliably more often than the object. This preference was significantly larger when the subject quantifier was every than when it was some. It was marginally bigger in actives than in passives. The effects of quantifier and voice did not interact.\(^7\)

Catlin & Micham suggested that the main effect of subject quantifier, where every preferred wide scope to a greater extent than some may be due to every being more definite, citing a finding by Grieve & Wales (1973) that definiteness contributes to indicating what a sentence is about.

2.5.2.5 Micham et al. (1980)

Micham et al. (1980) noted that the preference for wide-scope on the first QP in active and passive sentences with quantified subjects and objects (like those Catlin & Micham studied) could be due either to linear order playing a strong role in determining scope preferences or to surface subject position playing such a role. To determine which of these factors has more influence, they examined doubly-quantified sentences in which both QPs occurred postverbally in the underlying structure. Double object/dative verbs were used, as in (62), as well as verbs that take double PP complements, as in (63), where a full set of conditions is given. Within each item, half of the conditions were active sentences and half were passive, where one of the underlying objects became the surface subject. Voice was crossed with quantifier order and with\(^7\)

\(^7\)In addition to sentences like those in (5), Catlin & Micham looked at unambiguous sentences such as in (i), where the same quantifier appears twice. Participants either saw all ambiguous sentences or all unambiguous sentences.

(i) Some man knew some woman.
Every man was known by every man.

For the unambiguous sentences, the three measures agreed 73% of the time. The results cited in the text are for the ambiguous and unambiguous conditions combined. There was no main effect of ambiguity, nor any interactions involving it. The authors argued that this result indicates that there are similar procedures for verifying or disconfirming doubly quantified sentences, whether or not they are ambiguous.
which quantifier occurred within the underlying indirect object (first object for double object items, object of to for other items). In all cases the quantifiers were every and some.

(62) a. Bill told some child every joke.
   b. Bill told some joke to every child.

(63) a. John spoke to some girl about every problem.
   b. John spoke about some problem to every girl.
   c. John spoke about every problem to some girl.
   d. John spoke to every girl about some problem.
   e. Some girl was spoken to about every problem by John.
   f. Some problem was spoken about to every girl by John.
   g. Every problem was spoken about to some girl by John.
   h. Every girl was spoken to about some problem by John.

Participants saw only a single sentence each. Scope preferences were determined by how participants judged matrices representing possible situations the target sentence might refer to (this task was based on that used by Johnson-Laird, 1969). A sample matrix for (63a) is given in (64). The X in a row A–column 1 indicates that John spoke to girl A about problem 1. An O in a given row and column indicates he did not speak to that girl about that problem.

(64) Sample Matrix for Item (63a)

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<td>C</td>
<td>X</td>
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Participants judged the truth or falsity of the sentence as they understood it in relation to ten matrices. For example, if a participant saw matrix (64) and interpreted (63a) with wide-scope every, he or she would answer “true.” If the sentence were interpreted with wide-scope a, the
response would be “false.” On the two critical trials, the matrices were consistent with the every > some scoping. The matrices in four of the remaining trials had a full column of X’s, which were consistent with either reading of the sentence. The last four matrices corresponded to neither reading.

Only data for the critical trials was reported. The vast majority of participants were consistent in their interpretation across these trials (i.e. in both cases they gave the same response). There was an overall preference for wide-scope every (75%), corresponding to the answer “true.” The effect of which quantifier occurred in the indirect object was significant. With some in the indirect object (conditions (a,c,e,g)), every was given wide scope 53% of the time, and with every in the indirect object (b,d,f,h), every was given wide scope 96% of the time.

From this pattern, Micham et al. concluded that every prefers wide scope more than some does and that a QP which is underlying an indirect object (IO) is more likely to receive wide scope than a QP which is underlying a direct object (DO). They noted, however, that in all their items the IO was animate and the DO was inanimate, so that it may be animacy rather than grammatical role which influenced scope preferences.

The results for the active conditions mirrored the general results. Every received wide scope significantly more often than some, IOs received wide scope significantly more often than DOs, and every received wide scope significantly more often when every occurred in the IO (95%, conditions (b,d)) than when some did (60%, (a,c)). Moreover, the effect of quantifier order was not reliable. The authors took this last result as indicating that linear order does not play a strong role in determining scope preferences in these kinds of sentences.

Responses to the passives items generally matched responses to the corresponding actives. The researchers compared pairs of active/passive conditions in which the quantifier order and the coupling of quantifier with underlying grammatical role were held constant ((a) and (e); (b) and (f); etc.). The only significant difference was between conditions (a) and (e). From this,

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Since the every > some scoping allows it to be the same problem for every girl and the some > every scoping requires it to be the same one (see §2.2.2).
Micham et al. concluded that a QP in surface subject position does not favor wide scope more than QPs in other positions.

Micham et al.’s results and conclusions are generally consistent with Loup’s position, including the idea that scope preferences are not strongly influenced by linear order, the claim that IOs take wide scope more often than DOs, and the claim that every takes wide scope more often than some. They differ, however, on whether surface subject position is a favored position for wide scope. Micham et al. concluded that underlying grammatical function is more important than surface position.

Given the syntactic differences among the different constructions used in this experiment (double objects, datives, double PPs), it would have been beneficial to be able to examine the results from the two sets of verbs separately. Unfortunately, the authors do not present the data in this way. Although they report no significant differences in scope preferences according to verb type (PP PP vs. double object/dative), it is unclear what analysis they performed. Their phrasing implies they tested for effects of individual verbs rather than between the two verb types.

2.5.2.6 Fodor (1982)

J. D. Fodor (1982) considered what the mental representation of quantified sentences might be. She was interested in identifying a representation which would be useful to psychologists. One of her aims was to be able to predict from the representation which interpretations of quantified sentences are easy to compute. The representations that she proposed are called ‘models of the world.’ They are like mental models or discourse representations in that they schematically show the relations between various elements in the sentence.

Fodor argued against QR playing a role in interpreting quantified sentences. She proposed that the processor maps sentences directly from surface structure into models of the world representations. The preferred scoping of a doubly-quantified sentence is the one which is easier to compute at the model of the world level. Construction of the model proceeds step by step as
the words in the sentence are read. In general, forward scope is predicted to be preferred. This preference may be mediated by the specific quantifiers involved. Some quantifiers have a ‘hunger’ for inducing multiple interpretations of other elements (equivalent to taking wide scope). Each is said to be the hungriest, followed by every, then all. She also believed that prosody plays a role in resolving ambiguity.

2.5.2.7 Gillen (1991)

Gillen (1991) presented a series of studies on doubly-quantified sentences. She tested the predictions of Johnson-Laird and colleagues (especially Johnson-Laird, Byrne, and Tabossi, 1989), who employed mental models and predicted that the linear order of the quantifiers should be a major factor in determining scope preferences, and Ioup (1975a,b), who predicted that the individual quantifiers and the grammatical functions of the QPs should affect scope preferences.

Gillen used a variety of tasks. Her first five experiments involved either drawing a diagram representing the quantified sentence or choosing which of two diagrams best represented the sentence. The number of participants for these studies was quite low (10-24). In later experiments, she had participants either evaluate whether a (single) diagram was a good representation of the meaning of the target sentence or read target/continuation pairs, where the continuation was meant to be consistent with only one scoping of the quantified sentence. In presenting Gillen’s work, I will concentrate on the three experiments which I feel offer the strongest and most important results.

In her Experiment 6 Gillen compared the active and passive versions of subject-object sentences in the same study, as Catlin & Micham (1975) did. Participants first read sentences like those in (17) on a computer screen (the entire sentence was presented at once), and pressed a button. They then evaluated whether a diagram depicting either the wide-scope indefinite reading or the wide-scope universal reading was an accurate representation of the quantified sentence.
sentence they had just read. Sample diagrams are given in (66). The time it took to read the quantified sentence, the time it took to evaluate the diagram, and the response to the diagram were recorded for each item.

(65) All boys befriend a girl.
    Some boy befriends all girls.
    Every boy is befriended by some girl.
    A boy is befriended by every girl.

(66) Sample diagrams
    (for sentences where boy is universally quantified)

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Wide-scope Universal       Wide-scope Indefinite

There were five 2-level factors in the experiment, fully crossed, yielding 32 conditions. The factors were quantifier order (universal first or indefinite first), type of universal (all or every), type of indefinite (a or some), voice (active or passive), and type of diagram (wide-scope indefinite or wide-scope universal).

In terms of diagram acceptance, participants were significantly more likely to accept a wide-
scope indefinite diagram than a wide-scope universal diagram overall (80% vs. 54%). There was a main effect of quantifier-order (marginal by participants), with universal-first sentences having a higher diagram-acceptance rate than indefinite-first sentences (69% vs. 66%), and a main effect of voice (marginal by items), with passives having a higher diagram-acceptance rate than actives (69% vs. 66%).

There was no main effect of type of universal, but there was a significant interaction between this factor and type of diagram: the rate of acceptance was about the same for the wide-scope universal diagram, whether the quantifier was every or all, but the wide-scope indefinite diagram was accepted more often for all. This finding may indicate that all is happier receiving narrow scope than every. The type of indefinite also had some effect. Participants were significantly more likely to accept a diagram when the indefinite quantifier was a. This effect interacted with diagram type: the acceptance rate for a with the wide-scope indefinite diagram was reliably higher than the other combinations of factors. These results may indicate that a has a stronger preference for wide scope than some.

Because of the main effect of type of diagram in the experiment, it is not revealing to compare the rates at which the two different kinds of diagrams were accepted for a given condition in order to determine interpretation preferences. Rather, it is more useful to examine the two diagram types separately. On the following measures, every and all patterned together, as did a and some. For ease of discussion, I use every for referring to a universal quantifier and a for referring to an indefinite quantifier.

For the wide-scope universal diagrams (every > a), the acceptance rate was higher when the quantifier order was every-a than when it was a-every (60% vs. 49%), indicating that it is easier to give every wide scope when it precedes a. This effect was bigger in passives than in actives (passives: every-a 63%, a-every 48%; actives: every-a 57%, a-every 52%).

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10 Reading times and evaluation times were reported only for trials in which the participants accepted a wide-scope indefinite diagram. I will not discuss these results since they do not seem particularly enlightening.
Wide-scope indefinite diagrams \((a > every)\) were accepted more often after sentences in which \emph{every} occurred second than after sentences in which it occurred first (83\% vs. 78\%). This finding indicates that it is more difficult to give the indefinite wide scope when it is preceded by the universal at S-structure. There was no effect of voice in this measure, suggesting that actives and passives were processed similarly.

From these results Gillen concluded that there is support for Johnson-Laird et al.'s hypothesis that the order of the quantifiers plays a critical role in determining relative scope preferences, with the quantifier which is encountered first preferentially receiving wide scope. However, Ioup's hypothesis that the grammatical function of the universal quantifier affects scope preferences was not supported. Under this hypothesis, there should have been weaker support for wide-scope on the subject in passives than in actives, since the surface subject of actives is also the deep subject (and thus has the strongest preference for wide scope) while the surface subject of passives is the deep object (with a somewhat weaker preference for wide scope). Furthermore, although Gillen does not mention this, the results also support Reinhart's C-command Principle.

In her final experiments, Gillen investigated scope preferences in double object and DP-PP sentences like those in (67). In these experiments, a wider range of quantifiers was employed than in the active/passive study just discussed, in order to evaluate Ioup's Quantifier Hierarchy along with the word order and grammatical function hypotheses. Gillen was also interested in further testing Johnson-Laird's word order hypothesis.

(67) \begin{align*}
\text{DP-PP (indefinite first)} & \quad \text{Double Object ("universal" first)} \\
Margaret served a scone to some customers. & \quad Margaret served some customers a scone. \\
Bob suggested a schedule for all teachers. & \quad Bob left all teachers a schedule. \\
Charlie bought a tie from many salesmen. & \quad Charlie bought many soldiers a uniform.
\end{align*}

In Experiment 8, Gillen used the same reading and evaluation task she used for her active/passive study. There were three factors in the experiment: type of universal/multiple quantifier (\emph{somepl, several, many, most, all, every, each}), quantifier order (universal first or indefinite first), and type of diagram (wide-scope indefinite or wide-scope universal). The indefinite
quantifier was always a. The two quantifier orders were not tested in exactly the same environment; the indefinite-first order was tested in the DP-PP construction, and the universal-first order was tested in the double object construction. Note that the preposition in the DP-PP structure varied from item to item (sometimes yielding a to-dative), and that the verb and/or common nouns sometimes differed in the two structures.

In terms of diagram acceptance, participants were significantly more likely to accept a wide-scope universal diagram than a wide-scope indefinite diagram overall (83% vs. 69%). This effect interacted with quantifier order, showing up more strongly when the universal occurred second (DP-PP) (84% wide-universal, 60% wide-indefinite), in contrast to the prediction of the word order hypothesis. For sentences in which the universal occurred first (double object), the acceptance rates for the two diagrams were quite close (82% wide-universal, 78% wide-indefinite).

Reading times and evaluation times were analyzed for Yes responses to wide-scope universal diagrams only. On both measures, universal-first sentences (double objects) were faster than indefinite-first sentences (DP-PP). This finding is consistent with the word-order hypothesis.

As for quantifier effects, the acceptance rate for wide-scope universal diagrams was highest for each (92%) and every (91%), followed by most (87%), all (83%), many and several (both 79%), and some_{pl} (71%). The acceptance rates for the wide-scope indefinite diagram reversed this hierarchy; they were highest for some_{pl} and lowest for each. Individual statistical tests between pairs (or subsets) of quantifiers were not performed. These results supported Ioup’s Quantifier Hierarchy but for the relative positions of all and most. Discussion of these effects in postponed to Chapter 5.

For her Experiment 10, Gillen used materials very similar to those used in the study just described, but the task was somewhat different. Diagram evaluation was replaced by the reading of a continuation sentence. The continuations for the first example in (67) are given in (68). The

\[11 \text{Note that this is the reverse of the main effect of diagram in the passive/active study, though numerically the effect is not quite as large here. This difference could be due to the different constructions tested or perhaps to the wider range of quantifiers used here.}\]
time it took to read the quantified sentence and the time it took to read the continuation sentence, both of which were presented all at once, were recorded.

(68)  a. *The scone was hard and dry.*

    b. *The scones were hard and dry.*

Analysis of reading times for the quantified sentence revealed that universal-first (double object) sentences were read significantly faster, as in her Experiment 8. Singular continuations ((68a), wide-scope indefinite) were read significantly faster than plural continuations (68b). Continuation and quantifier-order did not interact in the continuation sentence, and the means for the interaction of these factors are not presented, but Gillen states (p. 176) that the effect of singulars being faster than plurals is especially evident in the universal-second conditions.

There was a reliable effect of quantifier in the quantified sentence, but no interaction with quantifier-order. In the continuation sentence, there were no significant effects of quantifier. The main effect of the singular continuation being faster than the plural holds for all quantifiers.

Gillen noted an effect of task in these studies. In Experiment 8, where a diagram had to be evaluated, the wide-universal diagram was accepted more often. But in Experiment 10, without direct judgement, the wide-scope indefinite continuation was favored (read faster). Gillen argued that readers were adopting the wide-scope indefinite interpretation by default while they were reading the quantified sentence, because this interpretation was easier. In Experiment 10, this default scope sufficed, but in Experiment 8 participants had to truly assign scope and flesh out the representation into a mental model in order to evaluate the diagram. Gillen concluded that doubly-quantified sentences are not disambiguated unless the task requires it.

Overall, Gillen found the word-order hypothesis inconsistently supported by the results of her experiments. She concluded that it has some effect, but is mediated by other factors such as the quantifiers involved, context, and general knowledge.

The task which Gillen used in her Experiment 10 is the closest to normal reading of all the methods she employed, but the design of that experiment is problematic. For one, it would have been better to not have had the different quantifier orders associated with two different
constructions (DP PP vs. double object), since the syntax of the constructions is not the same and could be playing a role in determining scope preferences. These constructions will be discussed in detail in Chapter 3. Second, the singular continuation sentences could be compatible with either scoping in the quantified sentence. This point is addressed in the following section, since it is relevant there as well.

2.5.2.8 Kurtzman & MacDonald (1993)

The first published computer-controlled studies of quantifier scope preferences were reported by Kurtzman & MacDonald (1993) (hereafter K&MacD). Their goal was to evaluate a number of the structural-based principles proposed in the literature to account for scope preferences:

(69) Linear Order– the leftward phrase prefers wide scope.

Surface Subject– the surface subject prefers wide scope.

External Argument– the external arguments prefers wide scope.

C-command– the NP which asymmetrically c-commands the other NP at S-structure prefers wide scope.

Topic– the topic phrase prefers wide scope.

Thematic Hierarchy– the NP higher on the θ-hierarchy prefers wide scope (Agent > Experiencer > Theme).

In their first experiment, they tested active sentences in which the subject and object were quantified, using the quantifiers every and a. Each item consisted of two sentences: the quantified sentence (S1) followed by a continuation (S2) intended to be consistent only with one interpretation (relative scoping) of S1. Interpretation was crossed with quantifier-order and with ambiguity to yield 8 conditions. Sample materials for the ambiguous conditions are given in (70a-d), along with the scoping which the continuation sentence was intended to be compatible with. In the corresponding unambiguous conditions in (e-h) the quantifier a was replaced by a different

12 Gillen (1991) used a similar technique and design in her final studies, but her results have not had a wide impact because they have never been available outside her dissertation.
(for wide-scope every) or the same (for narrow-scope every).

(70) Ambiguous Conditions

a/b. A kid climbed every tree.
   a. The kid was full of energy.   forward scope: a > every
   b. The kids were full of energy.  inverse scope: every > a

c/d. Every kid climbed a tree.
   c. The tree was full of apples.   inverse scope: a > every
   d. The trees were full of apples.  forward scope: every > a

Unambiguous Conditions

e. The same kid climbed every tree. The kid was full of energy.

f. A different kid climbed every tree. The kids were full of energy.

g. Every kid climbed the same tree. The tree was full of apples.

h. Every kid climbed a different tree. The trees were full of apples.

Participants read the quantified sentence, which was presented all at once, pressed a button, then read the continuation sentence and indicated if it was a good continuation for the quantified sentence by pressing a key. K&MacD reported the percentage of cases where subjects judged the continuations compatible.

The results indicated that the forward scoping of subject over object was significantly preferred in the ambiguous sentences. Continuation (a) was judged compatible more often than continuation (b) in (a/b) (about 81% vs. about 23%) and continuation (d) was judged compatible more often than continuation (c) in (c/d) (about 74% vs. about 46%). Furthermore, the preference for forward scoping was bigger for the a-every order (a/b) than for the every-a order (c/d). This difference between orders primarily came from the difference in the compatibility rates for the inverse-scope continuation. While the forward-scope continuation was accepted marginally more often in the a-every order than in the every-a order, the inverse-scope continuation was accepted significantly less often in the a-every order.

The passivized versions of the quantified sentences from Experiment 1 were used as
materials for K&MacD’s second experiment. The continuation sentences did not change. Thus (70a) became: *Every tree was climbed by a kid. The kid was full of energy.* The same design and procedure were employed. The results yielded a slight preference for wide scope on the subject in the ambiguous conditions, significant by participants but not by items. Overall, the compatibility judgements for the ambiguous passive items were in the 50-70% range, compared to 20-80% for the ambiguous active items in Experiment 1. The compatibility rate for the unambiguous items was comparable for the two experiments (75-95%).

In addition to the factors already discussed, K&MacD also manipulated the type of verb in the quantified sentence. The verb was either an action verb like *climb* (where the subject receives an agent thematic role) or a perception verb like *see* (where the subject receives an experiencer thematic role). For both verb-types the object is assigned a theme role. This manipulation was included in order to test the Thematic Hierarchy Principle. It predicted that stronger scope preference should be found with action verbs than with perception verbs, since the thematic roles of the QPs in action-verb sentences were farther apart on the hierarchy. There were some effects of verb type (action/perception) in both actives and passives which suggested that the Thematic Hierarchy Principle was playing a role in determining the preferred scoping.

From the combined results of these two experiments, Kurtzman & MacDonald concluded that more than one principle is involved in determining quantifier scope. At least one principle which favors forward scoping in both actives and passives (such as the Linear Order or C-command Principle) is needed, as well as at least one which favors forward scoping in actives but inverse scoping in passives (such as Thematic Hierarchy Principle, which also can account for verb-type effects). K&MacD suggested that the two scope interpretations of a quantified sentence are initially considered in parallel. When the scope principles converge on a particular scoping, as in actives, that scoping is strongly preferred. When two principles are in conflict, as in passives, one scoping is chosen at random, so that there is no consistent preference for one
K&MacD ran two other experiments, employing sentences containing complex NPs in which one quantified phrase was contained within another (such as, *George has every photograph of an admiral*). The review of these experiments is postponed until Chapter 5.

**Single Reference and Discourse Subordination**. Kurtzman & MacDonald’s Experiment 1 finding that a subject *a*-phrase seems to have a stronger preference for wide scope than a subject *every*-phrase deserves some discussion. To handle this result they formulated the Single Reference Principle, which says that “when an *a*-phrase in the surface subject or topic of a sentence is received it is immediately interpreted as referring to just a single entity” (p.257; see also J. D. Fodor, 1982). They argued that this principle is plausible “because single reference is easier to represent than multiple reference and because single reference is always possible and often obligatory.” (p.257) They noted that in (71a/b) (repeated from (70)) it is only at the point where the object *every tree* is encountered that it makes sense to consider the possibility that the subject *a kid* may have multiple reference. But by that time the processor, guided by the Single Reference Principle, has already adopted a single reference interpretation of *a kid* and switching to representing multiple reference would be complex and difficult. As a consequence, the preference for wide scope on *a kid* in (71a/b) is strong.

(71) a/b. A kid climbed every tree.
   a. The kid was full of energy.
   b. The kids were full of energy.

   c/d. Every kid climbed a tree.
   c. The tree was full of apples.
   d. The trees were full of apples.

On the other hand, when the processor reaches the object *a tree* in (71c/d) it has a choice of

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13While there is a difference between actives and passives in K&MacD’s study which should be accounted for, recall that Catlin & Micham (1975) and Gillen (1991, Experiment 6) did not find such a contrast, suggesting caution.
interpreting it as referring either to a single entity or to multiple entities without having to undo any of the previously established representation. Hence, although subject phrases in general prefer wide scope, this preference is not as strong in (71c/d) as it is in (71a/b) since in (71c/d) other factors can override it without much cost.

A number of criticisms can be raised in regard to the Single Reference Principle. First, from a processing point of view, if the reasoning behind it is sound, the Single Reference Principle ought to fall out of more general processing considerations, such as some form of an Immediate Interpretation Principle.

Second, in an approach to processing which is informed by linguistic theory, one which posits semantic and discourse-based levels of representation, the issue of switching from single to multiple reference does not arise. For example, in Discourse Representation Theory (DRT) (see Kamp 1981; Heim 1982) it is not more complicated to represent multiple reference than it is to represent single reference for a sentence like Every kid climbed a tree. To be more precise, multiple reference is simply not represented in this case. On the reading in which every kid has scope over a tree it is possible that there is are different trees for different kids but it is not required, so only a single variable is set up for a tree. As a later step, at a higher, non-linguistic, level, there may be inferencing to a group of trees, but this is not represented in the discourse structure and is unlikely to effect the cost of linguistic analysis. (Subsequent sentences may require that the group be represented, but in that case any cost is associated with the sentence which requires it, not with the original sentence.) In other words, single reference is the only possible representation for an a-phrase, no matter what its position.

This reasoning undermines the Single Reference Principle and Kurtzman & MacDonald’s account of the finding that in subject position an a-phrase prefers wide scope more than an every-phrase does. As mentioned above, this finding arise from the inverse scope continuation having a lower acceptance rate in the a-every order (plural; about 23%) than in the every-a order (singular). Rather than take the acceptance of the singular continuation in the every-a order as
evidence for the $a>every$ scoping, as K&MacD do, I would like to suggest that it could be evidence for the $every>a$ scoping.

First, as just noted, semantically the singular continuation is not necessarily compatible only with a wide-scope indefinite reading. $Every$ could be given wide scope in (71c/d) but it could turn out that it was the same tree for each kid (despite the fact that multiple trees would also be allowed). Kurtzman & MacDonald acknowledged this point, but claimed that to achieve the same-tree reading the indefinite must receive a specific interpretation (e.g. reference to a particular tree). They argued that a specific reading would be extra work for the processor, involving the inclusion of a specificity marker in the representation, so it is unlikely to be employed. However, the assumption that the indefinite must be specific is not supported. The $every>a$ scoping allows the indefinite to be associated with a single entity when it is interpreted existentially/weakly as well, as paraphrased below:

(72)  *For every kid, there was a tree that that kid climbed. (It turned out that) it was the same tree that all the kinds climbed.*

Second, continuation (71c) also makes sense when it is given the interpretation in (73). This interpretation is only available when $every$ is given wide scope.

(73)  *In each case the tree that was climbed was full of apples.*

This reading is obtained through a semantic process called ‘discourse subordination’ (Kadmon 1987; Roberts 1987b) by which the second sentence (S2) is construed as part of the first sentence (S1) rather than as independent. A result of this construal is that the variable which is set up in the discourse structure for *a tree* in S1 can be picked up anaphorically by *the tree* in S2. What is said about *the tree* in S2 is then applied to that variable. In this particular case, *was full of apples* falls under the scope of *every* in the discourse structure just as *a tree* does. Anything which is a tree and which was climbed by a kid must also be full of apples. (Without discourse subordination, each sentence would be independent in the discourse representation, and *a tree* would be too embedded in the representation of S1 to be picked up by *the tree* in S2.)
Many noted examples of discourse subordination contain modals such as could, would, might ('modal subordination,' Roberts 1987b): There might be a thunderstorm. It probably would destroy our peas. In this instance, would in S2 must be interpreted under S1, as if the sentence read: If there were a thunderstorm, it would probably destroy our peas. Kadmon (1987:190) notes that the subordination process is often “triggered by the need to find an antecedent for an anaphoric element in [S2], and licensed by plausible narrative continuity between [S1] and [S2], and by a match in mood and reference time between them.” Given these restrictions, it is unclear how common a semantic phenomenon discourse subordination is.

Similar to (71c), there is a subordinated reading available for the continuation in (71a) when every is given wide scope in the initial sentence:

(74) A kid climbed every tree. In each case the kid in question was full of energy.

Discourse subordination is more difficult here, where the anaphora is back to the subject variable, than in (73), where the anaphora is to the object. Sells (1985) suggests that in general subordination is easier with objects because it is usually the object DP which is the phrase which anaphora is expected to pick up. Another possible reason for the difficulty here is that subordination requires the dispreferred scoping for S1, with wide scope on every.

Once the fact that the every kid > a tree scoping does not require multiple trees is acknowledged and/or the possibility of discourse subordination is admitted, we have an alternative account of the finding that the so-called inverse-scope continuation is accepted more often in the every-a order than it is in the a-every order (i.e. why (c) is accepted more often than (b)). Now, we must consider the Yes responses for (c) to be a combination of two things: first, cases where the reader gave a tree wide scope, and second, cases where the reader gave every kid wide scope and assigned the same tree to each kid or subordinated the continuation. This brings the Yes responses up overall. There is no corresponding way for (b) to be considered acceptable more of the time.14

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14Ted Gibson (p.c) notes that the plural continuation (b) is compatible with the a>every scoping in (a/b) if one assumes there are other kids around who didn’t climb trees. Such an
2.5.2.9 Summary of Experimental Results on Scope Preferences

The results of the experiments reviewed above support the notion that individual quantifiers have an effect on scope preferences. Exactly why certain quantifiers seem to want wide scope more than others and how this interacts with other factors has yet to be determined. Evidence for the role of linear order, c-command, and grammatical function or thematic role in resolving scope ambiguities is mixed. VanLehn, Fodor, Gillen, and Kurtzman & MacDonald argued that linear order of the QPs and/or c-command relation between them are critical factors. K&MacD felt that the thematic roles of the QPs (which are related in part to their grammatical functions) is a determinant as well. On the other hand, Ioup, Catlin & Micham, and Micham et al. maintained that the grammatical functions of the QPs (at deep and/or surface structure) is more important than linear order and/or c-command. Why any of these factors should matter was often not addressed.

As for the studies themselves, a few comments are in order. First, in Ioup’s, VanLehn’s, and Gil’s gathering of intuitive judgements, the number of informants and items used is unknown. This fact makes it hard to judge the generality of their results. Second, because the tasks used by Catlin & Micham and Micham et al. (and by Gillen in some of her experiments) invited the participants to reason about the quantified sentences, it is unclear whether their findings will extend to cover how people deal with scope ambiguities when they are simply reading. Although K&MacD’s method was the much closer to a normal reading task, it still involved a judgement component, which they themselves note may have induced participants to resolve the scope ambiguities earlier than usual.

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assumption is likely only in certain contexts, such as where a group of kids went to a park. Furthermore, the same observation can be made with respect to continuation (d) in (c/d), so this idea does not increase the relative acceptability of (b) vs. (d).
2.6 Research Aims

In this chapter I have reviewed some semantic properties of quantifiers, including weak vs. strong interpretations and the tripartite structure that quantifiers enter into in the discourse/semantic representation. I have described the notion of relative scope of two quantifier phrases, the meanings associated with various scopings, the way in which different relative scopings are obtained in the syntax, and the idea that some scopings are costly to obtain. In addition, I have surveyed the studies which have been conducted in psychology and psycholinguistics on the processing of quantifiers and quantifier scope.

How the processor arrives at a particular scoping has not been specified in detail in previous work on scope preferences. In the psycholinguistic literature, the building of an LF representation for scope has generally not been considered. Yet the relative scoping of two QPs is defined at the level of LF, so this issue is critical. In the following chapter, I will argue that the general process for constructing LF representations is the primary factor in determining the preferred scoping of a doubly-quantified sentence. The observation that c-command often plays a strong role in determining scope preferences will fall out of this theory.

In later chapters, I will consider the influence of particular quantifiers in resolving scope ambiguities. I will show that *each* wants wide scope more than *every*, but only under certain circumstances. The differences with respect to scope between *each* and *every* will be traced to differences in the semantic conditions which are part of their meaning.
One of the major questions being investigated in this dissertation is how the processor assigns scope to a quantifier. I am especially concerned with cases of ambiguity, where the relative scoping of two quantifiers needs to be determined. In this chapter I will lay the experimental groundwork for the dissertation, establishing the basic principle which governs quantifier scope preferences and the primary factors which influence those preferences (e.g. surface position in the syntax, semantic type of quantifier, thematic role). In future chapters I will investigate the role of secondary factors, particularly the lexical biases of quantifiers.

The focus of the current investigation will be dative sentences which have two quantified phrases within the VP, one as the direct object (DO) and one as the indirect object (IO; the object of the preposition to), as in (1):

(1) a. Kelly showed a photo to every critic last night.
    b. Kelly showed every photo to a critic last night.

I have chosen such examples because little research has yet been done on scope preferences in this construction and because the various hypotheses that I consider make quite different predictions about which scoping should be preferred here.

The following section presents an economy-based hypothesis about how the processing of quantifier scope proceeds in sentences like (1). Section 3.2 reports on the experiment designed to test that hypothesis against the theory of Kurtzman & MacDonald (1993). Section 3.3. examines scope preferences in sentences other than datives. Section 3.4 summarizes the findings and outlines the questions that will be addressed in the remainder of the dissertation.
3.1 The Principle of Scope Interpretation

The relative scoping of two quantifiers is determined by the c-command relation between them at LF. Since both grammatical constraints and processing principles determine what LF-structure gets built, scope assignment is governed by both grammatical and processing considerations. The theory of scope preferences that I develop here draws on both of these areas. To begin, I lay out my syntactic and psycholinguistic assumptions.

3.1.1 Background Assumptions

I assume, following Diesing (1992), that the mapping from LF to a tripartite semantic representation is governed by a tree-splitting procedure (the Mapping Hypothesis), which divides the syntactic tree into two parts: the material contained inside the VP, which gets mapped into the nuclear scope, and the material in the rest of the tree, which gets mapped into a restrictor clause. QPs headed by strong quantifiers, such as every and most, which only have strong/ presuppositional/quantificational readings (where they function as operators), must be external to VP at LF, since they need to have a restrictor clause for interpretation and cannot form one from within VP.

The syntax I adopt is essentially that of Runner (1995), who argues that direct objects, as well as subjects, have moved out of VP at S-structure in English to the specifier position of an agreement phrase. (Diesing does not assume that English objects move at S-structure.) The verb adjoins to the head of a functional projection FP which intervenes between AGRsP and AGRoP:

(2) S-structure of simple subject-object sentence

\[
[AGRsP \textit{Every girl} \{FP \textit{kicked} \{AGRoP \textit{a ball} \{DO \{VP tS t_v tDO \} \} \} \} ]
\]

PP complements, such as the to-phrase in a dative sentence remain in the VP at S-structure. For example, the S-structure of (1a) is as in (3):

(3) S-structure of (1a)

\[
[AGRsP \textit{Kelly} \{FP \textit{showed} \{AGRoP \textit{a photo} \{DO \{VP tS t_v tDO \} \{PP \textit{to} \{every critic} \} \} \} ]
\]
The critical aspect of this structure is that the direct object (a photo) asymmetrically c-commands the indirect object (every critic).

In terms of syntactic processing, I assume that the processor builds a single S-structure for each input string and computes a single LF representation from this. The construction of a representation for a sentence occurs on line, word-by-word or phrase-by-phrase. The parser adds each word to the larger structure as it is encountered. In doing so it must obey both grammatical and parsing principles.

The LF representation is taken to be the same as the S-structure by default. A separate LF tree (or portion thereof) is only constructed when needed. In building LF structure, the processor follows the processing economy principle in (4):

(4) **General Processing Economy**

The processor does not do any more at LF than is required by the grammar, unless the extra structure building, movement, etc. is motivated in some way.

When movement is required, economy still plays a role: the shortest possible movement that satisfies grammatical requirements is used, since shorter movements require less structure building (e.g. require fewer chain links or intermediate traces).

The LF representation is interpreted into a semantic and discourse structure, which includes the construction of tripartite representations. Interpretation of each word or phrase proceeds rapidly.

### 3.1.2 Scope Interpretation

I propose that the initial scope assignment in a multiply-quantified sentence is determined by

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1Since I am not concerned with S-structure ambiguities, the assumption that only a single surface representation is built is not a critical one. For multiply-quantified sentences, it is the LF structure which is significant. There is a different LF representation for each scoping. An alternative to the model where only a single LF is constructed, following General Processing Economy, would be a ranked-parallel system in which multiple LFs are built, with Processing Economy determining the ranking. An LF with no unrequired or unmotivated operations would be ranked highest, one with a single unmotivated movement would be ranked next, etc. The two approaches make the same predictions for the cases I will be considering in this chapter. The parallel processing question will be revisited in §3.4.
the Principle of Scope Interpretation (PSI), stated below. The PSI follows directly from Processing Economy in (4).

(5) **Principle of Scope Interpretation (PSI)**

The default relative scoping in a multiply quantified sentence is computed from the required LF-structure of that sentence, where the required LF is determined by required grammatical operations acting on the S-structure. The default scoping is the preferred scoping unless there is evidence to go beyond it.

Since required syntactic operations (generally) do not change the c-command relations of QPs, the descriptive C-command Principle, which states that the preferred scoping corresponds to the scoping determined by surface c-command relations (Huang 1982; Reinhart 1983; and others), is a corollary of the PSI. Pica & Snyder (1995) made a similar observation with respect to their theory of scope preferences.

Quantifier Raising (QR), which moves a QP up in the tree and adjoins it to a higher projection, is one operation that applies at LF. Following (4), I assume that it applies only when necessary. For subject and direct object QPs containing strong quantifiers, QR is not required syntactically. These QPs can take scope from their surface positions in [Spec,AGRsP] and [Spec,AGRoP]. The preferred scoping in a simple subject-object sentence like (2) is therefore subject over object:

(6) LF of (2) (= S-structure)

\[
\begin{align*}
\text{AGRsP} & \quad \text{Every girl} \quad \text{FP} \quad \text{kicked} \\
\text{AGRoP} & \quad \text{a ball} \quad \text{DO} \\
\text{VP} & \quad \text{t} \quad \text{S} \quad \text{t} \quad \text{v} \quad \text{tDO} \quad \text{PP} \quad \text{to} \\
\text{preferred scope: every > a}
\end{align*}
\]

This scoping is called the ‘forward’ scoping because the first quantifier encountered receives wide scope. In the reverse, or ‘inverse,’ scoping the second quantifier would have wide scope.

In contrast to subject-object cases, QR is needed for strong QPs which remained inside the VP at S-structure, such as the indirect object (IO) in a dative sentence like (1a). The surface structure for such a sentence is given in (7a), repeated from (3), and the LF is shown in (7b).

(7) a. S-structure of (1a)

\[
\begin{align*}
\text{AGRsP} & \quad \text{Kelly} \quad \text{FP} \quad \text{showed} \\
\text{AGRoP} & \quad \text{a photo} \quad \text{DO} \\
\text{VP} & \quad \text{t} \quad \text{S} \quad \text{t} \quad \text{v} \quad \text{tDO} \quad \text{PP} \quad \text{to} \\
\text{every} & \quad \text{critic} \quad \text{IO} \quad \text{IIIIII} \quad \text{IIIIII}
\end{align*}
\]
b. LF of (1a)

\[
[_{AGRSP} \text{Kelly}_S [_{FP \text{ showed}} [_{AGR0P} \text{a photo}_D O [_{VP \text{ every critic}_I O} [_{VP \text{ t}_S t_v t_D O [_{PP \text{ to } t_{IO}}]]]]]]]
\]

The movement of *every critic* in (b) is required by the grammar because, as mentioned above, strong quantifiers cannot be interpreted within the VP. I assume that QR in this case adjoins the QP to VP—the shortest possible movement that satisfies its grammatical requirements.\(^2\) Critically, note that adjoining to VP will not change the c-command relation between the direct object and IO. The direct object (*a photo*) still c-commands the indirect object (*every critic*), as it did at S-structure.

In contrast to (1a), QR is not necessarily needed for (1b), since the strong quantifier phrase *every photo* is already outside the VP at S-structure. The S-structure and LF for (1b) are identical:

\[(8) \text{ S-structure and LF of (1b)}\]

\[
[_{AGRSP} \text{Kelly}_S [_{FP \text{ showed}} [_{AGR0P} \text{every photo}_D O [_{VP \text{ a critic}_I O} [_{VP \text{ t}_S t_v t_D O [_{PP \text{ to } a \text{ critic}}]]]]]]]
\]

A note should be made about the interpretation of *a critic* in this structure. Recall that in Diesing’s system an indefinite can have two readings: a weak/existential reading, which arises when the indefinite is within the VP at LF, or a strong/quantificational/presuppositional reading, which arises when the indefinite is outside the VP at LF. If *a critic* in (1a) is interpreted as weak, then the LF in (8) is appropriate. If, on the other hand, it is interpreted as strong, then QR must apply, yielding the LF in (9) (cf. (7b)):

\[(9) \text{ LF of (1b)}\]

\[
[_{AGRSP} \text{Kelly}_S [_{FP \text{ showed}} [_{AGR0P} \text{every photo}_D O [_{VP \text{ a critic}_I O} [_{VP \text{ a critic}_I O} [_{VP \text{ t}_S t_v t_D O [_{PP \text{ to } a \text{ critic}}]]]]]]]
\]

Whether *a critic* gets a weak or strong reading does not affect the c-command relation between the QPs. *Every photo* c-commands *a critic* in both (8) and (9). Since (9) requires QR at LF while (8) does not, I will assume on economy grounds that (8)—which leads to the indirect object

\[^2\text{While Diesing generally assumes that strong quantifiers adjoin to IP, she notes (p. 77) that adjunction to VP is possible, and sometimes necessary, and that a phrase adjoined to VP is not inside VP, in the formal sense of ‘inclusion’ defined in May (1985) and Chomsky (1986), so will be mapped into a restrictor clause of the tripartite structure and not the nuclear scope.}\]
Thus, in both quantifier-orders in (1), *a-every* and *every-a*, the direct object c-commands the indirect object in the required LF. According to the PSI, the preferred scoping in doubly-quantified dative sentences like (1) is thus predicted to be the forward scoping of DO > IO. This prediction was tested in Experiment 1, which we will turn to shortly.

As of yet, there has been no mention of what might induce the processor to go beyond the default scoping. Motives include: (i) the default scoping being implausible, (ii) the non-default scoping being clearly intended by the context, and (iii) the non-default scoping satisfying the lexical conditions on the quantifiers involved in the scope relation. The last of these is the central topic of Chapter 5, where the differences in the scope behavior of the quantifiers *each* and *every* are investigated. For the present, I will work with sentences in which none of these factors plays a (strong) role; sentences, in other words, where the default scoping, as determined by the Principle of Scope Interpretation, remains the preferred scoping.

### 3.1.3 Existential Direct Objects

Above I assumed that the preferred reading of indefinite indirect objects is existential/weak, on economy grounds. Suppose there is also a preference to interpret indefinite direct objects as existential. Such a preference could be related to a general strategy of taking material earlier in a sentence to be given and material later in a sentence to be new. Indefinite direct objects (as well as indirect objects) would be taken to be existential because they come late enough to be counted.

---

I would state that the preferred scoping in (8) is of the strong QP *every photo* over the existential indefinite *a critic*. Note, however, that existential indefinites do not themselves have scope. Their quantificational force comes from the existential closure operator. The tripartite semantic representation of (8) given in (i) makes this clearer (the subject and verb have been left out for simplicity):

(i) *Kelly showed …*  
\[
\text{[every}_x \text{ photo (x)} \quad [\exists_y [ x \text{ to a critic (y) } ]] \\
\text{Operator Restriction Nuclear Scope}
\]

In other words, *every* is really in a scope relation with the existential closure operator \(\exists\) here, not with the indefinite. For ease of discussion, though, in the sections that follow I will continue to refer to the relative scoping of strong QPs and indefinites without mentioning the existential closure operator.
as new. Indefinite subjects, on the other hand, would be counted as given and thus would be preferentially interpreted as strong/quantificational/presuppositional. If this hypothesis were added to the proposal of how scope interpretation proceeds which was laid out in the previous section, how would the scope-preference predictions be affected?

For indefinites to be interpreted existentially, they must be within VP at LF. One way to achieve this with direct objects is to lower them at LF from their S-structure position in [Spec,AGRoP] back into their base position. The second way is to have existential direct objects never leave their base position and to satisfy their Case requirements within VP (cf. de Hoop 1992). Strong/quantificational DOs would still raise to [Spec,AGRoP] at S-structure. Under the latter method, the surface position of an indefinite DO reflects its interpretation, and no movement is necessary for existential DOs. For simplicity, I adopt this second approach.

With these assumptions, the hypothesis that direct objects are preferentially interpreted as existential can be stated as follows:

(10)  **Existential Direct Objects Hypothesis (EDOH)**

The processor preferentially places indefinite direct objects in their base position in the S-structure representation, where they are interpreted existentially/weakly.

Adopting the EDOH does not change the predicted scope preferences for subject-object sentences. The subject with c-command the object whether the object raises to [Spec,AGRoP] or remains in VP, so the default scoping is subject > object.

The predictions for scope preferences in (1), though, need to be reconsidered. Under the EDOH, the S-structure of (1a) is as in (11a) rather than as in (7), since the indefinite direct object a photo does not raise out of VP. Given this S-structure, the Principle of Scope Interpretation predicts that the preferred scoping in (1a) should be every critic > a photo—contrary to what was predicted without the EDOH. As before, the strong QP every critic must raise and adjoin to VP at LF. But now, because the indefinite remains in VP, the [Spec,AGRoP] position is not occupied and the every-phrase is higher in the tree. The default scoping from the required LF in (11b) is therefore the inverse scoping, where every critic has wide scope.
(11) a. alternative S-structure of (1a)

\[
\text{[AGRsP}_{Kelly} [\text{FP showed } AGRoP_{\text{every critic}} \text{VP } t_s t_v \text{ a photo}_{DO} \text{PP to } t_{IO} ]]}
\]

b. alternative LF of (1a)

\[
\text{[AGRsP}_{Kelly} [\text{FP showed } AGRoP_{\text{every critic}} \text{VP } t_s t_v \text{ a photo}_{DO} \text{PP to } t_{IO} ]]}
\]

In contrast to (1a), the S-structure and LF for (1b) are not affected by the addition of the EDOH. They remain as given in (8) above. Hence, with the EDOH the *every*-phrase moves out of VP at or before LF in both (1a) and (b) while the *a*-phrase does not. The preferred scoping in (1) is therefore predicted to be wide scope on the *every*-phrase no matter what the order of the quantifier phrases is at S-structure. There should be a preference for inverse scoping in (1a) and forward scoping in (b). These predictions are tested in Experiment 1.

3.1.4 Predictions of Kurtzman & MacDonald (1993)

An alternative to the PSI is the theory of scope preferences offered by Kurtzman & MacDonald (1993) (K&MacD). Recall from the previous chapter that they presented an important set of computer-controlled studies of quantifier scope preferences. Their goal was to evaluate structural principles from the literature which were specifically designed to derive scope preferences. The major findings were a strong preference for forward scoping in active subject-object sentences, such as *A kid climbed every tree*, and a weak preference for forward scoping in passives (*Every tree was climbed by a kid*). In addition, there were some effects of verb type (action/perception; e.g. *climb* vs. *see*) in both actives and passives.

To account for this pattern, K&MacD proposed that there are a number of scope principles which work together to determine scope preferences and that the scope principles are like other probabilistic constraints that influence ambiguity resolution (MacDonald 1994). Alternative scope interpretations are initially considered in parallel. The interpretation which is most consistent with the scope principles is built; this is the preferred scoping. If two principles are in opposition, one scoping is chosen at random; so neither scoping is preferred. For their results, at least one
principle which favors forward scoping in both actives and passives (such as the Linear Order Principle or C-command Principle) is needed, and at least one principle which favors forward scoping in actives but inverse scoping in passives (such as Thematic Hierarchy Principle, which also can account for verb-type effects) is needed. In actives, these principles all converge on a preference for forward scoping. In passives, the principles conflict, so that there is no strong scope preference.

The various scope principles that K&MacD entertained make conflicting predictions about which scoping of the quantifiers is preferred in the dative cases in (1). Because they all relate only to subjects and/or topics, the Surface Subject, External Argument, Topic, and Single Reference Principles do not apply. The Linear Order and C-command Principles predict a preference for wide scope on the direct object: *a photo* in (a) and *every photo* in (b). The Thematic Hierarchy Principle predicts the opposite, favoring wide scope on the indirect object, since the θ-hierarchy puts recipient (*critic*) above theme (*photo*). Thus, following the reasoning they use in their own second experiment on passives, K&MacD would predict that neither scoping is particularly favored in datives.

### 3.1.5 Summary

K&MacD’s approach and the Principle of Scope Interpretation yield different predictions as to which scoping should be preferred in dative sentences where both the direct and indirect objects are quantified. Moreover, the predictions of the PSI are affected by whether the Existential Direct Objects Hypothesis is adopted or not, since the EDOH determines the position of indefinite DOs in the required LF representation.

There has been very little previous experimental work on scope preferences in datives. Ioup (1975) and VanLehn (1978) report informant data on a few relevant examples, but their results do not agree. Both Micham et al. (1980) and Gillen (1991), who ran more-controlled experiments than Ioup and VanLehn, included some dative sentences with quantified DOs and IOs in their studies, but it is impossible to draw general conclusions from their data about preferred scoping.
in these structures. Gillen did not run both quantifier orders, and Micham et al. did not present the dative results separately from the results for the other construction they used.

Hence, in order to determine which, if any, of the predictions laid out above were correct, I carried out a scope preference study on dative sentences.

### 3.2 Experiment 1 – Scope Preferences in Dative Sentences

The experiment was conducted using word-by-word self-paced reading along with a stops-making-sense judgement task. Participants read the items at their own pace and were able to indicate if/when an item no longer made sense to them. Self-paced reading was employed in order to get closer to normal reading and comprehension than previous experiments on scope preferences, which have used a wide variety of techniques. The stops-making-sense component was included so that it would be easier to compare the results to those from K&MacD’s series of studies, which also included a judgement task.

#### 3.2.1 Method

**Materials and Design.** The design was based on that used by K&MacD. Each item consisted of a quantified dative sentence (S1) followed by a continuation sentence (S2) intended to be consistent only with one reading of S1, as indicated:

\[
\begin{align*}
(12) & \quad a/b. \quad \text{Kelly showed a photo to every critic last month.} \\
& \quad \text{a. The photo was of a run-down building.} & \quad \text{forward scope: } a > \text{every} \\
& \quad \text{b. The photos were of a run-down building.} & \quad \text{inverse scope: } \text{every} > a \\
& \quad c/d. \quad \text{Kelly showed every photo to a critic last month.} \\
& \quad \text{c. The critic was from a major gallery.} & \quad \text{inverse scope: } a > \text{every} \\
& \quad \text{d. The critics were from a major gallery.} & \quad \text{forward scope: } \text{every} > a
\end{align*}
\]

When *every* has wide scope in (a/b), the photo in question can vary with each critic
considered. So there can be more than one relevant photo in the discourse model and a plural continuation makes sense.\(^4\) When \textit{a} has wide scope, it is the same photo that is shown to every critic. There is only one relevant photo in the model, and hence a singular continuation is appropriate. Parallel reasoning applies in (c/d). If the relative scope of the quantifiers has been determined by the time the subject noun and verb in S2 are read, then there will be slower reading times on those words when the assigned scoping does not mesh with the number marking. In addition, participants may indicate that the item has stopped making sense at or after the subject noun or verb in S2 when the number marking is inconsistent with the scoping which was assigned.

Summarizing the predictions laid out above for scope preferences in dative sentences like (12), the Principle of Scope Interpretation predicts that forward scoping should be preferred in (a/b) and (c/d), since in the required LF-structure of the sentence the direct object (\textit{photo}) c-commands the indirect object (\textit{critic}). \textit{A} should get wide scope in (a/b), favoring the singular continuation (i.e. the singular continuation should be read faster), and \textit{every} should get wide scope in (c/d), favoring the plural continuation. In terms of reading times, continuation (a) should be faster than (b), and continuation (d) should be read faster than (c). In contrast, the PSI combined with Existential Direct Objects Hypothesis predicts a preference for wide-scope \textit{every} in both (a/b) and (c/d), so the plural continuations should always be read faster: \textit{a}>\textit{b} and \textit{c}>\textit{d}. Lastly, according to K&MacD’s constraint-based approach both continuations should be equally good (\textit{a}=\textit{b} and \textit{c}=\textit{d}), since the scope principles are in conflict. The Linear Order and C-command Principles predict forward scoping in both (a/b) and (c/d), but the Thematic Hierarchy Principle predicts inverse scoping.

One important caveat needs to be raised here. As was pointed out in the discussion of K&MacD’s studies in Chapter 2, there are various ways in which a singular continuation may be compatible with the \textit{every}>\textit{a} scoping. First, it could be understood with a discourse subordinated

\(^4\)There may also be additional photos in the model which are not relevant for the current sentence, having been excluded by a contextual restriction earlier in the discourse.
reading, as in *In each case, the critic was from a major gallery*. Since discourse subordination occurs only under particular discourse conditions, however, it is doubtful that it would be employed in this experiment (see §2.5.2.8 for discussion). A second consideration is that semantically all that the *every photo > a critic* scoping means is that it is possible that there is a different critic for each photo; it does not require it. In other words, giving *every* wide scope in (c/d) is consistent with there being one or more critics. Given this, a preference for the *every>a* scoping may be indicated by the plural and singular continuations being read equally fast. We will return to this point in the Discussion section.

Twenty sentence pairs like those in (12) were constructed (see Appendix B for a complete list). The items were counterbalanced so that each participant saw each item in only one condition. Controls and fillers included items in which the noun picked up in S2 was a noun from an *every*-phrase (since in the experimental items it was always the noun in the indefinite phrase which was repeated), items without quantifiers where the continuation sentence referred to participants (some singular, some plural) that had antecedents in S1 (so that it was not only in the experimental items that S1 and S2 were related in this way), items which contained pronominal anaphora, and unrelated items of various types, some of which consisted of only single sentences. Of the 85 fillers, 22 were intended to stop making sense at some point, including examples like the following:

(13) a. *The girl stared the whole group because she was interested in the new boy.*

b. *The small sailboat sank in the yesterday cove. Everyone on board swam to shore safely.*

c. *The monkey that is losing hair swung all day long from tallest the tree.*

d. *The boy practiced this morning that Luke coaches.*

None of these “no sense” items contained quantifiers. In all, a total of 105 sentences or sentence pairs was presented.

Procedure. Each pair of sentences was presented on a computer screen using a self-paced (participant-paced) word-by-word stops-making-sense reading task. A moving-window display was employed (Just et al. 1982), such that every word appeared in its spatially correct position.
Each trial began with a series of dashes (-) marking the length and position of the words in the sentences, printed approximately a third of the way down the screen. The participant would then press the space bar to bring up the first word. When the button was pressed again, the second word appeared and the first was replaced by dashes, and so on. Participants had the ability to stop presentation of the sentence at any point where it stopped making sense to them, by pressing a different key than the one used to bring up the next word. After a “stop-judgement,” the current item terminated (without presentation of the remaining words) and a new item began. The amount of time the participant spent reading each word was recorded, as was the speed and position of a stop-judgement, if there was one. Simple true/false comprehension questions followed one-third of the items (as long as the sentence had not been terminated early), to make sure that the participant was indeed reading and comprehending the material. Of the items which were intended to elicit a stop-judgement, only the more subtle ones like (13d) were ever followed by questions.

In the presentation of the sentences, care was taken that a critical word or phrase did not appear at the right edge, where new-line effects could lengthen reading times. Approximately one third of all the sentences stopped making sense before the end of S2. The items were randomized separately for each participant. Before the main experiment, a short list of practice items was presented in order to familiarize the participant with the task. Each session with a participant averaged 30-45 minutes.

Participants. The study population consisted of undergraduate students from introductory linguistics at the University of Massachusetts in Amherst. They were given class credit for their participation. Twenty-six participants were tested. The participants were native speakers of

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I attempted to increase the number of participants in the experiment by running a group of introductory psychology students. However, the data from these participants alone revealed no significant effects. We have found in the past that participants run at the end of the semester, as these were, are often unmotivated to do well in an experiment, yielding poor data. For these reasons, the data from the second group of participants is not included in the analysis below. When ANOVAs were performed on all data with Group as a factor, all of the significant effects reported below remained significant. In addition, there were reliable effects of and interactions with Group.
English and naive as to the purposes of the study.

3.2.2 Results

For the purposes of analysis the items were divided into regions as indicated by vertical bars in (14).

(14)  Kelly showed | a photo | to every critic | last month. | The photo(s) was/were | of a run-down | building.

Only data from sentences which were judged to make sense in their entirety were analyzed. In addition, the data from three participants has been eliminated completely. One participant rejected every item in one of the conditions, another rejected all but one item in one condition, and the third answered less than 65% of the comprehension questions for the target correctly. The remaining data were trimmed to within 3 standard deviations of the mean for each word. Times above the cutoff (= 2% of data points) were ignored.

The mean residual (length-adjusted) reading times for each analysis region are shown in Figure 3.1 (pg. 67). See Appendix A for a table of raw and residual reading times and raw time analyses.

In the critical 3-word region consisting of the subject DP and following auxiliary or verb in S2, a two factor ANOVA yielded a main effect of Q-order (-47.11 a-every vs. -83.82 every-a), $F_1(1,22) = 10.57, p = .004; F_2(1,19) = 6.17, p = .023$; and a marginal effect of Number in the analysis by participants (-58.28 plural vs. -72.66 singular), $F_1(1,22) = 3.25, p = .085; F_2(1,19) = 3.0, p = .102$. The Q*N interaction was also significant, $F_1(1,22) = 9.61, p = .005; F_2(1,19) = 9.74, p = .006$. Means comparisons indicated that, as predicted by the PSI, the effect of Number in the a-every conditions was reliable (a<b), $F_1(1,22) = 12.54, p = .002; F_2(1,19) = 11.32, p = .003$. On the other hand, as expected under K&MacD’s account but not under the PSI, there was no true difference between the every-a conditions (c) and (d), $F_1(1,22) = 2.25, p > .14; F_2(1,19) < 1.$
In region 6, the three words following the critical region, the effect of Q-order was marginal by participants, with every-a continuing to be faster (-64.84 a-every vs. -82.93 every-a), $F_1(1,22) = 3.58, p = .072$ (the items analysis could not be performed due to unequal N). In the final region of the continuation sentence there were no significant effects.

Region analyses were also conducted for S1. Except for an effect of Q-order in the subject region, $F_1(1,22) = 6.64, p = .017$; $F_2(1,19) = 6.88, p = .017$, before any differences were present and thus presumably due to an accidental effect brought on by the task, all effects were thoroughly non-significant. That there were no reliable differences in reading times across conditions in S1 is a new and informative result; Kurtzman & MacDonald (1993) did not report reading times in their article. This finding suggests that there are no robust on-line effects of reading different quantifier-orders in multiply-quantified sentences, either at the quantified phrase or a few words downstream.
Residual reading times (deviations from predicted scores) have been presented here in order to factor out the effects of length as best as possible. While this technique is not perfect, it is better than using either raw scores or the msec./character correction (Trueswell, Tanenhaus, & Garnsey 1994, App. B). Although residual scores are adjusted for length, I would like to argue further that the effects detected at the critical region in S2 are not due to the length confound in that region (the plural continuation was on average one character longer than the singular). While in principle it is possible to account for the main effect of Number based on length differences, since plurals did take longer to read than singulars, the main effect of Q-order does not fall out of such an analysis. Furthermore, the fact that there is a Q*N interaction argues that the effect of Number is a true effect. If there were a length penalty for plurals, we would expect it to show up equally in both plural conditions. Instead, the data show that condition (b) was the worst cell.

One possible explanation for the Q-order effect in the critical region is that it is simply a lexical access effect, since different lexical items were used in the different quantifier-orders. Two points argue against such an analysis. First, this is the second time the word was seen (it occurred after a in S1) and thus lexical effects should be small. Second, the Q-order effect is reflected in the following region as well, where lexical effects are not likely to show up. In sum, there is good reason to believe that the effects observed at the critical region in S2 are true effects.

Table 3.1 (pg. 69) presents the number of stop-judgements which occurred at or after the critical subject noun in S2 (i.e. after the) for each condition. The figure in parentheses is the percentage of available trials that were rejected at or after this point (out of a total over all participants and items of between 105 and 113, depending on the condition, once early rejections have been factored out).
Table 3.1  Total Number and Percentage of Sentences
Rejected at or after the Subject Noun in S2 in Experiment 1

<table>
<thead>
<tr>
<th></th>
<th>singular</th>
<th>plural</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-every</td>
<td>(a) 9 (8%)</td>
<td>(b) 4 (4%)</td>
</tr>
<tr>
<td>every-a</td>
<td>(c) 7 (7%)</td>
<td>(d) 13 (12%)</td>
</tr>
</tbody>
</table>

As the table indicates, there were very few rejections for the dative sentences. A two factor
ANOVA yielded a significant interaction of Q-order and Number by participants, marginal by
items, $F_1(1,22) = 7.83$, $p = .010$; $F_2(1,19) = 3.68$, $p = .070$, reflecting the difference between (d) and
the other conditions. This difference may be due to the fact that in (c) and (d) there is a smaller
distance between the first and second instances of the noun critic than there is between the
instances of the noun photo in (a) and (b). In (d) vs. (c) this shorter distance may create a problem
since the two occurrences of the noun do not match in number marking. The greater number of
rejections in (d) may simply reflect the subject noticing this number mismatch.

For fillers which stopped making sense and for other subexperiments the percentage of stop-
judgements was much higher, indicating that the participants were indeed performing the stops-
making-sense task and not simply doing self-paced reading.

Twelve of the twenty target items were followed by simple comprehension questions. In all
conditions the percentage of questions answered correctly was at or above 90%. An ANOVA
performed on the error data indicated no significant effects (all Fs < 2). The overall
comprehension rate on questions was 93%.

3.2.3  Discussion

On the face of it, the outcome of Experiment 1 appears to fully support neither the Principle
of Scope Interpretation which I proposed nor Kurtzman & MacDonald’s (1993) combination of
principles. Only one prediction of each of these approaches was confirmed. The PSI predicted the
a<b finding (the singular continuation being read faster than the plural continuation in the a-
every order) and K&MacD predicted the c=d finding (the two continuations being read equally quickly in the every-a order). I will argue that the pattern of results is difficult to reconcile with K&MacD’s theory without making considerable changes to it, but that it is easily explained under the PSI once facts about the semantics of scope are incorporated into the theory. We will see, though, that the results of Experiment 1 provide no support for combining the Principle of Scope Interpretation with the Existential Direct Objects Hypothesis. This theory predicted a preference for wide-scope every, and therefore faster reading time on the plural continuations, in both quantifier-orders.

3.2.3.1 The Principle of Scope Interpretation and Vagueness

According to the PSI, it is the first quantifier in the quantified sentences in (15), repeated from (12), which should be given wide scope, since it c-commands the second quantifier in the required LF representation.

(15) a/b.  Kelly showed a photo to every critic last month.
         a. The photo was of a run-down building.
         b. The photos were of a run-down building.

c/d.  Kelly showed every photo to a critic last month.
       c. The critic was from a major gallery.
       d. The critics were from a major gallery.

This theory predicts that the singular continuation (a) should be read faster than the plural continuation (b) in the a-every quantifier-order. In the quantified sentence in (a/b), a photo is given scope over every critic. As a result, the processor commits to there being a single relevant photo in the model. The plural continuation (b) causes difficulty since it requires multiple relevant photos. As predicted by this reasoning, reading times for the critical region (subject + aux/verb) in S2 were found to be significantly slower in (b) than in (a).

In (c/d), the plural continuation (d) was expected to be favored, since it was assumed that when every is given wide scope over an indefinite DP there is more than one instantiation of that
indefinite in the model (here, more than one critic). Contrary to these expectations, there were no
differences between (c) and (d) at the critical region. Nevertheless, this finding makes sense if we
recall the point made earlier about the semantics of scope. The every photo > a critic scoping does
not require that there is a different critic for each photo, it merely makes it possible. The wide-
scope every interpretation in (c/d) allows there to be one or more critics. I propose that when the
processor gives every wide scope it can remain vague on how many critics are involved. This
information can then be filled in by subsequent context, as it is by the continuation sentences in
(15). On this approach, stated in (16), the singular and plural continuations are equally easy– both
fill in information about the number of critics, which was not previously specified– and the c=d
result is explained.

(16) Vagueness Principle

When the processor gives every wide scope over an indefinite, it can remain vague
(underspecified) as to whether the indefinite is multiply instantiated or not. This
information can be filled in by further inferencing or by subsequent context.

Underspecification has been proposed to account for other phenomena in language
processing as well (see e.g. Frazier & Rayner 1990).

Angelika Kratzer (p.c.) has suggested another account for the results obtained in Experiment
1. It still assumes the PSI, but approaches the semantics differently. Suppose that indefinites are
ambiguous not between a strong/quantificational reading (serving as an operator) and a weak/
existential reading (being bound by the existential closure operator) as Diesing argues, but
between a quantificational and referential reading (cf. Fodor & Sag 1982). On a referential
interpretation, an indefinite refers to a singular entity in the world/model. The identity of this
referent does not vary, no matter which elements every scopes over. It’s as if the indefinite has
wide scope. Suppose that sometimes the processor chooses a quantificational interpretation for
an indefinite and sometimes a referential one. In (a/b), if the indefinite is taken to be quantifi-
cational, we expect longer reading times in (b) since the indefinite gets wide scope and the
singular continuation is supported, as described above. On a referential reading, the indefinite
appears to have wide scope, so the same result is expected.
In (c/d), on the other hand, the two readings of the indefinite result in different (apparent) scopings. If quantificational, *every* is given wide scope over *a* by the PSI, and the plural continuation (d) is favored and read faster than the singular continuation (c), d>c. If referential, it is as if the indefinite had wide scope and the singular continuation is favored, c<d. If approximately half the time the processor chooses one interpretation for the indefinite and half the time the other, these will cancel each other out, c=d.

Although this proposal is interesting, it is not supported by further examination of the data from Experiment 1 or by what we know in general about language processing. First, for this approach to account for the present pattern of results it is necessary to assume that the processor is choosing 50/50 between the quantificational and referential reading of the indefinite – as if it were flipping a coin. However, there is little evidence within psycholinguistics that the processor ever proceeds in such a fashion. Rather, it is influenced in its decisions by general processing principles, lexical biases, and other factors.

Secondly, if this “coin toss” hypothesis were correct we would expect greater variation in the (c) and (d) continuations than in the (a) and (b) ones, since it would be as if the (c) and (d) cases contain two distributions. In (c) and (d), if the indefinite were taken to be quantificational, the singular (c) should have been hard and the plural (d) easy; vice versa if the indefinite were taken to be referential. So responses to (c) and (d) should have each varied between being easy and hard, fast and slow. On the Vagueness account, on the other hand, (c) and (d) are expected to be equally easy. Examination of the standard deviations for the critical region in S2 (subject + aux/verb), given in Table 3.2 (pg. 73), supports the Vagueness approach over the coin toss hypothesis. The SDs for the (c) and (d) items are not higher than those for the (a) and (b) items.

It is certainly possible that indefinites can get either a quantificational or referential interpretation in the grammar, but it is unlikely that the processor chooses randomly between them. There is no evidence that a referential reading is entertained for the indefinites in the dative sentences used in Experiment 1. Perhaps this is because both the direct object and the indirect object occur rather rightward in the sentence, while referential readings are often
associated with leftward phrases such as subjects.

To account for the results of Experiment 1, then, I adopt the Principle of Scope Interpretation in conjunction with the Vagueness Principle.\(^6\) Note that if the Vagueness approach is correct, a methodological problem with Experiment 1 and the experiments in K&MacD is confirmed. The continuation sentences were not consistent with only one scoping of the quantifiers in the quantified sentence as they were intended to be. This point underscores the need, which K&MacD also recognize, for better techniques for studying scope ambiguities, techniques which can measure in the quantified sentences themselves.

\(^6\)Recall from Chapter 2 that Gillen (1991) included some dative sentences in her later experiments. In principle, her data could potentially help to further support the theory proposed here, but it is in fact not very enlightening. The dative items were tested along with other DP PP items as in (i). The quantifier-order for these items was indefinite-first.

(i) Margaret served a scone to some customers.

Bob suggested a schedule for all teachers.

Based on the results from my Experiment 1, I would expect a preference for wide-scope a here. In Gillen’s Experiment 10, which used continuation sentences like those I employed, the singular continuation should have been read faster. Unfortunately, the reading times for the different continuations were not reported, so this prediction cannot be tested definitively. However, overall in the experiment (which also included double object sentences with the indefinite QP occurring second) the singular continuation was faster and Gillen comments (p. 176) that this effect was particularly strong in the DP PP items, advancing some support for the prediction.

In Gillen’s Experiment 8, the wide-scope indefinite diagram should have been preferred for sentences like (i). This was not found. For these items and overall in the study the wide-scope universal diagram was accepted more often. This is the reverse of the main effect of diagram in her passive/active study. It is unclear what is behind these diagram effects.

Furthermore, it is probable that the various DP PP sentences that Gillen used do not have the same syntactic structure. The kind of preposition or the location of the PP in the structure could effect scope preferences (cf. Pica & Snyder, 1995).
3.2.3.2 Evaluation of Predictions Made by Kurtzman & MacDonald (1993)

The theory that initial quantifier scope preferences are determined by the interaction of a number of constraints on scope assignment in the way that K&MacD (1993) suggested cannot account for the results of Experiment 1 without a number of changes, including the addition of the Vagueness Principle. Their approach predicted that there would be no strong scope preferences in dative sentences, as in passives, since the scope principles are in conflict: the C-command (or Linear Order) Principle favors forward scope, and the Thematic Principle favors inverse scope.\footnote{It is worth noting here that Pica & Snyder’s (1995) theory of scope preferences also wrongly predicted that neither scoping would be particularly preferred in datives. Their approach is somewhat similar to mine, but they allowed the to-phrase the choice to either c-command the direct object at LF, or be c-commanded by it. If half the time one position is selected and half the time the other is, both scopings will be equally supported. They do not go into what might determine the choice. See Chapter 2 for a review of their paper.}

A critical difference between K&MacD’s theory of scope preferences and the PSI-based theory is the claim that something other than the relative c-command relation of the QPs influences which scoping is preferred. They propose that the relative position of the thematic roles of the QPs on the thematic hierarchy plays a role as well. The results of Experiment 1 seriously question this claim.

Under K&MacD’s theory without the Vagueness Principle, the result that the (c) and (d) continuations are read at about the same speed is interpreted as indicating that there is no scope preference in (15c/d), as was predicted. But the finding of a strong preference for the forward scoping in (15a/b) is left unexplained.

With the addition of the Vagueness Principle, on the other hand, the puzzling aspect of the results of Experiment 1 for K&MacD’s theory concerns the Thematic Hierarchy Principle. Under Vagueness, Experiment 1 provides evidence for forward scoping in both (a/b) and (c/d), supporting the Linear Order and/or C-command Principles but not the Thematic Principle. Perhaps the Thematic Principle is ranked below the Linear Order and C-command Principles,
and that is why it appears to have little effect. K&MacD briefly mention sentence processing models which rank constraints but do not attempt to rank the scope principles. Alternatively, the Thematic Principle could be wrong altogether: it predicted wide scope for the indirect object, opposite to the other principles, and there is no obvious way to reconcile the results with this prediction. Whether it is discarded or lowly ranked, the Thematic Principle and the scope preference data it is meant to account for (in K&MacD and elsewhere) should be re-examined.

As a first step to doing this, I tried to replicate the findings from K&MacD’s Experiment 1, where simple subject-object active sentences were tested. K&MacD used two types of verbs in that study: action verbs like *climb* and perception verbs like *see*. With action verbs, the thematic roles of the subject and object QPs are agent and theme, respectively, while with perception verbs they are experiencer and theme. In both cases, the Thematic Principle predicts wide scope on the subject should be preferred (just as C-command does). Moreover, since agent and theme are farther apart on the thematic hierarchy than experiencer and theme, the Thematic Principle predicts a greater preference for subject wide scope with action verbs than with perception verbs. K&MacD found some effects along these lines. Replicating these findings would offer support for the Thematic Principle.\(^8\)

Running the subject-object sentences also gave me an opportunity to see whether the pattern of results found above in the dative sentences were particular to the dative construction or to sentences in which both quantifiers were non-subjects.

3.2.3.3 Attempted Replication of Kurtzman & MacDonald’s Experiment 1

For the attempted replication of K&MacD’s first experiment a self-paced region-by-region reading task was used. Their 32 target items were run in four conditions: Quantifier-order (*a-every, every-a*) was crossed with Number (singular, plural); see (17). Half the items contained

\(^8\)However, how influential the Thematic Principle could be in cases where it is in conflict with c-command, such as in datives and passives, would still be unclear.
action verbs, half perception verbs.\(^9\) The quantified sentence was presented in a single region, followed by the continuation sentence in a single region. One or two additional sentences were added after the continuation sentence in each item in order to match the length of other items in the experiment. These sentences were presented in regions of similar length to the quantifier and continuation sentences. There was a total of 96 items in the study. After each item, a yes/no comprehension question was given.

\((17)\) a/b. *A kid climbed every tree.*

a. *The kid was full of energy.*

b. *The kids were full of energy.*

c/d. *Every kid climbed a tree.*

c. *The tree was full of apples.*

d. *The trees were full of apples.*

The results from 40 participants revealed two reliable main effects in the continuation sentence, of Quantifier-order and Number; *a-every* items were read more slowly than *every-a* items, and plural continuations were read more slowly that singular continuations (see Figure 3.2, pg. 77). As K\&MacD found, there was a larger effect of Number in the *a-every* conditions than in the *every-a* conditions, so that the plural continuations in the *a-every* sentences were read particularly slowly. Although this pattern did not give rise to a significant interaction between Q-order and Number, it was supported statistically in the pair-wise contrasts. There was a significant effect of Number in the *a-every* conditions (a/b; marginal in the items analysis), versus a nonsignificant effect of Number in the *every-a* conditions (c/d). Furthermore, one-factor ANOVAs on the effect of condition showed (i) that there was some difference among the four conditions, (ii) that conditions (a,c,d) differed from condition (b), and (iii) that conditions (a,c,d) did not differ from each other. In other words, condition (b) was the worst cell, as in

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\(^9\)In addition, all of the continuation sentences started with the determiner *the*. K\&MacD used *that* in half of the items, but found no effect of determiner.
Experiment 1.10

There were no significant effects in the quantified sentence or in the first region after the continuation sentence.

As for Verb Type, the pattern of means did not match that found by K&MacD, and no reliable effects were found. Thus the results which supported the Thematic Principle were not replicated, calling the role of this principle in determining scope preferences further into question.

Importantly, though, the basic pattern of reading time results for subject-object sentences shown in Figure 3.2 reflects the primary compatibility-judgement findings that K&MacD report. It also matches the pattern of reading time results for dative sentences in my own Experiment 1. The PSI, in combination with the Vagueness Principle explains this pattern as follows: Forward

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10Raw reading times have been presented here rather than residual times (corrected for length) because the correlations of reading time and length were quite low for most participants. Since condition (b) is generally two characters longer than condition (a), one might argue that the effect of (b) being read more slowly is just due to length. However, this reasoning predicts that (d) would have been slower than (c), which was not found.
scope is preferred in both constructions, in both quantifier-orders. When \textit{every} has scope over \textit{a}, the processor remains vague about whether the indefinite is multiply instantiated or not. As a result, both plural and singular continuation sentences are compatible with the scoping and are read with little difficulty. When \textit{a} has scope over \textit{every}, multiple instantiation of the indefinite is not possible, so only the singular continuation is consistent with the scoping. Hence, this continuation is read more quickly than the incompatible plural continuation.

One might ask, however, why there seems to be a preference for the plural continuation over the singular continuation with the \textit{every-a} items in K&MacD’s study. There is no such preference in the attempted replication: a contrast looking at the effect of Number in the \textit{every-a} conditions was not significant. K&MacD do not report a corresponding contrast, but the numeric pattern of responses is suggestive of a reliable effect. Estimating from their graph, the percentage of Yes/Compatible responses for the singular continuation (c) was 46%, while for the plural condition (d) it was 74%. Why did K&MacD find a preference for the plural continuation with the judgement task while I found no such preference with a straight reading task? One possibility is that by the time a participant had read the entire continuation sentence and decided whether it was a good continuation or not, higher level processes had kicked in which resolved vagueness to a multiple instantiation of the indefinite, favoring the plural continuation. The reader may have reasoned that since the quantifier-order \textit{every-a} was used, \textit{every}\textsubscript{\textit{a}} scoping was intended, and the most informative interpretation of that scoping is multiple/plural. If the speaker knew that there was only one entity associated with the indefinite, s/he would have chosen to use a sentence for which the default scoping was \textit{a}\textsubscript{\textit{every}}. In the reading task, these processes have not applied by the time the participant presses the space bar to see the next segment of the item, and the Vagueness Principle allows both continuations to be read easily.

\textbf{3.2.3.4 A Preference for Existential Direct Objects?}

Before moving on, I turn briefly back to the Existential Direct Objects Hypothesis. The EDOH, in combination with the Principle of Scope Interpretation, predicted wide-scope
every would be preferred in both quantifier-orders, and therefore the same pattern of results would be observed in the two orders. But there is no evidence that the every>a scoping is preferred for the a-every quantifier-order. The EDOH as stated is wrong. This does not necessarily mean that there is not a preference to interpret DOs as existential/weak; the preference may have been overridden in the experimental items. Further research into whether/which indefinites prefer an existential reading is necessary, independent of questions of relative scope preferences. For the remainder of the dissertation, I will assume that DOs do not have an existential preference and, as stated in section 3.1.1 before the EDOH was proposed, that all DOs raise to [Spec,AGRoP] at S-structure.

3.3 Scope Preferences in Other Constructions

According to the Principle of Scope Interpretation, the preferred scoping of a quantified sentence is computed from the required LF structure of that sentence, where the required LF is determined by required grammatical operations acting on the S-structure. Generally, syntactic operations do not change the c-command relations between QPs, so surface c-command is often a good predictor of scope preferences. Experiment 1 provided support for the PSI in looking at scope preferences in datives. The attempted replication of K&MacD's Experiment 1 did the same with active subject/object sentences. In this section I consider the predictions of the PSI for scope preferences in a variety of other constructions and review the relevant experimental results when there are results available.

3.3.1 Passives

While there is considerable disagreement about how to analyze passive constructions syntactically and semantically, under most analyses the (surface) subject c-commands the by-phrase, and there is no grammatical reason to move the DP in the by-phrase above the subject at LF. According to the PSI, then, there should be a preference for the forward scoping of a>every in a sentence such as (18):

\[
\text{(18)} \quad \text{The old man \textbf{every}} \text{began to cry.}
\]
The available data generally supports this prediction, but it also suggests that the preference in passives may be less strong than in corresponding active sentences.

While a c-command-based principle predicts a forward scoping preference in passives, other principles, such as the Thematic Hierarchy Principle which K&MacD advocate for, predict an inverse scoping preference. Thus, if something other than c-command is at work in resolving scope ambiguities, evidence for it might show up well in passives.

In their Experiment 2, Kurtzman & MacDonald investigated the passivized versions of the items they had used in Experiment 1, using the same design and procedure. The results yielded a slight preference for wide scope on the subject significant by participants but not by items, as opposed to the strong preference for subject wide scope in the corresponding actives. Kurtzman & MacDonald take the combined results of their Experiments 1 and 2 to indicate that more than one principle is involved in determining quantifier scope (e.g. the C-command Principle and the Thematic Principle). They suggest that the principles converge on the forward scoping in actives, yielding strong preferences for that interpretation, but in passives the principles are in conflict, sometimes one “wins” and sometimes another does, so that there is no consistent preference for one scoping or the other.

There is clearly a contrast between actives and passives in Kurtzman & MacDonald’s data which deserves an explanation, but in presenting one Kurtzman & MacDonald seem to lose track of the fact that statistically the forward scoping was significantly preferred in the passives (though only on the analysis by participants). In their terms, one principle was, in fact, winning more often in the passives, just not as frequently as in the actives. I would argue that this principle is the PSI, and that other factors are coming in to override the default forward scoping. The degree to which there is a difference in the strength of scope preferences in actives vs. passives, however, is still unclear.

Studies by Catlin & Micham (1975) and Gillen (1991) found little or no effect of voice. Gillen compared the active and passive versions of subject-object sentences in the same experiment. Her
results provide further support for the theory that scope preferences are generally determined by c-command relations. They contrast with Kurtzman & MacDonald’s findings in that passives patterned with actives, rather than passives showing weaker effects.

The differences between the results of the two studies could perhaps be ascribed to the differences in task. In both experiments, participants began by reading a doubly quantified sentence. Following this, Gillen had participants judge whether a diagram accurately represented the meaning of the quantified sentence, while Kurtzman & MacDonald had participants judge whether a second sentence was a compatible continuation. More reflection about the meaning of the quantified sentence could be needed for the former task than for the latter. In addition, people are used to reading sentences but not to looking at the kinds of diagrams that Gillen used. Hence, her findings could be argued to be less of an indication of the natural understanding of the quantified sentence.

In terms of getting at a reader’s first interpretation of a quantified sentence, however, both tasks are lacking. A simple self-paced reading task, without a secondary judgement task of any kind, would be better suited. Additional data on scope preference in passives as compared to actives might reasonably be gathered in a self-paced reading study using the ambiguous items from Kurtzman & MacDonald’s Experiments 1 and 2, crossing voice with quantifier order and interpretation. Reading times on the continuation sentence could be compared across conditions. On the theory I have developed in this chapter, a preference for forward scoping in both actives and passives is expected. Given the various differences between the two constructions, though, it would not be surprising to find that the strength of scope preferences differed as well. Factors other than c-command may be involved, which can override the default forward scoping on some occasions. Considering the results of my Experiment 1 on datives and of the attempted replication of K&MacD’s study on actives, the Thematic Hierarchy Principle does not seem to be the answer. Hence what the critical factors are remains to be determined.  

\[\text{11}\]

\[\text{11}\text{For a review of early psychological studies on how various discourse factors influence the use of actives vs. passives, see Anisfeld & Klenbort (1973).}\]
3.3.2 Double Object Constructions

Double object constructions, like dative constructions, contain both a direct object (DO) and an indirect object (IO). In double object sentences, such as (19), the indirect object precedes the direct object, and neither object is introduced by a preposition.

(19) *Sarit showed some girl every picture.*

A variety of syntactic tests indicate that the indirect object asymmetrically c-commands the direct object. It is widely agreed that there is a very strong preference for the indirect object to take scope over the direct object when quantified phrases occupy both positions—stronger than for the forward scope reading in a dative sentence. Many researchers take this further and claim that sentences like (19) are unambiguous, with the inverse scoping being unavailable (among them Larson 1988; Hornstein 1995).

The forward scope preference is what is predicted by the PSI, but the question arises as to why it should be so strong. Under most syntactic analyses of the double object construction, the scope bias is accounted for by having the inverse scoping violate a syntactic constraint of some kind.

According to Runner (1995), for example, the two objects underlyingly form a ‘clausal DP’ constituent (a variation on a proposal by Johnson, 1991), as schematized in (20a). Both objects appear in [Spec,AGRP] positions at S-structure: $\text{DP}_1$ in [Spec,AGRo$_1$P] and $\text{DP}_2$ in [Spec,AGRo$_2$P]. $\text{DP}_2$ contains the trace of $\text{DP}_1$, as shown in (20b).
In order to satisfy the ECP (a grammatical condition on traces), *some girl* must c-command its trace. As a result, it also always c-commands *every picture*, since there is no way for *every picture* to QR over *some girl* and leave the trace of *some girl* behind.

Aoun & Li (1989; 1993) propose a general theory of which sentences should be scopally ambiguous. Differences across constructions, as well as across languages, are ascribed to differences in syntactic structure. They assume that double object sentences generally only have the forward scoping, but do admit there is some variability. In their (1989) article they report that they asked numerous native English speakers their intuitions on the sentences in (21) and (22). None of their informants found the examples in (21) ambiguous, but some speakers could get both scope readings for (22).

(21) a. *The committee gave some student every book in the library.*

b. *John asked two students every question.*

(22) *Mary showed some bureaucrat every document she had.*

To account for the variable judgements for (22), they suggest that for certain speakers and/or certain verbs, double object sentences have a different structure than usual, one which permits both scopings. They do not attempt to explain why this should be the case. It is unclear how often the inverse scope interpretation is available in double object sentences. Empirical data on scope
preferences in the construction is sparse. While Micham et al. (1980) looked at sentences with verbs that can occur in both the double object and dative constructions and verbs that take double PP complements, they do not give the results from the two sets of verbs separately. Gillen (1991) ran double objects sentences in her Experiments 8 and 10 (see Chapter 2 for a review), but the results are not very informative. She ran only one quantifier order— the indefinite was always second. Samples of her double object items are given in (23):

(23)  Margaret served some customers a scone.
      Bob left all teachers a schedule.

If these sentences scopally unambiguous, then the wide-scope indefinite reading should be unavailable. This prediction cannot be tested by looking for a very low rate of acceptance of wide-scope indefinite diagrams in Gillen’s Experiment 8 or slow reading times of singular continuations in her Experiment 10, since the Vagueness Principle allows for these to be compatible with a wide-scope universal interpretation. Gillen did find, though, that reading times for quantified double object sentences were faster than for related DP PP sentences in both studies. Possibly a strong scope preference in double objects leads to an easier and faster interpretation. While experimental data is lacking, that there is at least a strong preference for forward scoping in double object constructions is fairly clear. By itself, my theory cannot handle this; something extra is needed to get the difference in the strength of the preference for forward scoping between double objects and datives. The “something extra” is a grammatical constraint. Giving every picture inverse wide scope in (15) not only violates the PSI but the ECP as well. Grammatical conditions should be very hard to override. Therefore, the every>some reading should be very hard to get. For further discussion on the role of grammatical conditions, see sections 5.6.2 on sentences where one QP is contained within another.

Conceptually there is a difference between a sentence being ambiguous and having a very strong preference for one reading, but with the other reading still obtainable under certain conditions, and a sentence being unambiguous with the second reading absolutely unavailable. Depending how the data in scope-preference studies is gathered, though, these two cases may
look the same. It seems that at least for certain constructions participants ought to be asked not only what their preferred interpretation is, but also whether the other reading is available to them or not. Ioup’s (1975) technique of using an ambiguity scale could potentially get at this question as well. Double objects are an obvious place to use one of these alternative methods.

### 3.3.3 Double PPs

Consider the double PP construction in (24). On standard analyses, c-command does not seem to obtain between the two QPs at S-structure. Given this, the C-command Principle for determining scope preferences, which is defined on surface c-command relations, does not apply. VanLehn (1978) makes a similar point in discussing the judgements he gathered for this example (p. 38):

(24)  
\begin{align*}  
a. & \quad \text{Ron talked about a problem to each woman.} & 50\% \text{ each } a \\
 b. & \quad \text{Ron talked to each woman about a problem.} & 50\% \text{ each } a \\
 c. & \quad \text{Ron talked about each problem to a women.} & 80\% \text{ each } a \\
 d. & \quad \text{Ron talked to a woman about each problem.} & 75\% \text{ each } a 
\end{align*}

From the judgements VanLehn provides, it appears that surface order does not play a role here either: there is no difference between (a) and (b) or between (c) and (d) (his linear order hierarchy does indeed predict no preference here, since both PPs are verb-phrase PPs). According to VanLehn, the higher percentage of wide-scope each in (c/d) must be due to other factors.

Although the C-command Principle makes no prediction in double PP constructions, the Principle of Scope Interpretation does. When the LF structure of these sentences is considered, the forward-scope reading is predicted to be favored. Runner (1995) argues that the first DP (quantified or otherwise) must raise at LF to [Spec,AGRoP] to get Case, and from that position it asymmetrically c-commands the second DP. Even if the second DP contains a strong quantifier, as in (24a,d), and must raise out of VP, by shortest-movement economy it will adjoin to VP rather than to a higher node and will still be c-commanded by the first DP in [Spec,AGRoP]. Based on this required LF structure, the PSI predicts the \textit{a>each} scoping will be preferred in (24a) and (d).
and the each > a scoping will be preferred in (b) and (c).

These predictions are not supported by VanLehn’s data, but that is just a single example. Other experimental data is not available. (Recall that Micham et al., 1980, included PP PP items in their study, but that the results from them were not reported separately from the results for double objects and datives.) It would certainly be interesting to gather more data on scope preferences in the various PP cases, though Kyle Johnson points out (p.c.) that verbs which take two PP complements are quite rare and the construction may be outside the core grammar.

3.3.4 One QP Within Another

Sentences like (25) and (26), in which one quantified phrase is contained within another (so-called inverse-linking structures), have always posed a problem for theories of scope based on surface c-command relations, since intuitions suggest that the lower quantifier generally takes wide scope over the higher quantifier. As is the case with the double object construction, many researchers go further and claim that only one scoping is available (though here it is the inverse scoping and with double objects it is the forward scoping).

(25) \[
\text{All the gifts to } \left[ \text{some girl } \right] \text{ were wrapped in red paper.} \\
\text{Reinhart (1983:196)}
\]

(26) \[
\text{At the conference yesterday, I managed to talk to a guy from each/every raw rubber producer from Brazil.} \\
\text{100% each > a} \\
\text{85% every > a} \\
\text{VanLehn (1978: 31)}
\]

The PSI correctly predicts that inverse scope should be preferred here. I will discuss these cases in detail in Chapter 5, where the results from two studies by Kurtzman & MacDonald (1993) on the construction are presented.\(^\text{12}\) Briefly, my account goes as follows: For (semantic) type reasons, QP\(_2\) must raise and adjoin to a clausal projection at LF to be interpreted. QP\(_1\) cannot raise above QP\(_2\), because then QP\(_2\)’s trace would not be bound, violating the ECP. In the

\(^{12}\text{The topic of Chapter 5 is the effects of individual quantifiers on scope preferences, particularly each vs. every. The discussion of K&MacD’s experiments on examples like (25) is postponed until then because they compared the behavior of each and every in their items.}
required LF, then, QP₂ scopes over QP₁, so that is the preferred scope.

3.3.5 Summary

In this chapter I have developed a general theory of how quantifier scope preferences are determined. This theory was initially motivated and supported by two constructions. In this section I have examined the predictions of the Principle of Scope Interpretation for scope preferences in a number other constructions. In two of the cases considered here—passives with QPs as surface subject and in by-phrase, and double objects with QP objects—the leftward quantified phrase asymmetrically c-commands the other at S-structure. Thus the PSI predicts a preference for forward scoping. For passives, there is experimental data confirming this prediction, but it is unclear how strong the effect is. For double objects, there is wide intuitive support for the prediction. A third construction considered was double PP sentences. In these c-command does not obtain between the two QPs at S-structure, but required grammatical operations at LF yield forward scoping as the expected preferred scoping. There are no experimental results for these cases, and intuitions vary, so the prediction cannot yet be evaluated. For all three of these constructions, the gathering of more scope preference data in controlled experiments would be quite useful. At this point, the available data provides promising evidence for the PSI.

3.4 Concluding Remarks

Experiment 1 offers insight into basic questions related to the processing of quantifiers and paves the way for further research. I have argued that the preferred relative scoping of two quantified phrases is computed from the required LF structure and have accounted for this preference by a fundamental principle of processing economy, the Principle of Scope Interpretation. I have also provided support for the idea that when every has scope over a, the processor does not commit to how many entities the a-phrase represents (the Vagueness Principle). This number is left underspecified. Both economy and underspecification can be
considered parts of the general language processing system. There is evidence for these concepts in other domains.

The present study concerned scope preferences in dative sentences. Scope preferences in active and passive subject-object sentences, double object sentences, and double PP sentences were also discussed. As a general rule, when there is no evidence to change the default scoping as established by the PSI, the preferred scoping in a doubly-quantified sentence is the forward scoping of \( QP_1 \) over \( QP_2 \), when \( QP_1 \) c-commands \( QP_2 \) at S-structure. This is so because the required LF usually maintains the surface c-command relations between DPs. In other words, the C-command Principle falls out of the PSI in most cases. One place where the C-command Principle and the Principle of Scope Interpretation diverge is in complex NP structures, where one quantified phrase is contained within another, such as *a picture of every child*. These cases will be examined in detail in Chapter 5.

In addition to Experiment 1 on datives, I conducted an attempted replication of K&MacD’s experiment on active subject-object sentences. This study provided additional support for the PSI and the Vagueness Principle—precisely the same pattern of results obtained for these items as obtained in the dative items. Both Experiment 1 and the attempted replication also yielded evidence against the Thematic Hierarchy Principle playing a role in determining scope preferences.

I have assumed that the processor builds only a single LF for each S-structure, according to General Processing Economy. An alternative would be to construct multiple LFs in parallel, ranking them by how economical they are. The preferred scoping would be the one computed from the most highly ranked LF. The PSI and Vagueness Principle can handle the results of Experiment 1 just as well in such a model as in a single LF system. The inverse scoping is dispreferred because the building of its LF involves an unrequired instance of QR to raise \( QP_2 \) above \( QP_1 \). Thus the LF for the inverse scoping is ranked below the LF for the forward scoping. The present findings therefore do not decide between the single LF approach vs. the ranked multiple LFs approach. Factors involved in constructing LFs other than those considered
here might distinguish the two views. I leave investigation of this question to future research.

The PSI was designed to provide an answer to the question of how structural factors affect quantifier scope preferences. The role of other factors was not considered in any detail. In the coming chapters the PSI-based theory will be expanded to incorporate the influence that individual quantifiers may have in determining scope preferences. Ioup (1975a), VanLehn (1978), and others argue for a hierarchy of a quantifier’s tendency for taking wide scope. Fodor (1982) speaks of a quantifier’s “hunger,” its need to have something to scope over. *Each* precedes *every* on the hierarchy; that is, *each* is hungrier for wide scope. In investigating lexical biases, I will focus on the *each/every* contrast, attempting to define the differences between them in an explanatory way and to relate those differences to the manner in which quantifiers are processed in general. Chapter 4 presents the first part of this project, where I develop a linguistically motivated analysis of the differences in the meanings of *each* and *every*. In Chapter 5, I combine that analysis with the Principle of Scope Interpretation to provide an analysis of the differences in the scope behavior of these quantifiers and, more generally, present a theory of exactly when effects of individual quantifiers are expected in determining scope preferences.
CHAPTER 4

DISTRIBUTIVITY AND DIFFERENTIATION:
THE UNIVERSAL QUANTIFIERS EACH AND EVERY

Each and every are both universal quantifiers, in contrast to most, some, a few, etc. Sentences containing QPs headed by each and every make a claim about all the members of the set which is quantified over. Each and every are also distributive, while all— the other universal quantifier—and most, some, etc. are not. In many cases, each and every are interchangeable, but there are also a number of ways in which they differ. In particular, each seems to be more strongly distributive than every. In this chapter I present a linguistic analysis of the differences between each and every with respect to distributivity. The aim is to offer a level of discussion which is between a description of intuitions and a true formalization of the phenomena— an outline of what a semantic theory of each and every should capture.

4.1 Distributivity

Each and every are distributive in two ways. For one, they pick out the individual members of their restrictor set. When a quantified phrase headed by each or every is combined with a predicate, the predicate is understood as applying to each individual member in the quantified set rather than to the set as a whole. The primary evidence for this comes from investigating the types of predicates they can and cannot occur with.

The second way in which each and every are distributive is that they require multiple, or distributive, event structures, where the members of their restrictor set are associated with a number of different subevents. For instance, the basic meaning for a sentence like (1) is as follows: there is an event e and for each individual girl g in the set of girls there is a subevent e'
which is part of e such that in e' g sang. In a distributive event structure there are at least two
different subevents.

(1) Each/Every girl sang.

Both each and every are distributive in the first sense of predicking subevents of individuals.
The difference between each and every will be argued to be whether the event structure must be
totally distributive or not; that is, whether all the subevents e' must be entirely distinct on some
dimension. I will demonstrate that each requires total distributivity, while every merely requires
partial distributivity.

I begin by showing that each and every distribute down to individuals. In section 4.1.2 I
provide initial evidence for the claim that each and every require event distributivity. Sections
4.1.3 and 4.1.4 expand on event distributivity notion, presenting a continuum of distributive
event structures. How each and every differ is the topic of §4.2.

4.1.1 Distributing Down to Individuals

Each and every can occur with distributive predicates but not with collective predicates.
Purely collective predicates are predicates which can only be applied to groups or sums, with the
interpretation of a collective action or collective state. Collective predicates cannot apply to single
individuals. If each and every are analyzed as obligatorily distributing down to individuals, then
the fact that they are not licensed with collective predicates follows straightforwardly.

Dowty (1987), in accounting for the distribution of all distinguished a number of predicate
types, including collective ‘cardinality’ predicates like those in (2). (2c) is understood to mean
that there is a situation containing a group of students and this group is large. Versions (a) and
(b), which require applying the predicate to individual students, make no sense.¹

¹Both Roberts (1987a:5-6) and Lasersohn (1995:142-3) noted that these predicates do not
completely lack distributive construals. The examples in (i) are ambiguous. In (i-a), it is possible
for the group of students to be numerous on its own and the group of teachers to be numerous
on its own, as well as the combined group of students and teachers to be numerous. In (b), from
Roberts, there may have been numerous members in each species or many different kinds of
species.
(2)  
a. *Each/every student is numerous/is a large group.
   b. *One student is numerous/is a large group.
   c. The students are numerous/are a large group.  
   (Dowty 1987:100,102)  

A second set of predicates which Dowty identified is collective predicates which have distributive ‘subentailments’ as part of their meaning, as in (3) and (4), based on examples from Dowty (1987:98,110).

(3)  
a. *Each/every student is alike/gathered in the hall/met for lunch.
   b. *One student is alike/gathered in the hall/met for lunch.
   c. The students are alike/gathered in the hall/met for lunch.

(4)  
a. *Each/every student dispersed/scattered in all directions.
   b. *One student dispersed/scattered in all directions.
   c. The students dispersed/scattered in all directions.

As with the other sentences containing collective predicates, *The students gathered in the hall* in (3c) does not entail that each student gathered individually. Yet it does place a requirement on each individual student, that s/he “must come to the hall and remain long enough that they are all there at a common time. Thus *gather* distributively entails some property of members of its group subject … but *gathering* itself can only be true of the group *qua* group” (p. 101). Dowty suggested that distributive subentailments in a predicate are not enough to license *each* and *every*. They cannot appear with collective predicates of any kind— it is impossible for *each* N or *every* N to be interpreted as denoting a group in the way these predicates require. The examples in (3a) and (4a) support Dowty’s claim.2

(i)  
a. The students and the teachers are numerous.
   b. The species were numerous.
   This does not affect the main point here: because *each* and *every* distribute down to individuals, and not to subgroups, they do not occur with these predicates.

2In contrast to *each* and *every*, *all* is licensed by a distributive subentailment. Dowty argued that in fact it requires one. Other quantifiers such as *several* and *many* pattern similarly, though there are some differences:
*Gather* seems to collectivize its object in a way similar to the way it collectivizes its subject:

(5)  
\begin{enumerate}
\item *?Vic gathered each/every towel from the bathroom.*
\item *Vic gathered one towel from the bathroom.*
\item Vic gathered a bunch of towels from the bathroom.
\end{enumerate}

It has been difficult to find additional predicates which are obligatorily collective on their direct objects.

In contrast to the previous cases, QPs headed by *each* and *every* can occur with lexically distributive predicates, as in (6) through (8). These predicates only apply to individuals. When predicated of groups, they require distribution— the predicate applies to each individual member of the group. (6c), for example, can not be understood as saying that the group of girls fell asleep while the individual girls comprising the group did not.

(6)  
\begin{enumerate}
\item Each/every little girl fell asleep.
\item One little girl fell asleep.
\item The little girls fell asleep.
\end{enumerate}

(7) *Each/every table in the showroom had a walnut finish.*

(8) *Kim sharpened each/every pencil.*

That *each* and *every* are compatible with these predicates is expected: the predicates require individuals and that is exactly what phrases headed by *each* and *every* provide. In the next section predicates which are not lexically collective or distributive are considered.

A note on predicate types before moving on: I assume, following Roberts (1987a), that whether a predicate is distributive or collective or ambiguous follows from world knowledge and the sense of the predicate itself, rather being built into the lexical semantics as a feature. Predicates that are composed of multiple lexical items, such as *make a good team*, arguably do not

\begin{itemize}
\item *All the students/*many students are numerous/are a large group.
\item All the students/*many students are alike/gathered in the hall/met for lunch.
\item All the students/*many students dispersed/scattered in all directions.
\end{itemize}

(Dowty 1987:110)

See Dowty §6 for discussion.
have lexical entries, since their meanings can be obtained compositionally from their parts. Yet their distributive nature is clear. A group is required to make a team, so *make a good team* applies only to groups. The same is true of *win a relay race* but not of *win a 100 meter dash*, the latter being a distributive predicate (examples attributed to Barbara Partee).

### 4.1.2 Distributive Event Structures

With predicates which are not strictly collective or distributive, an *each* $N$ or *every* $N$ subject or object forces a distributive event structure. (9a) can be uttered truthfully about an event which is broken down into multiple events in which each girl lifted the package by herself, but it cannot be asserted truthfully about an event in which all the girls did the lifting collectively. When the subject or object denotes a group, as in (9c), the sentence can be true of a single event or of a distributive event. Adverbials such as *together* and *individually* can be used to draw out a one kind of event or the other.

(9)  
   a. *Each/every woman lifted the package up (*together/individually).*  
   b. *One woman lifted the package up.*  
   c. *The women lifted the package up (together/individually).*

(10)  
   a. *The Pope looked at each/every member of his flock (*at once).*  
   b. *The Pope looked at all the members of his flock (at once).*

((10) based on Beghelli & Stowell 1997:88)

Each and *every* are incompatible with predicates that describe once-only events, such as *tear down the sand castle* in (11). Since tearing down a particular sand castle can only happen once, an event structure involving multiple tearing-down events, as *each* and *every* require, is not available.

(11)  
   a. *Each/every boy tore down the sand castle.*  
   b. *One boy tore down the sand castle.*  
   c. *The boys tore down the sand castle (together/*separately).*

((based on Szabolcsi 1995:128-9)
Because *tear down* is once-only rather than collective like *gather* and *meet for lunch* in the preceding section, it can take a single individual as its subject. However, when the subject is a group the sentence can only be true of single events in which the group acted collectively. (See Szabolcsi & Zwarts (1993) for further discussion of this type of predicate).

The availability of a distributive event structure may depend on the common noun in the quantified phrase. *Surround* is often considered to be a purely collective predicate. For example, Beghelli & Stowell (1997:88), citing (12a) (which they rate as ‘?’), claimed that it requires an event with a semantically plural agent. But Szabolcsi (1997) noted this is not the case, offering example (13). She stated that “*surround* differs from *gather* … in that… a single entity may surround something by forming a full circle on its own” (p. 129). (13a) is only acceptable on the concentric circles interpretation, where each estate individually surrounds the castle by forming a circle by itself.

(12) a. *Each/every boy surrounded the fort.
    b. *The boy surrounded the fort.
    c. *All the boys surrounded the fort.

(13) a. *Each/every estate surrounds the castle.
    b. The estate surrounds the castle.
      (both OK on concentric circles reading)

Since boys cannot form circles around forts individually (unless the fort in question a toy fort or the boy is a giant), (12a) and (b) are ruled out. Thus it is not always solely the predicate which determines whether *each* or *every* is licensed. I will return to this point below in §4.3.2.

I will now go on to sharpen the event distributivity concept. I begin by laying out my semantic assumptions.

### 4.1.3 Semantic Assumptions

Following Lasersohn (1995) I assume that sentences denote sets of events and, as Bach (1986) proposed, the semantic domain of events has a part/whole structure much like the one ascribed
to the domain of individuals by Link (1983). For convenience, I use the term ‘event’ as a shorthand to refer to events, processes, and states.

Just as two individuals can combine to form a group, two events $e_1$ and $e_2$ can combine to form a third $e_3$. If Ken paints a wall in $e_1$ and paints a door in $e_2$, for example, then the combination of $e_1$ and $e_2$ is an event $e_3$ in which Ken paints both the wall and the door. The smaller events $e_1$ and $e_2$ are parts (or subevents) of the larger event $e_3$.

Distributive and collective events have different part/whole. Consider a sentence with a predicate which is not purely collective or distributive, such as (14):

(14) *The girls pushed the wagon.*

Suppose there are two girls, $g_1$ and $g_2$. An event $e_3$ in which $g_1 + g_2$ push the wagon *distributively* must have as parts a smaller event $e_1$ in which $g_1$ pushes the wagon by herself and an event $e_2$ in which $g_2$ pushes the wagon by herself. On the other hand, an event $e_4$ in which $g_1 + g_2$ push the wagon *collectively* does not have such subparts. Lasersohn (1988; 1995) provides one approach to how sentences are compositionally interpreted to make specific claims about such event structures.

4.1.4 A Distributive Event Continuum

Collective-distributive event structures form a continuous scale, with purely collective, non-distributive events at one end and completely distributive events at the other, and partially collective-partially distributive events in between. I borrow the term ‘partial distributive’ from Lasersohn (1995) to describe the latter, though he used it in a slightly different manner.\(^3\)

\(^3\)Lasersohn (1995:104-9) used the term for examples like (i). This sentence can be understood as saying that only part of the group of students asked questions, but those that did did so individually.

(i) *After the lecture the students asked questions.*

As I employ the term, partial distributivity is a level of distribution. It refers to the event being broken down into multiple parts, each of which may include one or more individuals.

Gillon (1987) and Schwarzschild (1991; 1996) have used the term ‘intermediate’ to describe the event structures which I call partially distributive. I use the latter phrase because I find it more descriptive. Gillon’s and Schwarzschild’s work are discussed in Tunstall (1998).
Consider the example in (15) and imagine that there are five relevant packages. The diagrams in (16) illustrate a number events which (15) could be true of, which have different part-whole structures.

(15)  *Mary lifted all the packages.*

In the purely collective event in (16a), all of the packages are lifted together in one lifting event $e$, with Mary as agent. In the completely distributive event in (d), each package is mapped onto its own lifting subevent, indicating that Mary lifted the packages one at a time. These subevents are combined to form one larger event. The diagrams in (16b) and (c) show two different partially distributive events: all packages are associated with lifting subevents with Mary as agent, but the mapping is neither all-to-one nor one-to-one. In both instances there is some amount of distributivity, but in (c) there are some subevents of individual packages being lifted, while in (b)
distributivity is only down to subgroups of the packages.\textsuperscript{4} If \textit{together} were added to (15)– \textit{Mary lifted all the packages together}– the sentence could only be true of the collective event in (16a). If \textit{individually} were added, the sentence could only be true of the completely distributive event in (16d).

Now that a range of distributive event structures has been identified, the obvious question is whether \textit{each} and \textit{every} require the same kinds of distributive event structures. I take up this issue in the following section.

\section*{4.2 Each vs. Every}

It has long been claimed that \textit{each} is more distributive than \textit{every}. I will argue that this observation arises because \textit{each} requires a completely distributive event structure while \textit{every} only requires a partially distributive event structure.

\subsection*{4.2.1 Each and Every on the Distributive Event Continuum}

Consider (17a) under the following scenario: if there are five apples and Ricky weighed each of a\textsubscript{1}, a\textsubscript{2}, and a\textsubscript{3} by itself but weighed a\textsubscript{4} and a\textsubscript{5} together, \textit{every} can be used felicitously to describe the situation but \textit{each} cannot be. That is, \textit{each} in (17a) requires a completely distributive event– no two apples can have been weighed in the same subevent. Similarly, \textit{each} is appropriate in (18a) only if no two students were photographed together. The (b) versions, which deny total distributivity with the addition of \textit{but not individually/separately}, sound quite odd with \textit{each}. (Examples which are odd or infelicitous are marked with the symbol \#.)

\textsuperscript{4}I have simplified matters by not sketching scenarios where a given package is lifted more than once, but (16b) would still be a partial distributive scenario even if p\textsubscript{3} were picked up in e\textsubscript{2} as well as in e\textsubscript{1}. 

98
(17) a. Ricky weighed each apple from the basket.
    b. Ricky weighed every apple from the basket, but not individually.

(18) a. Jake photographed each student in the class.
    b. Jake photographed every student in the class, but not separately.

For each, each affected object (apples or students here) must be acted upon individually in its own subevent, differentiated from the other subevents in some way. The apple situation outlined above cannot be described using each because there is no obvious way to distinguish the weighing of a4 from the weighing of a5.

Every, on the other hand, is happy with partial event distributivity, whether some of the objects are affected individually or they are only affected in subgroups. What is crucial for every is simply that there is some amount of distributivity. When every is used, (17) can be truthfully asserted about events in which there are at least two apple-weighing subevents involving two different subgroups of apples. Which apples were weighed together doesn’t particularly matter.

4.2.2 Distributivity and Differentiation

The examples above demonstrated that each and every are only licensed in a sentence which denotes an event with a distributed part/whole structure, where the “main” event is divided into a number of subevents. In the case of every, the event must be at least partially distributive. This requirement is stated as the Event Distributivity Condition below (in informal terms):

(19) The Event Distributivity Condition

A sentence containing a quantified phrase headed by every can only be true of event structures which are at least partially distributive. At least two different subsets of the restrictor set of the quantified phrase must be associated with correspondingly different subevents, in which the predicate applies to that subset of objects.
For each, the distributivity requirement is stronger: the event must be completely distributed. In addition it is necessary that the subevents that make up the distributed event be differentiated in some way. These factors are incorporated into the Differentiation Condition, stated informally in (20):

(20) **The Differentiation Condition**

A sentence containing a quantified phrase headed by *each* can only be true of event structures which are totally distributive. Each individual object in the restrictor set of the quantified phrase must be associated with its own subevent, in which the predicate applies to that object, and which can be differentiated in some way from the other subevents.

The distributive nature of *every* and the differentiating nature of *each* are lexical properties, not shared by other quantifiers such as *all*, *most*, or *many*. I propose building the above conditions into the meanings of *each* and *every*. An initial formalization of these meanings is given in section 4.5.

To see how the conditions apply, first consider (21), which has a lexically distributive predicate:

(21) *Each/every girl is smiling.*

In order to satisfy *each*'s Differentiation Condition, a subevent must be found for each girl in which that girl is smiling by itself: such a subevent is different from all other subevents of girls smiling at least in the identity of the girl (e.g. Emma in subevent e', Margaret in subevent e", and Sara in subevent e"'). Since it is not possible for a group to smile while its individual members are not smiling, any girl that is smiling will be smiling in her own subevent. It might be possible to find a subevent in which three girls are smiling, but such an event can always be broken down into smaller subevents in which each girl is smiling alone. Such is the nature of smiling. Thus, because of the type of predicate in (21), the Differentiation Condition will be satisfied by any event in which all of the girls are smiling. Since *every*'s Event Distributivity Condition is weaker than the Differentiation Condition, it will also always be fulfilled in such cases.

Consider now a sentence with a predicate which is in principle compatible with either collective or distributive event structures, such as *lifted*:
Imagine an event $e_1$ in which Jamie lifted three baskets, one at a time. In that case, a different subevent $e'$ can be associated with each basket, the number of basket-liftings will be three, and the Differentiation Condition and the Event Distributivity Condition will be satisfied. On the other hand, if Jamie lifted all of the baskets collectively in one lifting event $e_2$, then the same subevent $e'$ will be associated with every basket, and the number of basket-liftings will only be one. Since lifting is not obligatorily distributive, it does not follow that if three baskets are picked up together then each of them must have been picked up alone (vs. the case of sleeping). The Differentiation Condition and the Event Distributivity Condition will fail because a subevent $e''$ that is different from $e'$ cannot be found. Finally, an event $e_3$ in two baskets are lifted together in one subevent $e'$ and the third is lifted alone in another subevent $e''$, will satisfy the Event Distributivity Condition but not the Differentiation Condition, since the lifting of basket$_1$ cannot be distinguished from the lifting of basket$_2$ in $e'$. Note that when the object in (22) is changed to the baskets or three baskets, the sentence can be truthfully asserted about any of the events just described ($e_1$, $e_2$, or $e_3$).\footnote{When (22) is changed slightly to Jamie managed to lift every basket (at once), it be true of a collective event like $e_2$. In this case every is stressing universality--all the baskets were lifted, not just some of them--and distributivity is backgrounded. The phenomenon is discussed in §4.4.}

The that each requires complete distributivity in (22) was upheld in a small informal survey where I asked six linguists what their understanding of the sentence was: Were the baskets lifted one at a time, a few at a time, or all together? All six informants reported that they understood the sentence to mean the baskets were lifted one at a time.

Differentiation is often based on time and space. When each is used in (18a) from the previous section, for example, it is easy to imagine that the students were photographed one by one, a few minutes apart. The adverbs individually and separately are generally interpreted with respect to space and time as well. Combining not individually/separately with each, therefore, frequently results in a contradictory statement: claiming both that there are subevents that differ on the
space/time dimension and that there are no such subevents. But it is sometimes possible to
differentiate subevents on other dimensions, keeping space and time the same. In such cases,
adding *not individually/separately* does not yield a peculiar sentence. Moreover, the subevents can
sometimes be differentiated simply by having a different object in each one, as long as their is
enough interest in the individual objects. When (22) is passivized– *Each basket was lifted*– it does
not seem necessary to have separate-in-time lifting events for the baskets.\(^6\)

Consider why interest in the individual objects in the quantified set is sometimes necessary
for *each*. I have suggested that *each* requires that all the subevents involving the individuals in the
restrictor set be distinct from one another, whereas *every* merely calls for *some* of the subevents
to be distinct. Depending on how fine-grained one lets the notion of distinctness get, however,
*each’s* Differentiation Condition could always be trivially satisfied by having a different object in
each subevent. In that case, *each* and *every* would not be making truth-conditionally distinct
claims. A sentence with *each* could be truthfully asserted about exactly the same events which a
sentence with *every* could be. In order to distinguish *each* and *every* something else is needed. The
Differentiation Condition states that the subevents must be differentiated “in some way.” If there
is a pragmatic condition restricting this claim to interesting or relevant ways of differentiating,
the cases of trivial satisfaction will be eliminated.

In other words, a speaker must have a reason for choosing to use *each* rather than *every* to
indicate that differentiation is important, that the individual objects are of interest, etc. There are
various similar cases in language. For example, one needs a motive for saying *Paul cut the bread
with a knife* rather than simply *Paul cut the bread*, since cutting bread is normally done with a
knife. One possible reason for mentioning the knife outright is to be able to refer back to it in a
subsequent sentence: *It was very sharp and Paul almost cut himself*. Without such a reason, the
sentence which overtly refers to the knife sounds odd.

\(^6\)This observation is due to Lyn Frazier (p.c.).
In section 4.3 I address how interest in differentiation can be raised and how differentiation is accomplished. Before turning to that discussion, I consider in a little more detail the question of why a language user might choose to use *each* rather than *every*, or vice versa.

### 4.2.3 Employing *Each* vs. *Every*

Although *each* and *every* are both universal distributive quantifiers, they have different shades of meaning, due (at least in part) to the difference between the Event Distributivity and Differentiation Conditions. As with other words, using a particular term implies a particular emphasis or way of looking at the situation described. *Each* is used to stress the distributive nature of the event and to emphasize that each member in the common noun set was affected individually, thus requiring total distributivity. *Every* is used to stress the universality or exhaustive nature of the event, so the distributive conditions are less stringent.

The view that *each* and *every* have different emphases is shared by various researchers. The Oxford English Dictionary, second edition (1989), in the entry for *every* states:

1. Used to express distributively the sense that is expressed collectively by *all*. …
   In mod. usage, *every* directs attention chiefly to the totality, *each* chiefly to the individuals comprising it. It may also be observed that *each* usually refers to a numerically definite group, in contrast to the indefinite universality expressed by *every*: thus ‘Each theory is open to objection’ relates to an understood enumeration of theories, but ‘Every theory is open to objection’ refers to all theories that may exist. …

3. With loss of distributive sense: = ‘All possible,’ ‘the utmost degree of.’ [E.g. the modern:] They showed him every consideration. There is every prospect of success.

Using *every* non-distributively (meaning 3) amounts to putting even more emphasis than usual on the universal part of its meaning. Examples of this usage are discussed in section 4.4 (see also fn. 5). The “numerical definiteness” of *each* and *every* refers to whether the set that they quantify over has been established in the discourse or not, i.e. whether the domain of quantification has been restricted by context or not. This issue is addressed briefly in section 4.7.
Vendler (1967:78) observes:

[There is] a marked difference in emphasis: *every* stresses completeness or, rather, exhaustiveness…; *each* on the other hand, directs one’s attention to the individuals as they appear, in some succession or other, one by one. Such an individual attention is not required in vain: you have to do something with each of them, one after the other.

I take Vendler’s last point to mean that there must always be a pragmatic reason for using *each*, as I suggested above. If not, employing *each* sounds odd. I would argue that the same is true when using *every* non-distributively.

### 4.2.4 Summary

I have argued that *each* and *every* differ with respect to the conditions they place on the subevents which are associated with the members of the sets they quantify over. *Every* requires there to be some amount of distributivity in the event structure, so that there at least two different subevents (the Event Distributivity Condition). *Each* imposes the stronger requirement that all the subevents be distinct on some dimension (the Differentiation Condition). Furthermore, there is a pragmatic condition on *each* that the subevents be differentiated in a meaningful or interesting way.

### 4.3 Differentiation

In this section differentiation is investigated in more detail. Various dimensions on which differentiation can be achieved are discussed. I also consider a series of pairs of sentences where *each* sounds odd in one case but not the other. I argue that the examples which produce oddness are those in which the pragmatic condition requiring interest in differentiation is not satisfied and therefore the Differentiation Condition fails because a relevant way cannot be found to differentiate the subevents.
4.3.1 How Differentiation Is Accomplished

Delimiting events, defining their dimensions is a vague affair, compared to delimiting individuals. Since the dimensions of events are not well-defined, we should not expect the differentiation of events to be completely well-defined either. Various factors should play a role in differentiating events, and speakers may have different intuitions on particular examples.

There is a similar vagueness in the meanings of together and separately. The togetherness or separateness is often conceived to be on the dimensions of time and space. But it is also possible for together just to mean “at the same time” and for separately to mean at a different time or in a different space but not both.

The best differentiation of subevents, i.e. the one most readily obtained, is usually with respect to time. Sentences (17a), (18a), and (22) discussed earlier are easily differentiated on the dimension of time. Space, manner, instrument and participants are other dimensions which are sometimes relevant. For instance, while sentence (23) is freely taken to mean that each potato was mashed at a different time (though you might wonder why it was done that way, an (admittedly odd) situation can be imagined in which differentiation is accomplished on the dimension of space. Suppose the potatoes are lined up on the counter, with space in between them, and a board is pressed on top of them, mashing them all at the same time. (Perhaps the mashing was done this way as an experiment to see how different kinds of potatoes fare when mashed.) Under these circumstances, (24) is not a contradiction.

(23) Carol mashed each potato.

(24) Carol mashed each potato; in fact, she was able to mash them all at the same time.

Each’s Differentiation Condition is satisfied by the different positions of the potatoes. What the Differentiation Condition rules out is employing (23) to describe an event in which Carol put some of the potatoes in the food processor together and puréed them– since in that case there is no way to distinguish the mashing of any one of those potatoes from another.

Which dimension(s) differentiation is achieved on depends on the context. Differentiation on space was supported in (24) in the context of an experiment where it was important to see the
effect of mashing on different individual potatoes. That it was space alone and not also time would make sense if Carol was trying to finish the experiment quickly. Not only does context determine how subevents are differentiated, but also whether differentiation of any kind is supported in the first place. If Carol’s goal was simply to make a big bowl of mashed potatoes out of all the potatoes she had, it would not make sense to differentiate the mashing of individual potatoes based on space or time. In that case both (23) and (24) would be odd.

4.3.2 Interest in Differentiation

When each is used, context must support the emphasis on differentiation. That is, there must be interest in what is being differentiated. Most elements within a sentence can play a role in supplying interest. Extrasentential context can provide interest as well, as demonstrated in the previous section. When no element supplies interest in differentiation, sentences containing each are quite degraded.

(25a,b) are based on examples from VanLehn (1978:81), which in turn are drawn from examples and discussion in Vendler (1967:77-8). VanLehn suggests that (25b) is okay and (25a) is not because “weighing the whole basketful and weighing each apple individually are so pragmatically distinct,” while taking one apple at a time versus taking them all are not. The use of each indicates that the distribution is important, yet in (25a) whether the action was distributed doesn’t really matter and each is infelicitous.

(25) a. ?# Ricky took each apple.
   b. Ricky weighed each apple.

I asked six linguist informants for their intuitions on this example: Did they found (a) better, (b) better, or no difference between (a) and (b). I also requested that they rate the sentences on the (OK–?–*) grammaticality scale. Three of the informants found (b) better than (a), in line with my own intuitions. Of these three, one said that (a) sounded incomplete, and one observed that (a) is only good with the addition of one by one or and weighed it. A fourth informant noted of this and other similar comparisons he was asked to make: “[It’s] hard to judge. [There’s] no contrast in
grammaticality in the OK-?-* sense, to me they fit in the # scale (pragmatically odd). To the extent that I can come up with a bunch of individual events, they all work fine (i.e., if you add separately or individually at the end, they are all fine).” In other words, this person was devising ways to satisfy the Differentiation Condition. The remaining two informants found (a) and (b) equally fine in (25) and in other examples they were asked to judge (see below for those examples). These two people seem to have not paid any attention to the Differentiation Condition; perhaps this was because they were considering the items strictly with respect to the grammaticality scale, which was not after all the appropriate scale to use. The other informants seemed to use to the more relevant oddness scale instead, though not all said so explicitly.

(25a) and (b) differ with respect to the choice of verb. I will further discuss this example and the effect of predicate type shortly. Other intrasentential elements should be able to influence whether interest in differentiation is established as well. Below I consider how various other elements affect the acceptability of sentences containing each.

Note that every is okay in the (25a) and in all the examples discussed here where each is degraded. This is understandable. In (25a), for instance, there are many reasons for someone to care why all the apples were taken, but not many reasons to care why the apples were taken one by one.

4.3.2.1 Common Nouns

The smallest domain/closest element that could satisfy the Differentiation Condition is the common noun in the quantified phrase. Humans are inherently interesting, so using each with a human noun can satisfy the Differentiation Condition straight off—each says the differentiation of subevents should be possible, i.e. of some interest, and having a different human object in each subevent is interesting. On the other hand, inanimate objects have less built-in interest, so the Differentiation Condition is not usually satisfied simply by having a different object in each subevent:
(26)  
a. ? Melinda described each desk.
   b. Melinda described each visitor.

In (26b) it is hard to imagine Melinda describing all the visitors at the same time, but the Differentiation Condition can sometimes be satisfied by having different objects in each subevent where the subevents themselves take place at the same time and place. Each is satisfied in (27) because one cares about individual cats, even though not separately calls for at least some of the woundings to take place at the same time and place. If there are three or four cats, one can imagine all the woundings taking place simultaneously.

(27)  The cruel girl wounded each cat, but not separately.

Now consider a situation in which there were 100 chicks and 97 were lifted individually and 3 were lifted together. Can (28) be uttered truthfully about this situation given the theory I have proposed? With 100 chicks it is rather unlikely for there to be interest in each individual chick.

(28)  Mary lifted each chick out of the water.

My intuition is that (28) can be used for this scenario and, more generally, that each can be employed in situations where there is almost but not completely total distributivity, as long as the few odd cases where individuation does not hold are unimportant, such as when there is a large number of objects. Charity is at work here, allowing for some exceptions.

In addition to specifying objects which are themselves of interest or not, the quantified noun can affect the level of interest in how the event took place. In (29b), we are interested in how the carrying was accomplished— all the bags at once, a few together, one at a time— because bags can be awkward and heavy to carry and we might expect that only one can be carried at a time. But (29a) is odd, because we expect that it should be possible to carry more than one plate at a time, while the use of each suggests that they were carried one by one. Furthermore, the result of the event, that all of the plates ended up in the kitchen, seems more important than whether they were carried all at once or not. The Differentiation Condition has not been met in (29a)— there is little interest in differentiating the carrying subevents.
(29)  a.  The maid carried each plate to the kitchen.
   b.  The maid carried each bag of groceries to the kitchen.

4.3.2.2 Predicate Types

As was already observed with example (25), the kind of predicate in the sentence can play a role in satisfying the Differentiation Condition. Each sounds better with some predicates than with others. One critical difference in predicates seems to be whether the predicate emphasizes how the event was accomplished (the process) or what the result of the event was. This distinction was alluded to in the discussion of example (29). Consider now the pairs of sentences in (30-32). The predicates in the (a) versions of these examples are more oriented to the result of the event, while the (b) versions are more oriented to the process.

(30)  a.  Carol cooked each potato.
   b.  Carol mashed each potato.

(31)  a.  The trainer filled up each bag.
   b.  The trainer carried each bag to the locker room.

(32)  a.  Terry destroyed each lampshade.
   b.  Terry photographed each lampshade.

Whether distribution is considered important or of interest, and therefore whether each is acceptable, depends on the emphasis of the predicate. The general correspondence is that distributivity is important to process of the event but not to the result, so each is better with predicates which stress the process.

With predicates which emphasize the result of the event, the process is correspondingly less important. Since how the event was accomplished is not significant with such predicates, individuating the event is unimportant. The use of each is inconsistent with this, so it is hard to satisfy the Differentiation Condition and each sounds odd. Often the result does not change according to how the event was accomplished, further diminishing the process. In (25a) above and (32a), for example, whether the event was distributed does not affect the result. In the end,
all of the apples were taken, and all of the lampshades were destroyed. It does not matter whether they were taken or destroyed one at a time or a few at a time. Furthermore, even if the apples were taken one at a time, the result of each subevent was the same. One feature which identifies result predicates is that many of them, such as those in (31a) and (32a), are ‘gradable’ (Quirk, Greenbaum, Leech, & Svartvik 1985:404); the result can be graded by degree adverbials such as completely and partially. Perfective particles such as up in (31a) also help to direct attention towards the result (p. 595).

When the process is important, so is whether the event was distributed or not. The importance of the process can be brought out by using verbs which specify manner or means, as in (30b), or by adding manner/means adverbials. One reason why the process might be considered important is that the result of the event differs according to how the action was done. In (25b), for instance, it matters whether the apples were weighed one a time or not– the weight obtained is different. The weight of one apple might be five ounces, while three apples together weigh a pound. In (32b), whether the lampshades were photographed singly or not will result in photographs which look different. If a number of shades are photographed together, then it may be hard to see the details of some of them, or even see how many there are. Furthermore, when the process of the event is distributed, the result of one subevent can often be distinguished from the result of the other subevents. In weighing different apples, you are likely to end up with a different weight for each apples, and in photographing different lampshades you end up with different pictures. Hence, it is easy to satisfy the Differentiation Condition in such cases and each sounds fine.

As just mentioned, different kinds of adverbs can influence whether the result or process of an event is emphasized. (32a), with the result predicate destroy, is not improved by addition of a degree adverb in (33a), since the adverb simply reinforces the emphasis on the result of the event. In contrast, the manner adverb in (33b) draws attention towards the process and employing each is more natural.
(33)  a. ?? Terry completely destroyed each lampshade.
    b. Terry methodically destroyed each lampshade.

Context of use can change the built-in emphasis of a predicate as well. Suppose that Amy is interested in the weight of all of the apples together, and she asks Ricky to carry out the task. If she hears (25b), she is likely to think the sentence rather odd. There are numerous ways of figuring out the total weight of the apples, either weighing the apples singly or in subgroups and tallying up the results, or weighing them all at once. Amy should not particularly care how the job was accomplished. The result is the same in any case. On the other hand, if Amy is not only interested in the total weight of the apples, but also in how long it takes to figure it out, then the process once again becomes relevant. If there is a large number of apples, then weighing them one by one will take considerably longer than weighing them all together. In that context, (25b) is once again acceptable, especially if each itself is accented.7

4.3.2.3 Secondary Predicates and Subjects

The previous section concentrated on when attention is directed to how an event was accomplished. Now consider once again the role of the participants in the event. Besides common noun choice, there are a number of other ways in which interest can be drawn to participants.

First, in Tunstall (1996) I noted that adding a secondary predicate to a questionable each sentence improves it:

7The three linguist informants who found a contrast between (25a) and (b) above, also judged (b) to be better than (a) in examples (32). The judgements on (30) were a bit more mixed. (I did not ask them about (31).) Their comments support the theory I have been developing. In regard to (32), one informant remarked that all the or every sounds better in (a). For (30), one informant found (b) better than (a) but observed that (b) has to be used in the right context: “i.e. it has to be important that she mashed them one by one. It helps if mashing a potato is a difficult job, and Carol did it effortfully over an extended period of time; or say, if she mashed potatoes defiantly as part of a domestic dispute.” Another said, “Both sentences [in (30)] evoke a sort of strange image, involving cooking or mashing the potatoes one at a time. In such a scenario, neither sentence is worse than the other.” The third informant said both (30a) and (b) sounded incomplete.
(34)  
  a. ?? Alice remembered each camper.
  b. Alice remembered each camper happy.

(35)  
  a. ?? Each person in the room left.
  b. Each person in the room left tired.

One explanation for this behavior is that the secondary predicate directs attention to the individuals in the set it modifies (the each-phrase) and relays a property of those individuals that held during the process of the event. The emphasis on individuals reinforces each, and the property adds content to the subevents, thus satisfying the Differentiation Condition without requiring differentiation on another dimension. Alternative explanations will be suggested in the following chapter.

Secondly, many of the odd-sounding examples in this section improve with passivization. For instance, Each apple was taken sounds better than Ricky took each apple. My sense is that when each is in the subject position of a passive, even more attention is directed to the individuals in the restrictor set than is usual with each. The form corroborates that the individuals are of interest. In this way, passivization is quite similar to adding a secondary predicate.

Lastly, differentiation can obtain with respect to participants in the event other than those in the quantified set. When each is in object position, for example, the Differentiation Condition is sometimes satisfied by there being a different agent in each subevent. Awkward examples with result predicates (where it is difficult to satisfy the Differentiation Condition) improve with an indefinite subject:

(36)  
  a. #Ricky took each apple.
  b. A clerk took each apple.

(37)  
  a. ??Fatima ate each slice of banana bread.
  b. A child ate each slice of banana bread.

(38)  
  a. The trainer filled up each bag.
  b. A trainer filled up each bag.
The intuition is that the preferred scoping in such cases is \( \text{each} \succ a \). Examples with process predicates seem unchanged with an indefinite subject, with a preferred scoping of \( a \succ \text{each} \). Since the Differentiation Condition is easily met by the predicate, different agents are not needed.

(39) a. Ricky weighed each apple.
   b. A clerk weighed each apple.

(40) a. The trainer carried each bag to the locker room.
   b. A trainer carried each bag to the locker room.

This phenomena will be discussed at length in Chapter 5 where the effect of the Differentiation Condition on the scope behavior of \( \text{each} \) is investigated.

4.3.3 Summary

For the Differentiation Condition to be fulfilled a way must be found to differentiate the subevents associated with the individuals in \( \text{each} \)'s restrictor set. I have shown that what counts as a distinct subevent is contextually variable, depending on what the context cares about. The examples I employed focused primarily on how various intrasentential elements influence the context. In some cases time and/or space is relevant for differentiation; in other instances it is the participants in the event. When the context does not supply a dimension of interest on which to differentiate, the use of \( \text{each} \) is not supported and the sentence sounds odd.

In contrast to \( \text{each} \), \( \text{every} \) does not demand interest in differentiation. What matters for \( \text{every} \) is simply that there be some amount of event distributivity. How the subevents are distributed is not particularly important. Hence, all of the examples presented above which were odd with \( \text{each} \) are perfectly acceptable with \( \text{every} \).

Few explicit theories about the difference between \( \text{each} \) and \( \text{every} \) exist. Recently Beghelli & Stowell (1997) offered one analysis. They accounted for distributive event construals in sentences containing \( \text{each} \) and \( \text{every} \) by requiring that QPs headed by these quantifiers scope over an existential quantifier over events at LF. While they mentioned some differences between \( \text{each} \) and \( \text{every} \) in sentences containing clausal negation, they did not discuss partial vs. total event
distributivity and there is nothing equivalent to the Differentiation Condition in their system. Their account of the negation examples does not extend to the phenomenon I have discussed here where each sounds odd in certain sentences but not others yet every is always fine.

I provide an initial formalization of my analysis of each and every in §4.5. In section 4.6 I present the results of a questionnaire study in which participants chose whether each or every sounded better in a particular context. The results support the claims put forth here. Before taking up those topics, I discuss cases in which the universal sense of every's meaning is emphasized, backgrounding its distributive nature.

### 4.4 Stressing Exhaustiveness

According to the Event Distributivity Condition, every is only licensed in a sentence which denotes a partially distributed event. But there is a class of examples where it seems that this condition is not met. All are cases where the exhaustive nature of the event— the fact that all of the members of the common noun set were affected— is being especially emphasized. In such cases, distributivity seems to still play a role.

Some speakers report that (41a) and (b) can be uttered truthfully about an event in which all of the boxes were lifted together. I propose that this is possible because the addition of single in (a) and the use of pitch accent in (b) (indicated by capital letters) function to emphasize the universal part of every's meaning while diminishing interest in whether the action was distributive or not.

(41) a. Caroline lifted every single box.

b. Caroline lifted EVERY box.

However, it is one thing to draw attention away from the collective/distributive nature of the event and another to attempt to invalidate the Event Distributivity Condition outright, as with the addition of together, at once, at the same time. I find (42a) quite odd in contrast to (42b):

(42) a. ??Caroline lifted EVERY box at the same time!

b. Caroline lifted all the boxes at the same time!
More of a context doesn’t help much:

(43)  ??Caroline didn’t want to make multiple trips, so she carried EVERY box to the truck at once.

(41a) and (43) suggest that while every can be used to stress exhaustiveness, it cannot be used to also stress collectivity.

Furthermore, emphasizing that the event applied to all the member of the quantified set does not improve sentences containing collective cardinality predicates, as in (44), but does help some sentences with collective predicates which have distributive subentailments as part of their meaning, as in (45) (cf. examples (2-4) in §4.1.1):

(44)  *Every single student (here) is numerous/is a large group.

(45)  a.  ??Every single student here is alike!

   b.  ??Every single student in the dorm gathered in the hall.

   c.  ??Every single professor in the department met for lunch.

   d.  ??*Every single protester at the rally dispersed/scattered in all directions.

The ungrammaticality of (44) indicates that every is still distributing to individuals in its restrictor set. Be numerous and be a large group are not compatible with that. In (45), however, those individuals can be associated with the distributive subentailments of the predicates, while at another level of event structure the predicate can apply to the non-distributed group. These examples reinforce the point that when exhaustiveness is stressed, some sort of reduced distributivity requirement remains. Normally distributive subentailments are not enough to fulfill the Event Distributivity Condition.

The examples in this section imply that distributivity and universality are not separate meanings for every, but rather two aspects of its meaning. As of yet it is unclear how widespread the use of every to stress exhaustiveness– and correspondingly de-emphasize distributivity– is. I leave further investigation of this issue to further research.
4.5 Formalization

In (46) and (47) below I present a partial semantic formalization of the lexical meanings of each and every, incorporating the Differentiation and Event Distributivity Conditions. The analysis is further developed in Tunstall (1998).

The first two lines of these definitions give a fairly standard translation of each and every, phrased in the event-based framework of Lasersohn (1995) which I have adopted here. I assume that each- and every-phrases are of a type which can combine with an open sentence (the “ƒ” in the formulas below) to yield a complete sentence: they take as arguments functions from groups/individuals to sets of events and output sets of events. Such a denotation permits quantifiers to refer to event structure if they need to. Lasersohn’s treatment of monotone-decreasing quantifiers such as fewer than three is roughly parallel to my analysis of each and every in that the lexical semantics he gives for these quantifiers also makes reference to events.

(46) Translation of Every

\[ e \in [[\text{every } N]](f) \text{ iff } \forall x [x \in [[N]] \to \exists e' \leq e [e' \in f(x) \& \exists y [y \in [[N]] \& y \neq x \& \exists e'' \leq e [e'' \in f(y) \& e' \neq e'']] \]

(47) Translation of Each

\[ e \in [[\text{each/every } N]](f) \text{ iff } \forall x [x \in [[N]] \to \exists e' \leq e [e' \in f(x) \& \forall y [y \in [[N]] \& y \neq x \to \forall e'' \leq e [e'' \in f(y) \to e' \neq e'']] \]

The Event Distributivity Condition is encoded by the last line of (46) and the Differentiation Condition by the last line of (47). The difference between (46) and (47) is simply that whereas every requires that there be at least two distinct subevents (for every object that is acted upon in one subevent we simply need to find one other object that is acted upon in another subevent), each requires all the subevents to be distinct (for every affected object we must check that all other objects are in another subevent).

To understand the formalizations, it is helpful to work through a few examples:
Jamie lifted every basket.

\[
e \in \text{[[ Jamie lifted every basket ]]} \text{ iff } \\
\forall x [ \ x \in \text{[[ basket ]]} \rightarrow \exists e' \leq e [ \ e' \in \text{[[ lift ]]}(\langle j, x \rangle) \& \\
\exists y [ \ y \in \text{[[ basket ]]} \& y \neq x \& \\
\exists e'' \leq e [ \ e'' \in \text{[[ lift ]]}(\langle j, y \rangle) \& e' \neq e'' ]]]]
\]

"An event \( e \) is an event of Jamie lifting every basket if for every basket \( x \) there is a subevent \( e' \) which is part of \( e \) in which Jamie lifted \( x \), and there is a basket \( y \) which is not the same as \( x \) and a subevent \( e'' \) which is part of \( e \) in which Jamie lifted \( y \), and the subevent \( e' \) of lifting \( x \) is not the same as the subevent \( e'' \) of lifting \( y \)."

Jamie lifted each basket.

\[
e \in \text{[[ Jamie lifted each basket ]]} \text{ iff } \\
\forall x [ \ x \in \text{[[ basket ]]} \rightarrow \exists e' \leq e [ \ e' \in \text{[[ lift ]]}(\langle j, x \rangle) \& \\
\forall y [ \ y \in \text{[[ basket ]]} \& y \neq x \rightarrow \\
\forall e'' \leq e [ \ e'' \in \text{[[ lift ]]}(\langle j, y \rangle) \rightarrow e' \neq e'' ]]]]
\]

"An event \( e \) is an event of Jamie lifting each basket if for every basket \( x \) there is a subevent \( e' \) which is part of \( e \) in which Jamie lifted \( x \), and for every basket \( y \) that is not the same as \( x \), every subevent \( e'' \) which is part of \( e \) in which Jamie lifted \( y \) is not the same as the subevent \( e' \) of lifting \( x \)."

A final comment about these definitions. Consider whether a sentence such as (50) can be uttered truthfully about an event which does not contain any cats.

Every cat is sleeping.

My intuitions tell me that the sentence is neither true nor false in this case. The sentence is odd, not because of the use of every— it has nothing to do with distributivity or universality— but simply because there are no cats. I would feel the same way about A cat is sleeping. But what about if there is an event with only one cat in it and this cat is sleeping? Once more my intuition is that (50) is neither true nor false of the event, and the sentence is merely odd, this time because of the use of every in particular. Every cat seems to imply that there are at least two cats (perhaps even at least three). The definitions in (46) and (47) do not capture these intuitions. With respect to an event with no cats, the (50) would be trivially true. With respect to an event with only a single cat, the sentence would be false. The intuitions could be accounted for by adding the requirement (or presupposition) that there be at least two members in each's and every's restrictor set, but I will keep the simpler formulations at this time.
4.6 Experiment 2 – Quantifier Selection in Context

I have argued that each is subject to the Differentiation Condition. Each individual in the set each quantifies over must be associated with a subevent, and these subevents must be distinct from one another. This requirement directs attention to the individuals in each’s restrictor set. In contrast, every emphasizes its restrictor set as a whole, or at least does not stress the separate individuals which comprise the set. In a context where a set is established and individuals of that set are distinguished, each should be favored over every, while in a context where the individuals are not differentiated, every should be favored over each. This prediction was confirmed in a simple questionnaire study.

4.6.1 Method

Thirty-eight undergraduate students in introductory linguistics courses at the University of Massachusetts participated for course credit. Participants read on paper short paragraphs that discussed a set of objects or people, describing either how they differed or how they were the same. Participants were asked to choose whether each or every fit best into the final sentence of the passage, which referred again to the set of objects/people, and to circle their choice. There were two items, shown in (51) and (52). A given participant saw one instance of each condition.

(51) a. “Different” condition

Max was writing a story about the uniforms that workers at local stores had to wear. The new supermarket on the corner required their employees to wear a button-down shirt with a collar, but various colors were allowed. On Monday, the deli clerk had on a striped shirt and the cashier in the express lane had on a floral shirt. The manager’s shirt was red. …

b. “Same” condition

Max was writing a story about the uniforms that workers at local stores had to wear. The new supermarket on the corner had a strict dress code. They required their employees to wear a white button-down shirt with a collar, a narrow red tie, and black pants. In addition, anyone with long hair had to put it up in a pony tail. …

a/b. Final (target) sentence

…When Max visited that store he wrote down on his notepad what ( each / every ) employee was wearing.
(52) a. “Different” condition

Yvonne is a preschool teacher. Every morning before the kids arrive she gets the morning activities ready at the crafts tables. It’s important that all of tables are set up a different way. The children like to know that they can go to the next table and do something else if they get bored. On Thursday, she put out painting supplies on one table, play dough on another, and paper and stickers on a third. …

b. “Same” condition

Yvonne is a preschool teacher. Every morning before the kids arrive she gets the morning activity ready at the crafts tables. It’s important that all of tables are set up the same way. The children like to know that they aren’t missing something special at the next table. On Thursday, she put out painting supplies, including paper, different size brushes, and water-based paint. …

a/b. Final (target) sentence

…When the first little boy came in, he scrutinized ( every / each ) table.

4.6.2 Results and Discussion

Table 4.1 presents the percentage of each responses in the two conditions:

Table 4.1 Number of Times Each and Every Were Chosen per Condition in Experiment 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>each</th>
<th>every</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Different</td>
<td>29 (76%)</td>
<td>9 (24%)</td>
</tr>
<tr>
<td>b. Same</td>
<td>14 (37%)</td>
<td>24 (63%)</td>
</tr>
</tbody>
</table>

For analysis, items for which each was chosen were coded as ‘1’ and items for which every was chosen were coded as ‘0’. A one-factor ANOVA yielded a significant effect of Condition, $F_1(1,37) = 9.49, p < .005$. Participants overwhelmingly chose each more often in the Different condition than in the Same condition, supporting the Differentiation Condition as part of the
meaning of each. In a context where it has been made clear that the individuals comprising a set are of interest and should be considered, the use of each is not only appropriate, but preferred.8

4.7 Concluding Remarks

I have demonstrated that each and every differ with respect to the conditions they place on the subevents which are associated with the members of their restrictor sets. Every requires partial distributivity in the event structure, so that there at least two different subevents (the Event Distributivity Condition). Each demands that all the subevents be distinct on some dimension (the Differentiation Condition). Furthermore, what counts as a distinct subevent for the Differentiation Condition is contextually variable, depending on what the context cares about. Evidence for these claims came from examining the kinds of sentences and contexts in which each and every can and cannot occur and from Experiment 2, in which participants chose whether each or every was more appropriate in describing a particular scenario.

In the following chapter I will argue that differences in the scope behavior of each and every can be traced back to the differences between the Event Distributivity and Differentiation Conditions.

A final note. Aside from strength of distributivity, each and every seem to differ in that each requires that its domain restriction (restrictor set) be ‘given’ in the present sentence or discourse while every does not; that is, whether the domain of quantification for every can be free while for

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8The effect was bigger for item (51) than for item (52). The percentage that each was chosen for each item and condition is given below:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Item (51)</th>
<th>Item (52)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Different</td>
<td>84%</td>
<td>68%</td>
</tr>
<tr>
<td>b. Same</td>
<td>32%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Analysis on each item separately yielded a significant effect of condition for item (51), $F_1(1,19) = 14.29$, $p = .001$; but a marginal effect of condition for item (52), $F_1(1,19) = 2.71$, $p = 0.108$. It is possible that the effect was bigger in item (51) because the target sentence contained a wh-word (what). The scope of each and every relative to what had to be determined. In the “different” condition, the inverse scoping of each/every > what obtains, while in the “same” condition the forward scope of what > each/every obtains. One might argue that each was chosen more often in condition (a) in item (51) than in item (52) because each is better for inverse scoping than every. In Chapter 5 I will argue that each’s scope behavior stems from the Differentiation Condition.
each it must be contextually determined. A participant in one of my studies (not reported here) said it well: “Out of context, every insinuates every object/person in existence, but if it were in context, every would simply imply every object/person previously referred to…. Each… seems to refer to a group that must already have been defined.” A number of researchers have made similar observations (e.g. Gil (1995); cf. the entry from the Oxford English Dictionary cited in §4.2.3). Perhaps the fact that each’s domain restriction must be specified is related to the fact that differentiation of the subevents associated with the individuals in the quantified set needs to be supported by context. I leave investigation of this topic to further research.
CHAPTER 5

THE ROLE OF LEXICAL FACTORS IN SCOPE ASSIGNMENT

5.1 Introduction

Two factors readily come to mind as affecting scope assignment and scope preferences: syntactic structure and choice of quantifier. I have argued that the default scoping in a multiply-quantified sentence is computed from the required LF structure of the sentence, so that surface c-command relations generally determine scope preferences. This theory was supported by data from Experiment 1 on dative sentences (where the direct object and indirect object were quantified) and from my attempted replication of Kurtzman & MacDonald’s (1993) experiment on active subject-object sentences. Corroborating evidence came from examining what is known about scope preferences in a number of other constructions.

One aspect of how the choice of quantifier affects scope assignment was revealed in Experiment 1 and the attempted replication. When an every-phrase takes scope over an a-phrase, the processor remains vague about how many entities the a-phrase represents (the Vagueness Principle). But this effect is due to the logical nature of what it means for a universal operator to have scope over an existential operator– multiple instantiation of the existential is possible but not required– not specifically to every and a per se. It should hold of other quantifiers as well, other things being equal.

In this chapter I will consider the role that the lexical biases and conditions of individual quantifiers play in determining scope preferences and how they interact with syntactic structure, concentrating on the quantifiers each and every.
It is widely assumed that *each* and *every* have a greater propensity than other quantifiers to scope over a second quantifier in their clause—*each* even more so than *every*. Generally, scant evidence is offered to support this assumption. Many researchers simply reference Ioup’s work on scope preferences (Ioup 1975a,b).\(^1\) As is well known, she proposed that quantifiers differ with respect to their preference to take wide scope and presented a hierarchy that reflected these built-in tendencies:

(1)  Ioup’s Quantifier Hierarchy

\[
\text{each} > \text{every} > \text{all} > \text{most} > \text{many} > \text{several} > \text{some}_p > \text{a few}
\]

Two points are to be made here. First, this hierarchy is built from a small number of examples, and it is unclear how accurate it is. In a study comparing the scope preferences of all but one of the quantifiers in the scale, Gillen (1991) found numeric support for the hierarchy (except for the relative position of *all* and *most*), but it is unclear how reliable the differences between quantifiers were since statistical tests on pairs of adjacent quantifiers were not performed. The scope preferences of individual quantifiers plainly need to be investigated further. While a number of researchers (Liu 1990; Diesing 1992; Ruys 1992; Beghelli 1993, 1997) have begun to do this for the indefinite quantifiers at the bottom of the scale, the top of the scale has for the most part been left alone.

Secondly, the question arises as to why the various quantifiers hold the positions in the hierarchy that they do. Simply adopting a quantifier hierarchy to account for the scope behavior of different quantifiers is not sufficient. Ruys (1992:130) discusses the drawbacks of this approach with respect to indefinites, saying:

First of all, it leaves as a mystery why all weak quantifiers are located at the same end of the scale. … Furthermore, while it appears undeniable that quantification-al specifiers are lexically marked for their propensity for taking wide or narrow scope, it is unclear in what way, or why they are so marked. This approach … does not provide us with any insight into [scope] behavior. In the absence of a grammatical theory of wide scope-propensity which refers to a lexically specified

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\(^1\)Two exceptions are Kroch (1974) and Beghelli & Stowell (1997), who consider a variety of examples containing different quantifiers.
feature, it does not appear very enlightening to take this course.

In other words, we want to know what is behind the hierarchy.

My goal is to provide a combined grammatical and processing theory of the wide scope tendencies of why each is said to have a stronger preference for wide scope than every, employing the lexical conditions proposed for these quantifiers in Chapter 4. I begin by reviewing these conditions, and then present a more detailed outline of the present chapter.

The principal thesis in Chapter 4 was that every is subject to the Event Distributivity Condition in (2), while each is subject to the stronger Differentiation Condition in (3).

(2) The Event Distributivity Condition

A sentence containing a quantified phrase headed by every can only be true of event structures which are at least partially distributive. At least two different subsets of the restrictor set of the quantified phrase must be associated with correspondingly different subevents, in which the predicate applies to that subset of objects.

(3) The Differentiation Condition

A sentence containing a quantified phrase headed by each can only be true of event structures which are totally distributive. Each individual object in the restrictor set of the quantified phrase must be associated with its own subevent, in which the predicate applies to that object, and which can be differentiated in some way from the other subevents.

For example, (4a) means that Jamie lifted all of the baskets, in at least two subgroups; perhaps baskets 1, 2, and 3 together, and baskets 4 and 5 together. Which baskets were lifted together is not particularly important. On the other hand, (4c) can only be used felicitously to describe a situation where no two baskets were lifted in the same subevent. As such, the (d) version, which denies total event distributivity, sounds quite odd. (Examples which are odd or infelicitous are marked with the symbol #.)

(4) a. Jamie lifted every basket.

b. Jamie lifted every basket, but not individually.

c. Jamie lifted each basket.

d. #Jamie lifted each basket, but not individually.

Examples should be read without a strong pitch accent on any element in the sentence.
The Differentiation Condition requires that subevents be distinguished from each other on some dimension (e.g. time, manner, instrument). Moreover, the subevents must be differentiated in a meaningful or interesting way; what counts as “interesting” depends on context. Since delimiting events is a vague affair, differentiating subevents is as well, and the Differentiation Condition can be satisfied in a number of ways. In the appropriate context— as long as there is enough interest in the individual objects— the subevents can even be differentiated simply by having a different object in each one. When there is no interest in differentiation or individuation, the use of *each* is infelicitous.

These conditions create usage constraints for the quantifiers: *Each* is employed to stress differentiation and focus on the individuals in the set it quantifies over. *Every* is used to direct attention to the set as a whole. It is employed when distributivity obtains but is not critically of interest, and sometimes to emphasize, rather than just convey, universality and exhaustiveness.

Evidence that speakers utilize these constraints was provided in Experiment 2, where participants chose whether *each* or *every* fit best into the final sentence of a passage which described either how a set of objects or people differed or how they were the same. *Each* was chosen more often when the passage had been about the differences between the objects/people than when it had been about the similarities. These results are explained if the Differentiation Condition is part of the meaning of *each* and if language users are sensitive to such conditions in language production.

In this chapter I will investigate the hypothesis that the usage constraints of quantifiers also play a role in language comprehension. In particular, I will examine how the Event Distributivity Condition and the Differentiation Condition influence scope preferences in sentences containing *each* and *every*.

Much of the sense that *each* and *every* prefer wide scope more than other quantifiers likely comes from instances where they are in subject position. The general preference for forward scope in subject-object sentences is expected under the PSI. Cases which would offer more compelling evidence would be those where giving *each* or *every* wide scope involved changing
the required LF structure, such as giving an object *each*- or *every*-phrase inverse wide scope over the subject. Accordingly, I concentrate on determining and explaining the extent to which inverse scope readings for *each* and *every* are preferred in subject-object sentences.

I will argue (i) that the sense that *each* prefers wide scope to a greater extent than *every* arises from examples where an *each*-phrase takes scope over an indefinite which c-commands it in the required LF structure in order to satisfy the Differentiation Condition, and (ii) that when the Differentiation Condition is fulfilled in some other way, the scope preferences of *each* and *every* are very similar. Furthermore, I will demonstrate that the Event Distributivity Condition, shared by *each* and *every*, has little effect on their scope behavior.

The great majority of examples to be discussed here involve the relative scoping of quantified phrases headed by *each* or *every* and phrases headed by the simple indefinite determiner *a*. At the end of the chapter, I will address how the choice of indefinite can influence the scope behavior of *each* and *every*. Such examples are important to consider because in a sentence where the preferred scope is *each/every* over an indefinite it could be either *each/every* or the indefinite which is responsible for the preference, or both (abstracting away from structural factors). *Each/every* could prefer to be in a position which gives it wide scope, and/or the indefinite could prefer to be in a position which gives it narrow scope.

The chapter proceeds as follows. The first examples demonstrating that the Differentiation Condition can influence scope assignment are presented in section 5.2, along with a detailed theory of how syntactic structure interacts with the lexical preferences of quantifiers in determining scope preferences: the Quantifier Satisfaction Hypothesis. Section 5.3 continues with examples in which the Differentiation Condition plays a role: examples which contain secondary predicates. Sections 5.4 and 5.5 present experimental evidence in support of the Quantifier Satisfaction Hypothesis, using the secondary predicate items. Other studies comparing the scope behavior of *each* to that of another quantifier are reviewed in section 5.6. The effect of various types of indefinites on the scope behavior of *each* and *every* is examined in §5.7. Section 5.8 returns to Ioup’s Quantifier Hierarchy, investigating the scopal tendencies of *most* and *all* in
comparison to that of *each* and *every*. Open questions are laid out in §5.9. Section 5.10 contains concluding remarks.

## 5.2 Quantifier Satisfaction

The theory to be developed in this chapter of how the lexical conditions of quantifiers can influence scope preferences is built upon the theory proposed in Chapter 3 of how surface structure influences scope preferences. I therefore begin by restating the basic points of that theory.

### 5.2.1 Review of the Principle of Scope Interpretation

In terms of syntax, I assume that at S-structure in English both subjects and direct objects have moved out of VP into the specifier position of an agreement phrase (Runner 1995). The Mapping Hypothesis governs the translation of LF structures into a tripartite semantic representations (Diesing 1992). Material contained inside the VP gets mapped into the nuclear scope, and material in the rest of the tree gets mapped into the restrictor clause. Quantifier Raising (QR) applies only when necessary, such as to raise QPs headed by strong quantifiers (e.g. *every, most*) which are inside VP at S-structure. These QPs must be external to VP at LF, since they require a restrictive clause for interpretation and cannot form one from within VP.

With respect to syntactic processing, I assume that the processor builds a single S-structure for each input string and computes a single LF representation from this. The building of LF structure is guided by the General Processing Economy Principle, whereby the processor performs only those operations which are required by the grammar, unless the extra structure-building, movement, etc. is motivated in some way. When movement is required, the shortest possible movement that satisfies grammatical requirements is used. LF representations are interpreted into semantic and discourse structures, which include the construction of tripartite representations.

The relative scoping of two QPs depends on the c-command relation between them at LF.
The Principle of Scope Interpretation (PSI) in (5) determines the initial scope assignment. The PSI follows directly from Processing Economy.

(5) **Principle of Scope Interpretation (PSI)**

The default relative scoping in a multiply quantified sentence is computed from the required LF-structure of that sentence, where the required LF is determined by required grammatical operations acting on the S-structure. The default scoping is the preferred scoping unless there is evidence to go beyond it.

Generally, required syntactic operations do not change the c-command relations of QPs. Hence the descriptive C-command Principle, which states that the preferred scoping corresponds to the scoping determined by surface c-command relations, is a corollary of the PSI.

Scope preferences in various constructions were considered in Chapter 3. As a general rule, when there is no evidence to change the default scoping as established by the PSI, the preferred scoping in a doubly-quantified sentence is the forward scoping of QP$_1$ over QP$_2$. This corresponds to QP$_1$ c-commanding QP$_2$ at S-structure. One exception is so-called inverse-linking structures where one QP contains another at S-Structure. In those constructions, QP$_2$ c-commands QP$_1$ in the required LF, so that inverse scope is predicted to be preferred. Until §5.6.2, where these cases are discussed, I will speak of inverse scopings as if they are always the less economical scoping, the one not computed from the required LF structure.

5.2.2 **The Quantifier Satisfaction Hypothesis**

In this section, I expand the PSI-based theory to incorporate the influence that individual quantifiers may have in determining scope preferences. The central idea is that a quantifier’s scope behavior is driven by the lexical condition(s) which are part of its meaning. These conditions, such as the Differentiation Condition of *each*, make no reference to scope themselves, but they may be satisfied by moving the QP headed by the quantifier at LF to a position which changes the scope relations in the sentence.

Such a change comes about in the following way: When the processor encounters a QP, it first assesses whether the quantifier’s lexical conditions can be fulfilled in the required LF structure. This assessment cannot reasonably take place until enough material in the sentence has
been processed with respect to which the conditions can be evaluated (such as the verb and perhaps some required verbal complements). For cases where the QP being assessed is the second QP in the sentence, the required LF structure will embody the default relative scoping of the QPs, according to the PSI. If the lexical conditions of the quantifier(s) can be satisfied in the required LF, then the scoping is left unchanged and the preferred scoping for the sentence is the default scoping. If not, then the processor tries to find a way to meet them. One option, expressed in (6) as the Quantifier Satisfaction Hypothesis (QSH), is to build the less economical inverse scoping:

(6) **Quantifier Satisfaction Hypothesis (QSH)**

If necessary, the processor may move a QP at LF to a position above or below its required LF position in order to satisfy the conditions of the quantifier which heads the QP.

The QSH can be derived from the general notion that the processor uses the grammar to build structure, which is also an underlying component to the PSI.

A prediction of the QSH is that in a sentence where the lexical conditions of the quantifiers are satisfied on the inverse scoping but not on the default forward scoping, the forward scoping should be less strongly preferred than in a sentence where the quantifiers’ conditions are satisfied on the forward scoping—because the inverse scoping is motivated in the former case but not in the latter. An examination of scope preferences in various sentences containing *each* confirms this prediction.

Before taking up those examples, however, I would like to mention an alternative to fulfilling conditions on quantifiers through inverse scoping. If the conditions are not satisfied within the sentence on the default scoping of the QPs, then may be able to be fulfilled by using information from the discourse context or the common background of speaker and hearer. They may even be met only in a very general way. In a sentence containing *each*, for example, the hearer may simply come away with the sense that the speaker felt that differentiation is important, without determining the differentiating dimension. In other words, *each’s* Differentiation Condition is not as strict a condition as, e.g., that which governs the binding of reflexives. Rather, it can be
satisfied in a number of ways and is more akin to presuppositions attached to lexical items, which can be satisfied through the process of accommodation. For example, definite DPs carry a presupposition that their referent is already known. But if someone says to you “I’m upset that the maid didn’t come today” and you didn’t know already she had a maid, you can understand her statement; you simply update your knowledge base to reflect this piece of information. The same may be true for conditions on other quantifiers, which have yet to be worked out.

Given this alternative way of satisfying conditions on quantifiers, one question that arises is how often inverse scoping is employed. On the one hand, the processor may prefer to fulfill the conditions within the sentence, despite the cost of building an inverse scoping structure. Or, it may prefer to avoid such structures when possible, since they are uneconomical even when they are motivated, and go with the accommodation alternative when possible. Foreshadowing a bit, the results of the experiments involving each sentences, to be reported below in sections 5.4 and 5.5, indicate that while the inverse scoping option is chosen some of the time to satisfy the Differentiation Condition, the accommodation alternative is employed more often. For now, I will put this issue aside and focus on examples where inverse scopings are predicted to be preferred according to the QSH.

5.2.3 Scope and the Differentiation Condition

As a first example of where the Quantifier Satisfaction Hypothesis comes into play, consider the case of each and the Differentiation Condition. Recall from Chapter 4 that I conducted a small informal survey of linguists to gather judgements about a few sentences containing each and every, including those in (7). Three of the six informants found (7a) odd/infelicitous (indicated by the symbol #), particularly as compared to (7b).³

³Of the three informants who accepted (7a), one found a way to distinguish the different takings and thus satisfy the Differentiation Condition (this is clear from his statement, “To the extent that I can come up with a bunch of individual events, [it is] fine.” The other two seemed to be rating the sentences strictly on a grammaticality scale, which is not appropriate for violations of the Differentiation Condition. See the discussion in Chapter 4.
(7)  

a. #Ricky took each apple.

b. Ricky weighed each apple.

I argued that this oddity was due to the Differentiation Condition not being satisfied. The use of each indicates that distribution is important, yet in (7a) it is hard to see why it is significant whether the action was distributed or not. It is not difficult to carry more than one apple at a time; one does not need to be particularly careful with them (as opposed to, e.g., a crystal platter). What seems most important is that in the end all the apples are taken, no matter how it was done. In (7b), on the other hand, it does matter whether the apples were weighed one a time or not– the weight obtained is different. So each is felicitous in (7b).

Changing the subject in (7a) to an indefinite, as in (8) below, improves the sentence. The indefinite provides a way to meet the Differentiation Condition: if each takes scope over the subject, then there are multiple clerks involved in the overall taking event and the taking of one apple can be differentiated from the taking of another apple by the agent of taking in each case. In this way, specifying different agents thus adds more descriptive content to the subevents.

As applied to each, the Quantifier Satisfaction Hypothesis says (i) that each will take inverse wide scope over an indefinite subject in order to satisfy the Differentiation Condition, and (ii) that it will do so only if the Differentiation Condition is not satisfied when each is given narrow scope. This predicts that when an indefinite subject is added to a sentence where the Differentiation Condition fails, as in (7a), wide scope on each will be preferred. This prediction was confirmed by my informants. Those informants who found (7a) odd preferred wide scope each in (8).

(8) A clerk took each apple. preferred scope: each>a

Syntactic reanalysis is usually triggered by a real problem, such as ungrammaticality, with the first analysis. What induces the reanalysis of LF structure in (8) to produce the inverse scoping is not as concrete. The Differentiation Condition is not a syntactic condition, nor a feature that needs to be checked in order for the derivation to be valid. It is part of the meaning of each and must be supported by the sentence or the context. If it is not met, the result is not ungrammaticality, but infelicity or a feeling that something is missing. Upon hearing (8), the
hearer wants to make sense of the fact that each was employed by the speaker. But it is hard (for some people) to imagine why attention is being directed to the taking of individual apples on the default $a\geq each$ scoping. Re-scoping is triggered by the desire to justify why each was used and to fulfill each’s Differentiation Condition.\(^4\)

In contrast to (8), when an indefinite subject is added to a sentence where the Differentiation Condition is met, such as (7b), the QSH predicts that narrow scope each will be preferred:

(9) A clerk weighed each apple. preferred scope: $a\geq each$

This prediction was also upheld by my informants. In contrast to their judgements on (8), here they either reported a preference for the $a\geq each$ scoping or no preference at all.

Moreover, two of the informants who rated (7a) as perfectly fine—no violation of the Differentiation Condition—preferred wide scope on $a$ in (8) (the third had no preference), further supporting the QSH. Giving each inverse wide scope was not motivated.

### 5.2.4 Scope and the Event Distributivity Condition

Having demonstrated that scope preferences can be influenced by the Differentiation Condition, I now consider whether they might also be affected by the Event Distributivity Condition.

While for many speakers there is difficulty satisfying each’s Differentiation Condition in (7a), all awkwardness disappears when every replaces each; see (10a). The Event Distributivity Condition is readily met. It is easy to imagine in (10a) that Ricky took the apples in two or three batches. Or, alternatively, if exhaustiveness is emphasized, to not care about distributivity; i.e. the Event Distributivity Condition is relaxed (see §4.4). The same can be said for (10b).

(10) a. Ricky took every apple.

b. Ricky weighed every apple.

According to the Quantifier Satisfaction Hypothesis, then, every should generally disprefer

\(^4\)This relates to the more general question of how semantic interpretation can influence what kind of structures are built, cf. Fox (1995) who argued that QR is generally uneconomical but that it is licensed when it produces a reading that cannot be generated otherwise.
inverse wide scope because there is no lexical condition forcing it to raise above the subject and it is uneconomical to do so without reason. Thus, when an indefinite subject is added in (10), as in (11), the preferred scope should be $a > $every (cf. (8) and (9)):

(11) a. A clerk took every apple. preferred scope: $a > $every  
    b. A clerk weighed every apple. preferred scope: $a > $every

Again, the scope preferences of my informants were as expected, upholding the QSH. Five out of the six reported a preference for wide scope $a$ or no preference at all. (The sixth preferred wide scope $every$ in both (a) and (b).) See sections 5.7 and 5.8 for discussion of a few cases where the Event Distributivity Condition may help to support inverse wide scope in combination with another factor.\(^5\)

We now have a reason why each is said to want wide scope more than every. Under certain conditions each will raise over an indefinite subject to fulfill the Differentiation Condition, but every does not have a corresponding condition which motivates it to take inverse wide scope.

These findings in this section and the previous one support both the QSH and the Differentiation Condition. They are not captured either by other theories of scope preferences, since those theories do not specify how it is that particular quantifiers affect scope preferences, or by theories of the differences between each and every, such as that proposed by Beghelli & Stowell (1997).\(^6\) Under my approach, this pattern of responses is not only understandable, it is precisely

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\(^5\)In Chapter 4 sentences containing each or every and a predicate which is obligatorily collective, such as (i-a,b), were discussed:

(i) a. *Each/every student gathered in the hall/met for lunch.  
     b. *?Vic gathered each/every towel from the bathroom.  

These examples are not relevant to the present discussion. (i-b) is not ungrammatical because the Event Distributivity and Differentiation Conditions are violated but because the verb gather can only apply to an object which denotes a group and each/every-phrases can never denote a group. A QP headed by each/every always distributes down to the individuals in its restrictor set. This is true whether it scopes over an indefinite or not. Thus, the addition of an indefinite for each/every to scope over does not improve these sentences.

(ii) a. *Each/every student gathered in a hall/met for lunch at a cafe.  
     b. *?A maid gathered each/every towel from the bathroom.  

Furthermore, there is no sense that each or every scopes over the indefinite subject in (ii-b).

\(^6\)Recall from Chapter 4 that Beghelli & Stowell (1997) offered a theory of some of the differences between each and every. They were concerned with the distributive nature of each and every, not with scope preferences per se. Yet they did claim that their syntax explicates why QPs (footnote continued …)
what is expected.

5.2.5 Summary

To summarize so far, I have proposed a hypothesis, the Quantifier Satisfaction Hypothesis, about how the lexical conditions of quantifiers can affect scope assignment and a theory of how it interacts with the PSI. I have argued that the Event Distributivity Condition does not drive inverse scoping, but the Differentiation Condition does, thus providing an explanation for why \textit{each} prefers wide scope more than \textit{every}. In the following section, I present additional examples where the scope preferences of \textit{each} and \textit{every} differ because the Differentiation Condition drives \textit{each} to take inverse wide scope over an indefinite.

5.3 Secondary Predicates and the Differentiation Condition

The PSI favors the subject scoping over the object in a simple subject-object sentence. Yet we have seen that lexical factors can sometimes override this preference. I have argued that when \textit{each} is in object position it will take inverse scope over an indefinite subject in order to meet the Differentiation Condition, and have offered a number of examples and informant responses to support this claim. Those examples contrasted in whether they contained the verb \textit{take} or the verb \textit{weigh}. While I have attempted to elucidate why the Differentiation Condition is satisfied in \textit{Ricky weighed each apple}, but is not satisfied in \textit{#Ricky took each apple} for many speakers, the determining factors are still somewhat elusive. A more well-defined factor which yields the desired paradigm is the absence or presence of an adjectival secondary predicate. The addition of a secondary predicate ameliorates questionable \textit{each} sentences, as noted in Chapter 4:

\begin{quote}
headed by these quantifiers often receive wide scope: they raise at LF to a position which is relatively high in the tree. While they observed that the scope behavior of \textit{each} and \textit{every} is different in sentences containing negation, their account of those examples does not extend to the examples discussed in this chapter which show that in particular situations \textit{each} takes inverse wide scope over an indefinite to a greater extent than \textit{every}. There is nothing in their theory equivalent to the Differentiation Condition that could affect relative scopings in such cases.
\end{quote}
The (a) versions of these examples are degraded because the Differentiation Condition is not satisfied. In (12a), for example, there is no obvious reason to differentiate the buying of one brush from another, no reason to think the individual brushes are of interest (during the buying) or that the time or manner in which they were bought is important. The use of each is not supported.

When each is replaced by every, the sentences are fine.

According to Halliday (1967:62), a secondary predicate is a kind of ‘attribute,’ “a characteristic ascribed to one of the participants in the clause; but it is one that relates specifically to the process in question.” So a secondary predicate connects to both the event and the individuals described in the sentence. For instance, dirty and tired apply to individual objects and beings: a group of objects cannot be collectively dirty while its members are not dirty. Examples (12b) and (14b) are more acceptable than (12a) and (14a) because the secondary predicate directs attention to the individuals in the set it modifies (the each-phrase) and relays a property of those individuals that held during the event. This emphasis on individuals reinforces each, and the property adds content to the subevents, thus satisfying the Differentiation Condition without requiring differentiation on another dimension.

Now consider the examples in (12) with one modification: the indefinite determiner a rather than the in the subject DP, creating a scope ambiguity; in (15). Given the degraded status of (12a), the Quantifier Satisfaction Hypothesis predicts that there should be an increased preference for each to take inverse wide scope over the indefinite subject, in order to satisfy the Differentiation Condition. Furthermore, the QSH predicts that the preference for wide-scope each should go away when the secondary predicate is added. Since the secondary predicate can fulfill the
Differentiation Condition on its own, the uneconomical inverse scoping is not supported. These predictions are intuitively supported: in (15a), the preferred scoping is each>a, but in (15b), with the secondary predicate, there is no temptation towards inverse scope.

(15)  
  a. *A painter bought each brush.* preferred scope: each>a  
  b. *A painter bought each brush dirty.* preferred scope: a>each

With every as the head of the object QP, the preferred scope is subject over object whether there is a secondary predicate present or not. There is no reason to override the PSI in either case.

(16)  
  a. *A painter bought every brush.* preferred scope: a>every  
  b. *A painter bought every brush dirty.* preferred scope: a>every

To my knowledge, the effect of a secondary predicate on scope preferences has not been noted before.7

I will assume a syntactic structure in which the secondary predicate and the object NP do not form a constituent (e.g. they do not form a small clause). Even if they did, it would be hard to argue that this clause structure blocks the object from raising to scope over the subject. As was pointed out in Chapter 2, there are a number of examples which show that QR is not always clause-bounded, including sentences with full CP complements, which have more structure than a small clause. Moreover, when the quantifier in the subject QP is changed to one which has a lexical bias to be interpreted existentially/weakly (see §5.7) the preference for narrow scope each is not nearly as strong, indicating that object QP can take wide scope:

(17)  
  a. *Fewer than three boys wiped each table clean.*  
  b. *More than three women stained each bookcase dusty.*

Similarly, when a different is employed the sentence is perfectly fine, showing that the each-phrase has raised over the subject.8

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8The secondary predicate in (17a) and (18) is a ‘resultative’ secondary predicate, and the one in (17b) is a ‘depictive’ secondary predicate. A resultative conveys the state of its associated NP at the completion of the process described by the verb, while a depictive conveys the state of the NP (footnote continued … )
A different boy wiped each table clean.

A different N must be within the scope of a each or every to be interpreted (Beghelli & Stowell 1997). Together these observations demonstrate that the difference between (15a) and (b) should not be ascribed to syntax.

Because the factors in (15) and (16) are well-defined– a difference in quantifier (each or every) and the presence or absence of a secondary predicate which applies to individuals– they are easily manipulated experimentally. Thus they offer an advantageous setting in which to test the Quantifier Satisfaction Hypothesis. In the following sections I report on two questionnaire studies which were conducted to gather scope preferences on sentences such as these. The results provide strong support for the QSH.

5.4 Pilot Experiment 1 – Scope Preferences and the Differentiation Condition

The secondary predicate examples discussed in the previous section were first tested in a small pilot study.

5.4.1 Method

Nineteen volunteers from the MIT community participated. Eight items like those in (19) (from (15) and (16) above) were presented in a printed questionnaire, crossing quantifier (each or every) with presence/absence of a secondary predicate. The items were counterbalanced across four lists. See the Appendix for a full list of targets.

during (or at least at the start of) the process. As (i-a) shows, depictive secondary predicates, unlike resultatives, are incompatible with a different. The source of the awkwardness of (i-a) is not the difficulty of giving each wide scope; rather, it seems related to interpretation. While (i-a) is degraded, so is (i-b), which approximates it’s meaning:

(i) a. ??A different woman stained each bookcase dusty.
   b. ??A different woman stained each bookcase while it was dusty.
   cf. More than three women stained each bookcase while it was dirty.
   OK: each > more than three

This is true for cases where a different N marks the set to be distributed over within the sentence; the reading in which it picks out an N different from the N discussed earlier in the discourse is not relevant here.
(19)  a. A painter bought each brush.
   b. A painter bought every brush.
   c. A painter bought each brush dirty.
   d. A painter bought every brush dirty.

There were twelve potentially ambiguous filler sentences,\(^{10}\) for a total of 20 items. At least one filler item intervened between target sentences.

Participants were told to read each sentence once and to fix in their mind the first impression of what the sentence meant, and then to turn the page and choose which of two paraphrases given there was closest to the meaning they had arrived at. The importance of determining the meaning of the target sentence before reading the paraphrases was stressed. The paraphrases for example (19) were as follows:

(20)  a. The brushes were all bought by the same painter (and they were all dirty when bought).
      [ Forward Scope: \(a > \text{each, every}\) ]
   b. Each brush was bought by a possibly different painter. (Plus each one was dirty when it was bought.)
      [ Inverse Scope: \(\text{each, every} > a\) ]

The parenthesized material was given only in conditions (c) and (d), where there was a secondary predicate. The “same” paraphrase, as in (20a) above, was listed first for half of the items and second for the other half.

According to the Quantifier Satisfaction Hypothesis, the inverse scoping will be preferred to a greater degree (i.e. the “possibly different painter” paraphrase will be chosen more often) in condition (a), when the quantifier is each and there is no secondary predicate, than in any other condition, since only in condition (a) is there a reason to violate the PSI. There should be little difference among conditions (b,c,d). Thus, an interaction of quantifier and ±predicate is predicted.

\(^{10}\)Two of the lists contained one filler with every, and two lists contained four. No fillers included each.
5.4.2 Results and Discussion

Figure 5.1 gives the percentage of cases where the preferred scope was the inverse scoping of *each* or *every* over *a* (i.e. the “possibly different painter” paraphrase was chosen), by condition. As expected under the QSH, there were more inverse scopings in condition (a), *each*/–predicate, and the rest of the conditions differed little from one another.

![Figure 5.1 Percentage of cases where the preferred scope was each, every > a in Pilot Experiment 1](image)

For the purposes of analysis, items in which *each* or *every* was given scope over *a* were coded with a ‘1’ and items in which *a* was given scope over *each* or *every* were coded with a ‘0’. Planned contrasts of condition (a) compared to each of the other conditions were significant in the participants analysis, but very weak in the items analysis; for the effect of ±predicate on *each* (condition (a) vs. (c)), and the effect of quantifier when there was no secondary predicate ((a) vs. (b)), $F_1(1,18) = 5.03, p < .05$; $F_2(1,7) = 3.28, p < .15$; for each/–predicate vs. every/+predicate ((a) vs. (d)), $F_1(1,18) = 7.86, p = .012$; $F_2(1,7) = 4.78, p = .065$. No other contrasts approached significance, all $Fs < 1$. Since the predicted pattern of effects was significant only in these
analyses, and even then only by participants, a larger and better controlled version of the pilot study was designed and conducted.

5.5 Experiment 3 – Scope Preferences and the Differentiation Condition

The main manipulations in Experiment 3 were as in Pilot 1. In addition, since the intuitions of some speakers suggested that different types of secondary predicate had different effects on scope judgements, two more conditions were added so that the effect of two kinds of secondary predicates– resultatives and depictives (see fn. 8)– could be compared. One reason to suspect that these kinds of secondary predicates might influence scope in different ways is that they are given distinct syntactic structures on most analyses. Beyond this single change, the design for Experiment 3 was the same as for Pilot Study 1.

5.5.1 Method

Materials and Design. As in the pilot study, the materials were presented in a written questionnaire, with the experimental sentences printed on one side of a page and the paraphrases on the other side. Eighteen sets of sentences with the general form in (21) were constructed. An example sentence set and the corresponding paraphrases are given in (22) and (23).

(21)  a. $N_1 \ V \ each/every \ N_2 \ (Pred)$

(22) a. A boy sliced each carrot. no predicate each
      b. A boy sliced every carrot. every

\[\text{\textsuperscript{11}}\text{A two-factor ANOVA of \pm secondary predicate x quantifier yielded a main effect of \pm predicate, so that sentences without secondary predicates assigned wide scope on each or every more often than sentences with a secondary predicate, } 26.3\% \text{ vs. } 13.2\%, F_1(1,18) = 10.84, p < .005; F_2(1,7) = 5.73, p < .05. \text{ There was a very marginal effect of quantifier, with each being given wide scope more than every, } 26.3\% \text{ vs. } 13.2\%, F_1(1,18) = 2.89, p = .106; F_2(1,7) = 3.99, p = .086. \text{ The predicted interaction was not significant Fs < 2.}\]

\[\text{\textsuperscript{12}}\text{For one proposal on the syntactic differences between predicate types and how they might affect the processing of these constructions, see Frazier & Clifton (1996).}\]
c. A boy sliced each carrot thin.  
resultative predicate  
each

d. A boy sliced every carrot thin.  
every

e. A boy sliced each carrot raw.  
depictive predicate  
each

f. A boy sliced every carrot raw.  
every

(23)  
a. All the carrots were sliced by the same boy { Ø / into thin pieces / when they were raw }.
   [ Forward Scope:  a > every, each ]

b. Each carrot was sliced by a possibly different boy { Ø / into thin pieces / when it was raw }.
   [ Inverse Scope:  every, each > a ]

N₁ was always animate and N₂ was always inanimate. The “same” paraphrase, as in (23a) above, was listed first for half of the items and second for the other half (balanced across conditions).

The primary predictions for this experiment are the same as for Pilot 1. Following the Quantifier Satisfaction Hypothesis, inverse scope should be assigned more often in condition (a), when the quantifier is each and there is no secondary predicate, than in any of the other conditions, since the Differentiation Condition is not satisfied in (a). No effects of predicate are predicted for every, because its Event Distributivity Condition is fulfilled on the forward scoping whether a secondary predicate is present or not.

In addition to the target items, four control sentences were constructed which looked like the (a,b) target sentences but which were pragmatically biased towards a particular scoping: two towards the each, every > a scoping and two towards the a > each, every scoping. The control sentences and their intended scopings are given in (24). The paraphrases for these items were identical in form to the paraphrases for the target items.

(24)  
a. A cat was sleeping on each chair.  
each>a

b. A pen lay on every book.  
every>a

c. A doctor checked each finger.  
a>each

d. An editor corrected every typo.  
a>every

These sentences were included to make sure that participants were truly thinking about the items and not simply responding the same way every time they say an item of the form in (21). Since the strength of the bias was stronger in (24a,b) than in (c,d), it was decided that a participant
would be excluded from analysis if he or she chose the wrong paraphrase for (24a), or for (24b), or for both (24c) and (d).

There were 24 filler sentences similar in length to or slightly longer than the targets, for a total of 46 items. Twenty of the fillers were ambiguous and 4 were unambiguous. As with the controls, the unambiguous fillers were included to assess whether participants were paying attention. A sample unambiguous filler and its paraphrases are given in (25):

(25)  *The worker patiently explained how to load the truck.*

a.  *The worker explained how to be patient while loading the truck.*       [Incorrect]

b.  *The worker was patient as s/he explained how to load the truck.*       [Correct]

Of the 20 ambiguous fillers, 12 were part of another experiment on the interpretation of adjectives and 8 were of various other types, including ambiguities of PP attachment and the scope of negation. None of the fillers contained *each* or *every* or a secondary predicate.

Six lists were made up, counterbalanced so that each participant saw three target items in each condition and only one version from each sentence set. Some secondary predicates were used more than once in the materials, but the lists were constructed so that a given predicate occurred only once on each list. The lists were pseudo-randomized so that at least one filler followed each target or control item. The experimental sentences were printed on one side of the page and the paraphrases were printed on the other side. The survey was three pages (front and back) long. The order of the pages was shuffled for each subject. At least one control item occurred on each page.

**Procedure.** The procedure was the same as for Pilot Experiment 1. The survey took about 10-15 minutes to complete. It was given to participants after an unrelated 35-minute self-paced reading study.

**Participants.** Seventy-seven participants took part in the study. Thirty-one were undergraduates from the University of Massachusetts, Amherst, who received course credit in introductory psychology for their participation. Forty-six were from the MIT academic community (primarily undergraduates at MIT), who were paid for taking part. All were native
speakers of English and were naive as to the purpose of the study. None of the participants took part Pilot 1.

5.5.2 Results

Participants’ performance on the control items and unambiguous fillers was quite poor. Of the 77 participants, there were 9 who failed the criterion set up for the control items, 2 who got two of the unambiguous fillers wrong, and an additional 24 who got one unambiguous filler wrong. Nevertheless, the pattern of results and the strength of the effects is very similar whether all 35 of these poorly-performing participants are excluded, only the 11 worst ones are, or none are. The results reported below are based on the data from all 77 participants. There were no differences between the group of participants run at UMass and the group run at MIT.

The type of secondary predicate did not have any effect, so the resultative and depictive predicate conditions for each quantifier were collapsed for analysis (i.e. conditions (c) and (e) were combined, as were (d) and (f)), yielding two levels for the predicate factor (absent, present) rather than three (see Appendix B for the results broken down by predicate type).

For the purposes of analysis, items for which the “possibly different boy” paraphrase was chosen (indicating each, every > a scope) were coded with a ‘1’ and items for which the “same boy” paraphrase was chosen (indicating a > each, every scope) were coded with a ‘0’. A 2x2 ANOVA of quantifier and predicate presence was performed. Across the whole experiment, there was a significant main effect of predicate presence, with –predicate items yielding more inverse scopings (each, every > a) than +predicate items, $F_1(1,76) = 17.19$, $p < .001$; $F_2(1,17) = 13.50$, $p < .005$. This result was numerically but not statistically bigger for each (21% each/–predicate; 17% every/–predicate; 9% +predicate, for both each and every). No other effects approached significance, Fs < 2.

Many participants reported noticing and disliking the secondary predicate items in the
In order to assess whether these observations had an effect on how participants responded to the target items, the data from each participant was split into two halves: the first nine items s/he saw vs. the second nine items s/he saw. Figure 5.2 (pg. 145) presents the percentage of cases where each or every was given wide scope in the combined predicate conditions and in the conditions without predicates, broken down by halves. As can been seen, the predicted pattern was obtained in the first-half items: there were more inverse scope readings for each/-predicate than for any other combination of factors. For the second-half items, there were no differences between each and every. It seems that part-way through the experiment, participants were bothered by the secondary predicate items enough that they began paying attention only to whether there was a secondary predicate or not, and were no longer noticing what the quantifier was.

2x2 ANOVAs of quantifier and predicate presence were performed separately for the first-half and second-half items. Analysis of the first-half items yielded a significant main effect of predicate presence, $F_{2}(1,17) = 7.28, p = .015$; and a main effect of quantifier, $F_{2}(1,17) = 4.47, p = .05$. The interaction of quantifier and predicate presence was marginal, $F_{2}(1,17) = 3.30, p = .087$. Planned contrasts on the means showed the expected pattern. Critically, there was a significant effect of predicate presence when the quantifier was each, $F_{2}(1,17) = 8.00, p = .012$; but not when the quantifier was every, $F_{2} < 1$. In addition, the effect of quantifier was marginal without a secondary predicate, $F_{2}(1,17) = 4.33, p = .053$; but unreliable with a secondary predicate, $F_{s} < 1$. Furthermore, one-factor ANOVAs on the effect of condition showed that the each/-predicate items differed significantly from all the other conditions, $F_{2}(1,17) = 8.56, p < .01$; and that the non-each/-predicate conditions did not differ from one another, $F_{2} < 1$.

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13 For instance, a number of subjects said that e.g. A gardener pruned every bush frozen should have been A gardener pruned every frozen bush, with the secondary predicate changed to a prenominal adjective.

14 Only items-analyses were possible for most statistical tests reported here. In the participant analyses, there was not an equal number of participants for all combinations of factors. The lists had not been constructed with the intention of analyzing only the first (or second) half of the items a participant saw.
For the second-half items, there was a reliable main effect of predicate presence,
$F_2(1,17) = 7.08, p = .016$. The effect of quantifier and the interaction of quantifier and predicate
presence were not reliable, $Fs < 1$. Planned contrasts on the means revealed significant effects of
predicate presence for both $each$, $F_2(1,17) = 4.43, p = .05$, and $every$, $F_2(1,17) = 4.36, p = .052$. The
effect of quantifier was nonsignificant with a secondary predicate, and without one, $Fs < 1$.

5.5.3 Discussion

The results from the first-half items in Experiment 3 replicate the findings of Pilot
Experiment 1, with a different set of items and a different participant pool. Together the two
experiments provide strong support for the Quantifier Satisfaction Hypothesis. As predicted, $each$
had a stronger preference for inverse wide scope when there was no secondary predicate than it
did when a secondary predicate was present, and there was no effect of predicate presence on
$every$. These findings are explained as follows: The presence of a secondary predicate satisfies
$each$’s Differentiation Condition by directing attention to the individuals involved in the event
described by the verb (more on this point below). By the QSH, the uneconomical inverse scoping
is therefore not supported, and the preferred scoping is the default scoping determined by the

Figure 5.2 Percentage of cases where the preferred scope was $each, every > a$
in Experiment 3, for the first nine items vs. the second nine items that a participant saw.
PSI, where each has narrow scope. Without the secondary predicate, on the other hand, the Differentiation Condition is not easily met on the default forward scoping. One way to satisfy the condition in such cases is to give each wide scope over the subject indefinite, thus providing different agents for each subevent. This option is taken at least some of the time: the percentage of inverse scope readings is higher for each when there is no secondary predicate than when one is present. With every, forward scoping is always strongly preferred, whether of not there is a secondary predicate, because there is no reason to go beyond it. Every does not have a condition corresponding to each’s Differentiation Condition to drive it to take inverse wide scope.

Readers may be surprised that although there were significantly more inverse scope readings with each/–predicate than in any other condition the percentage was nevertheless fairly low, about 24%. That is, participants still preferred the forward scope reading for this condition. I believe this is primarily due to two related factors. First, as was discussed in Chapter 4, language users vary considerably as to how they fulfill the Differentiation Condition. While some people find the sentence Ricky took each apple (= 7a) odd because it is difficult to satisfy the condition using the default differentiating dimension of time, others find it acceptable because they go beyond time and find another way to differentiate or they invent scenarios that make differentiating based on time relevant. Some participants in the study may have been inclined to go beyond the overt content of the sentence, as just described, in order to meet the Differentiation Condition. This would help to explain the low percentage of inverse wide scope readings for the each/–predicate condition. According to the QSH, when the Differentiation Condition is fulfilled in another way, there is no need to give each wide scope over an indefinite subject (cf. the discussion of informant responses for examples (7a) and (8) in §5.2.3).

It seems unlikely, though, that the majority of participants fell into this category, especially given the experimental setting. No aspect of the task motivated participants to invent differentiating scenarios for the each/–predicate sentences they encountered. Giving each wide scope over the subject would be a conceivable way to differentiate, without having to go beyond the sentence and imagine a context. That this option was not taken more often suggests that the
processor commonly avoids inverse scope readings— or, more exactly, readings not generated from the required LF structure— even when they satisfy the lexical conditions of the quantifiers.

The picture that develops, then, is that the preferred scoping of a sentence is the default forward scoping which is consistent with the PSI, and that changing this scoping is quite difficult. Satisfying the lexical conditions of quantifiers provides a motivation for changing the default scope, yet it is not a strong enough motivation to produce inverse scopings all the time, since there are alternative ways of satisfying lexical conditions. Most participants in the present study probably simply read the sentences containing each and got the general sense that differentiation was important and felt this was enough to understand the sentence. As discussed in section 5.2.3, such an unspecific understanding of each is possible because how the Differentiation Condition is satisfied depends on context; an experimental setting is a kind of context.

I have been assuming a processing model in which a single LF is built from each S-structure. On such a model, only one reading is initially computed for a doubly quantified sentence, in accordance with Processing Economy and the PSI. Obtaining the other reading requires reanalysis. I have suggested that reanalysis only occurs under particular circumstances, such as when it is motivated by a desire to fulfill the Differentiation Condition. In Chapter 3 I argued that Experiment 1 did not distinguish between a single-LF system such as this and a ranked-parallel system in which multiple LFs are built, with Processing Economy determining the ranking. The results of Experiment 3 do not help to decide between these approaches either. In a ranked-parallel model, if the Differentiation Condition is not satisfied on the default forward scoping, the alternative, lower-ranked scoping would be assessed to see whether it fulfills the condition. If it does, its ranking would go up. Experiment 3 suggests that this alternative LF does not win out very often. In other words, its ranking does not seem to improve much even when it satisfies the Differentiation Condition. Perhaps this is because it is quite costly to compute and is therefore ranked quite low to being with.

The Secondary Predicate Effect. The results of Experiment 3 indicate that the presence of a secondary predicate satisfies each’s Differentiation Condition. But it is not precisely clear how it
does so. The explanation I have given so far is that the secondary predicate directs attention to
the individuals involved in the event described by the verb. This explanation has a different
flavor than the one given for how the condition is fulfilled by each scoping over an indefinite
subject. The secondary predicate does not contribute to the differentiation of subevents or
individuals per se. In fact, it specifies something which is the same about all of them.

It is possible that by identifying ways in which the subevents are the same, it becomes easier
to pick out the dimension on which they differ. This may also account for why adding various
adverbials helps questionable each sentences ((26c), pointed out by Tim Stowell, p.c.):

(26) a. ?? Each person in the room left.

b. Each person in the room left tired.

c. Each person in the room left early / at five o’clock.

A number of studies in psychology support this idea (e.g. Gentner & Markman 1994).

An alternative is that the use of each is more supported when more descriptive content about
the subevents is given. The extra content, like the use of each itself, indicates that the subevents
are considered important. This account better relates the secondary predicate cases to the
scoping-over-an-indefinite cases. Scoping over an indefinite subject provides more content for
the subevents as well, a different agent in each case.

I leave a more precise account of how secondary predicates satisfy the Differentiation
Condition to future research.

5.5.4 Summary

The present study provides evidence for the claim that the scope behavior of each and every
diffs only under particular circumstances. Each’s Differentiation Condition can drive each to
take inverse wide scope when it is not easily satisfied under the default forward scoping. Even in
these cases, inverse scoping is adopted at a surprisingly low rate. When the Differentiation
Condition is fulfilled each and every exhibit similar scope preferences, as predicted by the QSH.
Furthermore, Experiment 3 offers additional support for the PSI. The preferred scoping in the
target items was overwhelmingly subject > object.

**5.6 The Scope Behavior of *Each* in Other Constructions**

I am aware of two experiments which compared the scope behavior of *each* to that of another quantifier. First, *each* was compared to *all* in active and passive sentences. The results showed that *each* has a stronger preference for wide scope than *all*. Second, both *each* and *every* were employed in a study of sentences in which one QP is contained within another. No differences between *each* and *every* were found. These findings can be accounted for in the present theory if the materials used in the studies are considered.

**5.6.1 *Each* vs. *All* in Actives and Passives**

The scope behavior of *each* was compared to that of *all* in a study conducted by Brooks & Braine (1996, Experiment 2) as part of their research on children’s understanding of these quantifiers. Data from adults was used as a point of comparison for the developmental data. Active and passive sentences like those in (27) were used.

(27)  *Each man is building a boat.*

    *All the men are building a boat.*

    *A boat is being built by each man.*

    *A boat is being built by all the men.*

According to the PSI, forward scope should be preferred in both actives and passives, since the first QP c-commands the second QP in the required LF structure. What effect might quantifier choice have here? The QSH predicts that *each* should only take inverse wide scope if it is motivated to do so in order to satisfy the Differentiation Condition. *All*, on the other hand, may take inverse narrow scope in order to fulfill a condition of its own that favors collective readings.

The experiment proceeded as follows: Each item was read aloud and participants chose which of two pictures better represented the sentence they had just heard. The pictures were consistent either with a wide-scope indefinite interpretation of the sentence (in which all of the
actors were shown acting collectively on an object) or a wide-scope universal interpretation of
the sentence (in which each of the actors was shown acting separately on a different object; i.e.
depicting a strictly distributive event). The universally quantified phrase was always the agent.

After a participant completed the picture-choice task for all items in the experiment, he or
she was read a small number of target sentences again (one of each of the four types shown in
(27)). Again, he or she was asked to choose the picture that went best with the sentence just
heard. After the selection was made, the participant was asked whether the remaining picture
could also go with the sentence.

The results of the main picture-choice task were as follows. Each was given wide scope more
often than all, and there were more wide-scope universal readings for actives than for passives.
Because the universal quantifier was the head of the first QP in the active sentences but of the
second QP in the passives, the latter finding amounts to saying that there were more forward
scope readings in the actives than there were inverse scope readings in the passives. This result is
expected under my theory, since inverse scopings violate the PSI.

By quantifier, each received wide scope 99.2% of the time in actives, and 82.5% of the time in
passives, while all received wide scope 16.7% of the time in actives and 1.7% of the time in
passives. These findings are consistent with the idea that all is often used to indicate a collective
event structure and each is used to indicate a distributive event structure. That the default
forward scoping in the target sentence was sometimes overridden in order to satisfy these lexical
conditions– giving each inverse wide scope, giving all inverse narrow scope– is predicted by the
Quantifier Satisfaction Hypothesis.

What is surprising, however, is how frequently this occurred with each, around 83% of the
time compared to 24% for inverse wide-scope each in my own Experiment 3. Given the small
number of items in the study (18, with no fillers), it is possible that participants became aware of
the quantifier manipulation, and that this heightened the influence of the quantifiers’ lexical
biases. The nature of the pictures probably also contributed to this effect. In the collective picture, it is difficult to satisfy the Differentiation Condition, making it incompatible with each: all the men are shown working on the same boat at the same time, for example. Furthermore, although all can be used to express distributive action, it is not employed to stress distributivity—but that is what the distributive picture seemed to be doing, in that it depicted a strict distributive event.

When participants were asked whether the target sentences could be used to describe each of the pictures, the picture showing collective action (scope: indefinite > universal) was accepted 100% of the time for all, and the picture showing distributive action (scope: universal > indefinite) was accepted nearly 100% of the time for each. These results held whether the sentence was in active or passive voice. More telling are the acceptance rates for the pictures depicting the reading which did not match the bias of the quantifiers. For each, the collective picture was accepted 25% of the time after an active sentence and 20% of the time after a passive sentence. According to the theory I have developed, these rates are low because, as mentioned above, the Differentiation Condition is not easily fulfilled in the collective picture. For all, the distributive picture was accepted 70% of the time after an active sentence but only 20% of the time after a passive. This difference is expected on my theory, since the active sentences supported the distributive event structure on the default forward scoping, but the passive sentences supported it only on the inverse scoping which violates the PSI. The relatively high rate of acceptance of the distributive picture for all in an active sentence suggests that all’s preference for a collective event structure is weaker than, and thus can be set aside more easily than, each’s Differentiation Condition.

15The participants in my Experiment 3 probably picked up the quantifier manipulation as well, but analyses of the first vs. second halves of the study indicated that they noticed the ±predicate manipulation more.

16These comments are not meant as criticisms of the study. Brooks & Braine’s intention was to investigate each as a distributive quantifier and all as a collective quantifier. The pictures clearly served this purpose.
In sum, Brooks & Braine's findings provide further support for the current theory, showing effects of both syntactic structure and quantifier type predicted by the PSI and the QSH.

5.6.2 One QP Within Another: Inverse-Linking Structures

Intuitions suggest that the lower quantifier in sentences like (28) and (29), in which one quantified phrase is contained within another (called inverse-linking structures by May, 1977), generally takes wide scope over the higher quantifier. Many researchers go further and claim that only one scoping is available in these structures, as in the double object construction (though here it is the inverse scoping and with double objects it is the forward scoping). (Gabay & Moravcsik, 1974, are often cited as the first to have discussed examples like these.)

(28) \[ QP_1 \text{ All the gifts to } [QP_2 \text{ some girl }] \text{ were wrapped in red paper.} \]  
   (Reinhart 1983:196)

(29) a. Everybody in some Italian city met John.

b. Some people from every walk of life like jazz.

c. Every senator on a key congressional committee voted for the amendment.  
   (May 1977:62,102)

The results of two studies by Kurtzman & MacDonald (1993) on these structures support the intuitive preference for inverse wide scope. Their data is particularly interesting because they employed each and every in some of their items. I will begin by discussing the syntax of these structures, then turn to a review of the studies.

Inverse-linking examples have always posed a problem for theories of scope based on surface c-command relations, since although the first quantifier c-commands the second, it is the second which gets wide scope. But note that the C-command Principle is usually formulated as referring to the relation between the two whole QPs, not the quantifiers/determiners within them. On this formulation, it does not apply to inverse-linking structures, since one QP contains the other. The first Q and N do not form a constituent on their own. So QP_1 does not c-command and is not c-commanded by QP_2. Hence, on this formulation, the C-command Principle makes no prediction about the preferred scope in these structures. The Principle of Scope Interpretation
that I have proposed, however, correctly predicts that inverse scope should be preferred. I will return to this point shortly.

The analysis usually given for why the forward scoping is difficult (or impossible) to get in these structures is in the same vein as that given for why the inverse scoping is difficult (or impossible) to get in double object structures: in both cases there is a trace that can only be properly bound in one configuration. The difference between the two constructions is the constituency of the QPs. In inverse-linking structures the quantifier and noun of the first QP (*some people*) do not form a constituent while in QP2 they do (*every walk of life*). Thus, QP2 can move on its own, but QP1 cannot; it always drags along QP2 or a trace of QP2. In the double object construction, as analyzed by Runner (1995), the reverse is true (see Chapter 3, §3.3.2).

At S-structure, the entire phrase *some people from every walk of life* in (29b) is in [Spec,AGRsP], as shown in (30a). At LF, QP2 (*every walk of life*) must raise because it cannot be interpreted as the complement of a preposition, since that is a type-e position. It adjoins to AGRsP (the PP, NP, and DP are not of the appropriate semantic type for the QP to adjoin to) and leaves behind a trace within QP1. If QP1 were to also raise, and adjoin to AGRsP above QP2, then the trace of QP2 would not be properly bound, violating the ECP. Thus QP2 must scope over QP1.
May (1977) argues that the inverse scoping is the only one which the grammar can generate for sentences like (12) and (13). He admits, however, that a small number of examples, including (13c), also allow the forward scope reading. He calls this reading the ‘relative’ reading because it is interpreted like a relative clause. For instance, for (13c) this reading can be paraphrased as “Every senator who is on a key congressional committee….” May maintains that this interpretation is idiosyncratic, depending on the choice of preposition and the choice of quantifiers, whereas the inverse scope reading is always available. When every in (13c) is replaced by each or all of the, for example, the relative reading is no longer available. May suggests that the relative reading must be derived outside the sentence grammar.

Huang (1982:196-7) maintains that inverse-linking structures are ambiguous, but that some interpretations are harder to get because of pragmatic effects. It seems fairly clear that pragmatics and plausibility are indeed playing a role here. Consider (13b). Individual people come from one
or two occupations, not every one; the some>every scoping is implausible. Similar comments can be made about the well-known example in (31) (from May 1977):

(31) Some exits from every freeway are badly constructed.

Though one can imagine exit ramps from two close freeways merging together to form one, it is impossible to extend this picture so that the exit is from every freeway. Numerous inverse-linking examples have this character. Reinhart (1983:195) offers a similar example, The policeman found a bomb in every mailbox. All the examples I have encountered of this type have an indefinite as the first quantifier and a universal as the second quantifier.

According to the theory of scope preferences that I have developed in this dissertation, the scoping based on surface c-command is generally preferred. Why is that not the case here? To be interpreted, QP₂ must raise and adjoin to a clausal projections; that’s part of the required LF. QP₁ cannot raise above QP₂, because then QP₂’s trace would not be bound. So in the required LF, QP₂ scopes over QP₁, and the PSI predicts this to be the preferred scoping. The forward scoping of QP₁ > QP₂ can be obtained, but only through employing an expensive operation of some kind: violating the ECP, building extra syntactic structure into the phrase such as adding a clausal node inside it, as May suggested, or employing high semantic types to interpret the QPs (see Heim & Kratzer, 1998, for discussion of these alternatives). Such expensive operations are dispreferred when not motivated.

Experiments on Inverse-Linking Structures. As mentioned above, Kurtzman & MacDonald (1993) conducted two studies on inverse-linking structures which supported the widespread intuition that inverse scope is preferred in them. Moreover, they employed both each and every as one of the quantifiers in the items, allowing a comparison of their scope behavior.

According to the QSH, each should generally pattern with every, unless it is motivated to override the PSI and take wide scope in order to satisfy the Differentiation Condition. Because the scoping computed from the required LF in inverse-linking sentences is QP₂ > QP₁, the place to look for quantifier effects is in items where the each- or every-phrase is QP₁.

K&MacD’s inverse-linking experiments used a design very similar to their active and passive
studies (reviewed in Chapter 2). In their Experiment 3 there were eight conditions: four “ambiguous” and four “lexically biased.” I begin by describing the former, leaving the latter to be discussed prior to their Experiment 4, which further explored lexically biased items.

In the ambiguous conditions of Experiment 3, the quantifiers were a and every, and quantifier order crossed with continuation type. See (32) for sample items, along with the scoping the continuation sentence was intended to be consistent with. As in K&MacD’s other experiments, participants judged whether the continuation was compatible with the quantified sentence. The items were constructed so that both scopings were plausible (unlike (31) discussed above).

(32) a. George has a photograph of every admiral. The photograph was quite famous. a>every
b. George has a photograph of every admiral. The photographs were quite famous. every>a
c. George has every photograph of an admiral. The admiral was quite famous. a>every
d. George has every photograph of an admiral. The admirals were quite famous. every>a

The results for these conditions indicated a weak preference for inverse scope in the every-a order (approximately 57% compatibility for inverse scope, condition (c), vs. 42% for forward scope (d), a difference of 15%) and a strong preference for inverse scope in the a-every order (about 90% compatibility for inverse scope (b) vs. 38% for forward scope (a), a difference of 52%). K&MacD do not present an ANOVA on just these four conditions, or relevant t-tests, so it is unclear whether there is a significant interaction here, i.e. whether the strength of the preference for inverse scope is significantly different for the two different quantifier orders. However, the data clearly point in that direction.

The lexical bias conditions of Experiment 3 contained either each or the, as quantifiers biased to take wide scope. Each was paired with a as the second quantifier, and the was paired with every. For both pairs, both quantifier orders were presented but only the continuation that was consistent with the lexical bias of the quantifiers was used. As shown in (33), for each/a the continuation was plural, consistent with each getting wide scope, and for the/every the continuation was singular, consistent with the getting wide scope.
The compatibility rates for the lexically-biased conditions were very similar to those for the ambiguous *a-every* conditions, yielding high compatibility judgements in (b) and (c) where the continuation was consistent with wide scope on the second quantifier.

In Experiment 3 as a whole, the preference for inverse scoping was significant, and due to the weak preference for inverse scope with *every-a* vs. a strong preference for inverse scope elsewhere, there was a significant three-way interaction of ambiguity, continuation, and quantifier order.

In Experiment 4, K&MacD further examined lexically biases, using the quantifier pairs *each/a* and *every/the*. In contrast to Experiment 3, only one quantifier order was employed— the universal quantifier was always first— but the continuations varied, half the time being inconsistent with the lexical bias of the quantifiers. Conditions (33c) and (d) from Experiment 3 were re-run, along with those in (34):

(34) a. *George has each photograph of an admiral. The admiral was quite famous.*  
    b. *George has every photograph of the admiral. The admirals were quite famous.*

The *each-a* items in Experiment 4, (33d) and (34a), yielded a weak preference for inverse scope (about 58% compatibility for inverse scope vs. 44% for forward scope, a difference of 14%), marginally significant by a *t*-test. Hence the results for *each-a* items here matched those for the *every-a* items in Experiment 3, (32c,d). This finding is important to the question of how *each* and *every* differ with respect to scope preferences. I will return to it shortly.

For the *every-the* conditions in Experiment 4, (33c) and (34b), there was a strong inverse scope preference, matching the *a-every* pattern in Experiment 3, (32a,b): 78% for inverse scope vs. 30% for forward scope, a difference of 48%. There was a significant interaction between the strong
preference in the *every-the* conditions and the weak preference in the *each-a* items.\textsuperscript{17}

Kurtzman & MacDonald observed that none of the scope principles they were assessing can account for the preference for inverse scope that they found in these experiments. They stated that their findings indicate that the C-command and Linear Order Principles either are completely invalid or for some reason do not operate in inverse-linking structures, and that a new principle, yet to be composed, is needed to capture the preferences in these structures. I maintain that the PSI can handle the inverse scope preference in inverse-linking structures as well as it can account for scope preferences in other constructions. For inverse-linking sentences, inverse scope is assigned because it is this scoping which is computed from the required LF.

The fact that K&MacD found some support for forward scope readings in inverse-linking structures led them to state that ruling out this reading by grammatical principles seems “extreme” (p. 269). I concur. The forward scoping should not be considered impossible to generate, but rather less economical.

I turn now to a comparison of the *each-a* and *every-a* items. These items were the critical place to look for differences between *each* and *every*, since giving the *each-* or *every-*phrase wide scope would override the PSI. The results indicated that the *each-a* and *every-a* conditions were treated similarly by participants. K&MacD did not point out this similarity directly. Instead, they commented on finding a lower rate of compatibility judgements for wide-scope *each* than they had expected. They concluded (p. 267) that “the preference [for inverse scope in inverse-linking structures] is so strong that it can overcome the scope tendencies of particular quantifier terms.” I take a different view. *Each* is not inherently biased to take wide scope more often than *every*, but it will do so, following the QSH, in order to meet the Differentiation Condition. That *each* did not take wide scope more than *every* here suggests that the Differentiation Condition is fulfilled in these items without *each* taking wide scope. For example, in *Jack photocopied each article about a*

\textsuperscript{17} K&MacD suggested that the weaker inverse scope preference in items where the second quantifier was *a* may be due to some awkwardness in having an indefinite in a deeply embedded position.
hostage it is easy to differentiate articles even when they are about the same hostage, and in The
manager responded to each request from a worker it is easy to differentiate requests even when they
are from the same worker.

Thus, Kurtzman & MacDonald’s experiments on inverse-linking structures had the potential
of revealing differences between the scope behavior of each and every, but in the end exhibited
none. These results are accounted for by the QSH, providing that the Differentiation Condition
was satisfied in the items they tested. Furthermore, these studies provide additional support for
the PSI, using a construction in which the C-command and Linear Order Principles at best yield
no prediction about which scoping should be preferred.

5.6.3 Further Investigations of the Scope Behavior of Each

Clearly, more research should be done on comparing the scope behavior of each to that of
other quantifiers. The studies reviewed above bring forward some issues that should be
considered in designing such studies. First, each should be studied in a setting which does not
amplify the Differentiation Condition the way it was in the strict distributive and strict collective
pictures in the Brooks & Braine experiment. Offering a picture of an event with a partial
distributive event structure might be a solution. Second, and more importantly, it would be best
if the materials in the study were pretested to show whether they did or did not satisfy the
Differentiation Condition without each scoping over an indefinite. Unfortunately, how to do such
pretesting is unclear. A simple acceptability rating task allows for too many other factors to
possibly influence participants’ responses. A method is needed which gets at the differentiation
question more directly. Using linguists as informants was helpful to me because they are trained
to think about and discuss their judgements of sentences. Future work on investigating the scope
behavior of each should begin with the question of how to have non-linguists evaluate whether
the Differentiation Condition is fulfilled or not.
5.7 The Role of Different Kinds of Indefinites

In this section I will demonstrate that the tendency for *each* and *every* to take wide scope is, in at least some cases, affected by the lexical conditions of the indefinites they occur with.

Recall from Chapter 2 that in Diesing’s system, indefinites are ambiguous between a weak/existential interpretation and a strong/presuppositional/quantificational interpretation. What has yet to be discussed is what determines which reading is obtained. Two factors play a role. First, the position of the indefinite: subjects are more apt to be interpreted presuppositionally than direct or indirect objects. This is likely due to the tendency to interpret the subject as given material, already established in the discourse. Second, the indefinite quantifier itself matters: certain quantifiers seem to prefer to be interpreted presuppositionally, while others prefer to be interpreted existentially.

For the present discussion I will concentrate on a particular set of QPs: those containing monotone decreasing quantifiers and modified numerals, such as *no one, fewer than three,* and *more than six.* There is general agreement that it is quite difficult, if not impossible, to get strong/presuppositional interpretations of these QPs, while QPs headed by *some, one, two, four,* etc., and perhaps to a lesser degree, *several,* are easily taken to be presuppositional (Ruys 1992; Beghelli 1993). For example, (35a) allows a presuppositional interpretation, while (35b) does not (see Ruys for a pragmatic account of why this is so):

(35) a. *The boy has kissed three girls.*

= “there is a (particular) set of three or more girls that have been kissed by the boy”   Strong reading

---

18 The strong tendency for overt partitives, built with the addition of *of the,* to be interpreted strongly/presuppositionally is also fairly well accepted, though, as was pointed out in Chapter 2 (§2.3.2), there are dialects where they can receive weak readings. On the other side, bare plurals are widely thought to require existential interpretations. Researchers disagree, however, on how strongly a *N* prefers one reading or the other. It is likely that there are individual and/or dialect differences here as well.
b. The boy has kissed less than three girls.

≠ “there is a (particular) set of less than three girls, who are girls who have been kissed by the boy” Strong reading

= “the number of girls that the boy kissed is less than three (possibly none)” Weak reading

based on Ruys (1992:166)

Beghelli (1997) investigated the availability of different scope readings in various constructions involving two QPs (c.f. Liu 1990). He was not concerned with scope preferences, but with which QPs in which positions yield which readings. The following examples are based on the paradigm that Beghelli offered.

(36) a. {Two of the women / several women / a woman / more than three women} visited every/each man.

b. {Two of the clerks / several clerks / a clerk / fewer than five clerks} weighed every/each package.

(37) a. John introduced {two of the professors / a professor / more than three professors} to every/each student.

b. Mary showed {two of the books / a book / fewer than five books} to every/each child.

My intuitions are that it is possible to get a wide scope interpretation of the every/each-phrase in these sentences (the inverse scoping), but that this reading is only preferred when the indefinite is more than three N or fewer than five N, which prefer to be interpreted weakly/existentially (see (38) and (39)). With the other indefinites forward scoping is preferred.

(38) Inverse scoping of (36a)

“for every/each man, there is a (possibly different) set of more than three woman who visited him”

(39) Inverse scoping of (37a)

“for every/each student, there is a (possibly different) set of more than three professors whom John introduced her/him to”

The LF representations for the inverse scopings of (36a) and (37a) are given in (40) and (41), respectively. In Diesing’s system indefinites must be internal to VP at LF to receive a weak/existential interpretation (so that they are mapped into the nuclear scope of the tripartite
semantic structure and captured by existential closure). Weak indefinite subjects and objects must therefore lower at LF from their surface [Spec,AGRP] positions into their base positions within VP.\(^{19}\) In both (40) and (41), the QP \textit{more than three women}, with its preference to be interpreted existentially, lowers into VP, placing it below the \textit{every/each}-phrase. In (40), \textit{every/each man} remains in its surface position, [Spec,AGRoP]. In (41), \textit{every/each student} has raised and adjoined to VP because as a strong QP it can not remain inside the VP at LF.

\[
\begin{align*}
\text{(40) } & \quad [\text{AGRsP } t_i \text{ visited } [\text{AGRoP } \text{every/each man}_i [\text{VP } \text{[more than three women] } k t_v t_i ]]] \\
\text{(41) } & \quad [\text{AGRsP } \text{John}_k \text{ introduced } [\text{AGRoP } t_i [\text{VP } \text{every/each student}_j [\text{VP } t_k t_v [\text{more than three professors} ]_k \text{ to } t_j ]]]]
\end{align*}
\]

The Quantifier Satisfaction Hypothesis explicates the effect of indefinite-type in (36) and (37): the lexical preference of \textit{more than three N} and \textit{fewer than five N} to be interpreted weakly/existentially motivates the violation of the PSI, while with the other indefinites there is no such motivation.

Although inverse wide scope of an object over a subject in a simple subject-object sentence is possible for \textit{every} (though not preferred), it is much harder for presuppositional indefinites such as \textit{three of the men}, as pointed out by Beghelli (1997). Compare:

\[
\begin{align*}
\text{(42) a. } & \quad \text{More than one woman visited three of the(se) men.} \\
\text{b. } & \quad \text{More than one woman visited every man.} = \text{(36a)}
\end{align*}
\]

\begin{align*}
\text{Inverse scope} = & \quad \{ \text{for each of these three men/for every man }, \text{there is a (possibly different) set of more than one woman who visited him}\}
\end{align*}

The contrast in (42) offers the first evidence that the Event Distributivity Condition is playing a role in determining the availability of inverse scope readings for \textit{every}. The subject here is an indefinite with a lexical bias for being interpreted weakly/existentially, thus inverse scoping is obtained by lowering the subject into VP, below the object in [Spec,AGRoP]. It seems that the subject's bias is not enough to make the inverse scoping easy in (a), but the combination of this

\(^{19}\) An alternative to syntactic lowering is 'semantic reconstruction' (see e.g. Bittner 1994; Cresti 1995; Rullmann 1995).
bias and every’s Event Distributivity Condition is sufficient to do so in (b). In essence, every says “I like distributing, so I will endorse a structure where I get to distribute over an indefinite.”

A final note on (42): when the head of the object QP is most, the inverse scope reading is easier to obtain than with a presuppositional indefinite, as can be seen by comparing (43) to (42a):

(43) More than one woman visited most of the men.

The interpretation of a partitive such as three of the men in (42a) as strong/presuppositional is favored, but not absolute. Most, on the other hand, is like every and each in always receiving a strong/presuppositional interpretation. Perhaps it is this factor which somehow makes inverse scope more available in (43) than in (42a). The question remains whether there is a difference between the ease/difficulty of assigning most wide scope in (43) versus assigning every wide scope in (42b). My judgements are unstable. Such direct comparisons of every and most are not often made. I take up this issue now.

5.8 Residue of the Scope Hierarchy

I have argued that the sense that each has a stronger preference for wide scope than every comes from cases where each takes wide scope in order to satisfy the Differentiation Condition, and that every’s Event Distributivity Condition does not affect scope nearly as strongly. What about the other quantifiers on Ioup’s hierarchy? Is the relative positioning valid? If so, what is behind it? There are two quantifiers in the hierarchy other than each and every which are strong quantifiers— which do not have the option of being interpreted within VP at LF, where they would be scoped over by QPs higher in the structure— all and most. How does their scope behavior compare to that of each and every?

The little data available on such comparisons are inconclusive. Gillen (1991) found slight differences in the scope behavior of every, most, and all in her Experiment 8, where participants judged whether a diagram depicting one of the scope readings was compatible with the quantified sentence they had read. Wide-scope universal diagrams were accepted at a slightly higher rate with every than with most (91% vs. 87%) and, correspondingly, wide-scope indefinite
diagrams were accepted slightly more often with *most* than with *every* (68% vs. 65%). On both measures, *all* was not far behind *most* (83% acceptance for wide-scope universal diagrams; 70% for wide-scope indefinite diagrams). However, as already noted, statistical tests comparing pairs of quantifiers were not conducted, so it is unclear whether these small differences are reliable.

*All* is often used to convey a collective event structure, though it does not absolutely require one. (To unambiguously indicate and emphasize a collective event, a collectivizer like *together* is used in addition to *all.*) Consider the example in (44). For this sentence to be true of a collective event– all the girls worked together at the same time to pick up a piano– it must have been the same piano they were all trying to lift. So the relative scoping of the quantifiers must be $a > all$.

(44) All the girls picked up a piano.

Thus *all* likely takes inverse narrow scope (overriding the PSI) to the extent that it favors collective structures in the sentences in question. In §5.6.1, I noted that the results of Brooks & Braine’s study comparing *each* and *all* suggested that *all*’s preference for a collective event structure is not as strong as *each*’s Differentiation Condition. It has yet to be determined how the strength of *all*’s lexical condition compares to that of *every*.

Unlike *each* and *every*, *most* does not require any amount of event distributivity, as (45) shows, though it does not bias towards a collective event structure the way that *all* does.

(45) Jamie lifted most of the baskets together (and the rest one at a time).

Consequently, if *every*’s Event Distributivity Condition has any effect on scope preferences, that effect might best show up when comparing *every* and *most*.

We have seen that obtaining inverse wide scope over a subject is often difficult. How does *most* fare in such sentences? Beghelli (1993:70), who maintains that QPs headed by *each* and *every* undergo QR but that QPs headed by other strong quantifiers do not, offers example (46a). He notes that it is very difficult to give *most* inverse wide scope over *a* here, despite the fact that the sentence is pragmatically biased towards an interpretation with multiple salesreps. In contrast, the latter interpretation is not only available with *each* and *every*, but preferred.
(46) a. A salesrep convinced most customers at the convention.

b. A salesrep convinced every/each customer at the convention.

Thus, each and every seem more amenable to pragmatic influence than does most. In (46b), as in (42b) at the end of the previous section, the Event Distributivity Condition and the Differentiation Condition have enough influence to, along with another factor—here plausibility, in (42b) the bias of the subject quantifier—make overriding the PSI easier. Most appears not have a corresponding lexical condition to help it out.

Certainly more experimental data should be gathered on the scope behavior of different types of quantifiers, especially within the same syntactic frame. The Quantifier Satisfaction Hypothesis allows for the lexical conditions of all quantifiers to play a role in determining scope preferences. We need to establish what those other lexical conditions are.

5.9 Open Questions

A number of open questions about the scope behavior of each and every remain. For one, recall from §4.7 that the domain of quantification for every must be specified in the context, while for each it can be accommodated much more easily. Whether this difference between each and every relates in any way to their scope behavior has yet to be determined.

Secondly, there is the question of whether the Differentiation Condition can be highlighted or backgrounded in certain contexts and, if so, how that would affect scope preferences. If the condition were highlighted, then it might be desirable to differentiate the subevents more than “normal,” on more than one dimension. Hence, we might expect more inverse wide scope of each over an indefinite subject even when the Differentiation Condition is satisfied on the forward scoping. If the Differentiation Condition were backgrounded, there might be less inverse scoping, even when the condition is not fulfilled on the forward scoping. I leave to future research how highlighting or backgrounding could be achieved.

A third issue concerns whether each and every respond differently to the Vagueness Principle. There are two situations to consider: when each is given scope over an indefinite by default,
following the PSI, and when each takes inverse wide scope\(^{20}\) in order to satisfy the Differentiation Condition.

In regard to the first case, consider the examples in (47), based on Kurtzman & MacDonald’s Experiment 1 materials. The preferred scoping is predicted to be each > a here. If the Vagueness Principle holds equally for each and every, then the (a) and (b) continuations should be read equally quickly, as was found with every in my attempted replication of K&MacD’s experiment.

(47) Each kid climbed a tree.
    a. The tree was full of apples.
    b. The trees were full of apples.

But the Vagueness Principle may not apply to each here. Each’s Differentiation Condition may influence the processor to multiply instantiate a tree. If so, the plural continuation (b) would be predicted to be read significantly faster than the singular continuation (a).

For cases where each is in object position and it is given inverse wide scope, consider Experiment 3 once again. In order to satisfy the Differentiation Condition, each carrot can scope over a boy in (48), providing a different agent for each subevent. Since there must be different agents in order to fulfill the condition, I would expect the Vagueness Principle not to hold in such cases. Note that the Experiment 3 survey cannot help us determine whether this hypothesis is correct because subjects were forced to choose an interpretation. In a reading study, this hypothesis would predict continuation (b) to be read faster than (a):

(48) A boy sliced each carrot.
    a. The boy was careful with the knife.
    b. The boys were careful with the knives.

One caveat should be raised here. Although there were significantly more instances of inverse wide scope in these cases (each/–predicate) than in other the conditions in Experiment 3, the rate was still quite low (24%). If this result carries over to a reading experiment, then more often than

\(^{20}\)For the remainder of this chapter I will use the term ‘inverse wide scope’ to mean the less economical scoping, achieved by changing the required LF structure.
not the scoping in (48) will be $a > each$ and only the singular continuation will be appropriate, with (a) being read faster than (b). It is unclear how this effect would balance out against the predicted effect of (b) being read faster than (a) when each is given wide scope. A different experimental design may be needed.

Finally, I have argued that there is a contrast between the scope behavior of each and every in the examples discussed in §§5.2-5.5 because of the Differentiation Condition, but the question arises as to whether there is a contrast only in such directly contributable cases. It is beyond the scope of the chapter to consider this question in detail, but I sense that the answer is no. It may be that due to examples such as those discussed earlier, a more general contrast between each and every with respect to scope has been established. Language users may choose each when they want to indicate inverse wide scope, even in cases where the Differentiation Condition is satisfied. But I would be surprised if studies revealed more instances of such cases than of cases of inverse wide scope motivated by the Differentiation Condition. If this were to happen, I would suspect that each is subject to some other condition, yet to be determined, in addition to the Differentiation Condition. The QSH would apply to both of them.

5.10 Concluding Remarks

Various factors play a role in determining quantifier scope preferences. The focus of the present chapter has been on the role that individual quantifiers play in this process. I have proposed a detailed and motivated theory of how and why specific quantifiers can influence scope preferences.

Following the results from Chapter 3, I assume that the default scoping for a doubly quantified sentence is determined by the economy-based Principle of Scope Interpretation (PSI): it is computed from the required LF structure of the sentence. Generally, if QP$_1$ c-commands QP$_2$ at S-structure, then the default scoping is QP$_1 >$ QP$_2$. The preferred scoping for the sentence is the default scoping, unless other factors operate to change it.

The central addition to this theory is the Quantifier Satisfaction Hypothesis, repeated in (49):
(49) **Quantifier Satisfaction Hypothesis (QSH)**

If necessary, the processor may move a QP at LF to a position above or below its required LF position in order to satisfy the conditions of the quantifier which heads the QP.

This hypothesis essentially specifies circumstances under which the inverse scoping, where the surface c-command relations are reversed, can be assigned. (Inverse-linking structures are an exception to this generalization. Since inverse scoping is the default scoping in such cases, it is the forward scoping that the QSH generates.) According to the QSH, a quantifier’s scope behavior is driven by the lexical condition(s) which are part of its meaning.

The QSH correctly predicts the differences in the scope behavior of the universal quantifiers *each* and *every*. *Each* has often been said to prefer wide scope more than *every*. I have provided evidence from informant responses and two questionnaire studies that a QP headed by *each* will take inverse scope in order to satisfy the Differentiation Condition, but that otherwise *each*- and *every*-phrases behave similarly, both taking narrow scope when they are c-commanded by another QP in the required LF structure. The Event Distributivity Condition does not seem to play much of a role in motivating inverse scoping for either *each* or *every*.

First, drawing on data from informants, I showed that sentences containing an *each*-phrase in object position which are awkward because the Differentiation Condition is difficult to satisfy, such as #Ricky took each apple, are improved by the addition of an indefinite subject and that the preferred scoping in the latter case is of the *each*-phrase over the indefinite. This phenomenon is accounted for by the QSH. The *each*-phrase takes wide scope in order to satisfy the Differentiation Condition: the subevents can be differentiated from one another by who did the taking in each one. Because the Differentiation Condition is fulfilled, the sentence loses its awkwardness. In contrast to that case, when an indefinite subject is added to a perfectly acceptable *each*-sentence, where the Differentiation Condition is already met, such as Ricky weighed each apple, the preferred scoping is the default, forward scoping where the *each*-phrase has narrow scope. This effect is predicted under the QSH, since there is no motivation for the *each*-phrase to scope over the subject here. Furthermore, when *each* was replaced by *every* in both of types of sentences, the
preferred scoping was of the indefinite over the *every* phrase. This result is expected because *every* does not have a condition corresponding to *each*’s Differentiation Condition to drive it to take inverse wide scope.

The second set of evidence for the QSH came from two survey studies on scope preferences in sentences with an object quantified by *each* or *every* and an indefinite subject. Sentences with a secondary predicate were compared to those without one. The results indicated a stronger preference for inverse scoping when the quantifier was *each* and there was no secondary predicate than when there was one and than when the quantifier was *every*. That secondary predicates can influence scope preferences has not been observed before. The explanation for the secondary predicate effect on *each* is as follows. Without the secondary predicate, it is difficult to satisfy the Differentiation Condition, so, by the QSH, the *each*-phrase can take wide scope over the indefinite subject in order to fulfill it. When the secondary predicate is present, however, inverse scoping is not supported because the secondary predicate itself satisfies the Differentiation Condition. It does so by directing attention to the individuals members in the set quantified by *each* and by adding descriptive content to the subevents, without requiring differentiation on another dimension. Surprisingly, the percentage of inverse scope readings in the surveys was quite low, even for *each*–predicate condition where inverse scope is motivated. This suggests that computing the inverse scoping is quite costly.

In sum, I have shown that, contrary to what is often assumed, *each* and *every* do not generally prefer to take wide scope over another quantifier. When taking wide scope would violate the PSI, it occurs at a very low rate. Moreover, I have presented evidence that *each* only wants wide scope more than *every* under very specific circumstances– in order to satisfy the Differentiation Condition, when it is not satisfied on the default scoping.

Such an approach is an improvement over simply adopting a hierarchy which specifies the inherent tendency to which a particular quantifier prefers wide scope as compared to other quantifiers, as Ioup (1975) did. It explains what is behind such tendencies. Future work should aim to further dismantle the scope hierarchy, examining the scope behavior of *all* and *most*. 
The present approach also helps to provide insight into why there is variability in scope preferences across language users and sentences—scope preferences are determined in part by quantifier conditions and quantifier conditions can be satisfied in a number of ways, depending on the sentence and the language user. This property sets my theory apart from alternative theories of scope preferences.
APPENDIX A

EXPERIMENT 1 RAW READING TIMES

Table A.1  Raw Reading Times for Each Region in Experiment 1 (msec./word)  
(Residual Reading Times in Parentheses)

<table>
<thead>
<tr>
<th>Analysis Region</th>
<th>(a) a-every singular</th>
<th>(b) a-every plural</th>
<th>(c) every-a singular</th>
<th>(d) every-a plural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Kelly showed</td>
<td>534 (-31)</td>
<td>540 (-27)</td>
<td>498 (-74)</td>
<td>477 (-82)</td>
</tr>
<tr>
<td>2. a/every photo</td>
<td>539 (10)</td>
<td>508 (-25)</td>
<td>558 (-12)</td>
<td>552 (-6)</td>
</tr>
<tr>
<td>3. to a/every critic</td>
<td>525 (-18)</td>
<td>499 (-47)</td>
<td>476 (-53)</td>
<td>490 (-30)</td>
</tr>
<tr>
<td>4. last month.</td>
<td>561 (6)</td>
<td>557 (-1)</td>
<td>545 (-13)</td>
<td>542 (-9)</td>
</tr>
<tr>
<td>5. The critic(s) was/were</td>
<td>463 (-65)</td>
<td>527 (-18)</td>
<td>469 (-71)</td>
<td>456 (-82)</td>
</tr>
<tr>
<td>6. from a major</td>
<td>464 (-69)</td>
<td>483 (-56)</td>
<td>455 (-77)</td>
<td>452 (-68)</td>
</tr>
<tr>
<td>7. gallery.</td>
<td>708 (100)</td>
<td>705 (87)</td>
<td>640 (68)</td>
<td>625 (55)</td>
</tr>
</tbody>
</table>

The effects in the analyses of raw reading times for the critical region, region 5, were as follows: Q-order, F$_1$(1,22) = 8.02, p = .01; F$_2$(1,19) = 2.57, p > .10; Number, F$_1$(1,22) = 8.43, p < .01; F$_2$(1,19) = 3.93, p < .07; Q*N interaction, F$_1$(1,22) = 9.15, p < .01; F$_2$(1,19) = 17.77, p < .001; means comparison of (a) vs. (b), F$_1$(1,22) = 16.72, p < .001; F$_2$(1,19) = 14.58, p = .001; means comparison of (c) vs. (d), Fs < 1.

The significant effects for other regions were: Region 1: Q-order, F$_1$(1,22) = 5.91, p < .05; F$_2$(1,19) = 6.45, p < .05. Region 3: Q-order, F$_1$(1,22) = 4.82, p < .05; F$_2$(1,19) = 3.48, p < .08. Region 6: Q-order F$_1$(1,22) = 8.63, p < .01; F$_2$ unequal N.
APPENDIX B

EXPERIMENT 3 ADDITIONAL ANOVAs

Table B.1  Percentage of Cases Where each, every > a Scope was Preferred for All Items in Experiment 3

<table>
<thead>
<tr>
<th></th>
<th>– Predicate</th>
<th>+ Predicate</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Resultative</td>
<td>Depictive</td>
<td>Combined</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a)</td>
<td>21.4</td>
<td>(c)</td>
<td>9.5</td>
<td>(e)</td>
<td>10.0</td>
<td>9.7</td>
</tr>
<tr>
<td>each</td>
<td>(b)</td>
<td>17.3</td>
<td></td>
<td>(d)</td>
<td>9.1</td>
<td>(f)</td>
<td>9.5</td>
<td>9.3</td>
</tr>
<tr>
<td>every</td>
<td>(a)</td>
<td>21.4</td>
<td></td>
<td>(c)</td>
<td>9.5</td>
<td>(e)</td>
<td>10.0</td>
<td>9.7</td>
</tr>
<tr>
<td>every</td>
<td>(b)</td>
<td>17.3</td>
<td></td>
<td>(d)</td>
<td>9.1</td>
<td>(f)</td>
<td>9.5</td>
<td>9.3</td>
</tr>
<tr>
<td>Mean</td>
<td>19.4</td>
<td>9.3</td>
<td>9.7</td>
<td>9.5</td>
<td>12.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A 2x3 ANOVA with quantifier (each or every) and predicate type (none, resultative, depictive) as factors was performed on all the data. There was a significant effect of predicate, with the sentences containing no secondary predicate getting more wide scope on the universal than the sentences with either type of secondary predicate, $F_1(2,152) = 11.54, p < .001; F_2(2,34) = 11.72, p < .001$. But there was no effect of quantifier and no interaction, $F$s < 1.3.

In order to assess whether the type of secondary predicate played a role, a 2x2 ANOVA of quantifier and predicate type (resultative, depictive) was performed. There were no reliable effects, all $F$s < 1. Hence, the resultative and depictive conditions were collapsed for further analysis.

Table B.2  Percentage of Cases Where each, every > a Scope was Preferred for the First Nine Items a Participant Saw in Experiment 3

<table>
<thead>
<tr>
<th></th>
<th>– Predicate</th>
<th>+ Predicate</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Resultative</td>
<td>Depictive</td>
<td>Combined</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a)</td>
<td>24.2</td>
<td>(c)</td>
<td>6.9</td>
<td>(e)</td>
<td>10.1</td>
<td>8.7</td>
</tr>
<tr>
<td>each</td>
<td>(b)</td>
<td>11.0</td>
<td></td>
<td>(d)</td>
<td>9.3</td>
<td>(f)</td>
<td>7.8</td>
<td>8.7</td>
</tr>
<tr>
<td>every</td>
<td>(a)</td>
<td>24.2</td>
<td></td>
<td>(c)</td>
<td>6.9</td>
<td>(e)</td>
<td>10.1</td>
<td>8.7</td>
</tr>
<tr>
<td>every</td>
<td>(b)</td>
<td>11.0</td>
<td></td>
<td>(d)</td>
<td>9.3</td>
<td>(f)</td>
<td>7.8</td>
<td>8.7</td>
</tr>
<tr>
<td>Mean</td>
<td>17.6</td>
<td>8.1</td>
<td>9.0</td>
<td>8.7</td>
<td>11.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the first nine items that a participants saw, a 2x3 ANOVA of quantifier and predicate type yielded a significant effect of predicate, $F_2(2,34) = 5.07, p = .012; a marginal effect of quantifier, $F_2(1,17) = 3.59, p = .075; and a marginal interaction, $F_2(2,34) = 2.48, p < .10$. A 2x2 ANOVA of quantifier and predicate type (resultative, depictive) was also conducted on the first-half items. As in the analysis on all items, no effects were significant, $F$s < 1.
APPENDIX C

EXPERIMENTAL MATERIALS

Experiment 1

Item one gives the full four-condition paradigm. Subsequent items are listed only in their singular forms.

1. Kelly showed a photo to every critic last month. The photo was of a run-down building.
   Kelly showed a photo to every critic last month. The photos were of a run-down building.
   Kelly showed every photo to a critic last month. The critic was from a major art gallery.
   Kelly showed every photo to a critic last month. The critics were from a major art gallery.
2. Jacob told a story to every reporter this week. The story was about the mayor.
   Jacob told every story to a reporter this week. The reporter was eager for news.
3. Linda gave a doll to every girl over the weekend. The doll was dressed entirely in satin.
   Linda gave every doll to a girl over the weekend. The girl was very excited and happy.
4. The guide lent a map to every busdriver before the trip. The map was of the surrounding area.
   The guide lent every map to a busdriver before the trip. The driver was unfamiliar with the area.
5. Trisha offered an interesting prize to every young poet last night. The prize was worth twenty dollars.
   Trisha offered every interesting prize to a young poet last night. The poet was not very well-known.
6. Matthew sent a purchase order to every assistant manager last week. The order was for new computers
   and equipment.
   Matthew sent every purchase order to an assistant manager last week. The manager was in charge of
   buying equipment.
7. The nurse loaned a new magazine to every elderly patient on Thursday. The magazine was about
   Hollywood.
   The nurse loaned every new magazine to an elderly patient on Thursday. The patient was extremely
   grateful.
8. The day care worker read a picture book to every sick child this morning. The book was about jungle
   animals.
   The day care worker read every picture book to a sick child this morning. The child was allowed to stay
   in bed.
9. The stage manager issued a small prop to every minor actor before the show. The prop was for the final
   scene.
   The stage manager issued every small prop to a minor actor before the show. The actor was in the final
   scene.
10. The professor assigned a long article to every graduate student last semester. The article was about the
    greenhouse effect.
    The professor assigned every long article to a graduate student last semester. The student was
    supposed to write a report.
11. Helen demonstrated a task to every intern yesterday morning. The task was very time-consuming.
    Helen demonstrated every task to an intern yesterday morning. The intern was young and energetic.
12. The accountant explained a statute to every client on Monday. The statute was related to taxes.
    The accountant explained every statute to a client on Monday. The client was quite wealthy.
13. The prisoner reported a problem to every watchman during the night. The problem seems quite
    difficult to solve.
    The prisoner reported every problem to a watchman during the night. The watchman seems unwilling
    to help out.
14. Kenny delivered a message to every secretary before five o’clock. The message seems rather cryptic.
    Kenny delivered every message to a secretary before five o’clock. The secretary seems overworked.
15. Francine announced a job opening to every skilled dancer after class. The opening seems to be quite
    promising.
    Francine announced every job opening to a skilled dancer after class. The dancer seems to be looking
    for work.
16. Carol sang an amusing song to every little boy this afternoon. The song seems to have an upbeat
    melody.
    Carol sang every amusing song to a little boy this afternoon. The boy seems to like all kinds of music.
17. David submitted a complex proposal to every federal agency last month. The proposal seems
    somewhat interesting.
    David submitted every complex proposal to a federal agency last month. The agency seems to fund a
    lot of projects.
18. The artist described an original painting to every serious collector last evening. The painting seems to be highly valued. The artist described every original painting to a serious collector last evening. The collector seems to be very rich.
19. The drunk recited a mailing address to every police officer last night. The address seems incomplete. The drunk recited every mailing address to a police officer last night. The officer seems unimpressed.
20. The doctor recommended a therapy group to every rape victim this month. The group seems to be helpful. The doctor recommended every therapy group to a rape victim this month. The victim seems to need to talk.

**Pilot Experiment 1**

The parenthesized material occurred only in the +secondary predicate conditions.

1. A busboy squeezed each/every napkin (dry).
   1a. Each napkin was squeezed by a possibly different busboy (until it was dry).
   1b. The napkins were all squeezed (until they were dry) by the same busboy, possibly all at the same time.
2. A reporter saw each/every boy (naked).
   2a. The boys (were all naked and) were all seen by the same reporter. They may have all been seen at the same time.
   2b. Each boy was seen by a possibly different reporter (while he (the boy) was naked).
3. A painter bought each/every brush (dirty).
   3a. Each brush was bought by a possibly different painter. (Plus each one was dirty when it was bought.)
   3b. The brushes were all bought by the same painter (and they were all dirty when bought).
4. A counselor remembered each/every camper (happy).
   4a. The campers were all remembered by the same counselor. (In the memory, the campers were all happy.)
   4b. Each of the campers was remembered by a possibly different counselor. (In each memory, the camper was happy.)
5. A child painted each/every tree (blue).
   5a. Each tree was painted (the color blue) by a possibly different child.
   5b. The trees were all painted (the color blue) by the same child.
6. A teenager tasted each/every cake (warm).
   6a. The cakes were all tasted by the same teenager (while they were warm).
   6b. Each cake was tasted by a possibly different teenager (while it was warm).
7. A friend prepared each/every vegetable (raw).
   7a. The vegetables were all prepared by the same friend (and were all raw when they were prepared).
   7b. Each vegetable was prepared by a possibly different friend (and was raw when it was prepared).
8. A girl made each/every sweater (small).
   8a. Each sweater was made by a possibly different girl. (In each case, the girl either made the sweater in a small size or did something to it to cause it to become small.)
   8b. The sweaters were all made by the same girl. (She either made them in a small size or did something to them to cause it to become small.)

**Experiment 3**

The first secondary predicate listed is a resultative predicate. The second is a depictive predicate.

1. A maid polished each/every mirror (Ø/spotless/steamed-up).
   1a. Each mirror was polished by a possibly different maid (ø/until it was spotless/when it was steamed-up).
   1b. All the mirrors were polished by the same maid (ø/until they were spotless/when they were steamed-up).
2. A helper dyed each/every shirt (Ø/blue/damp).
   2a. Each shirt was dyed by a possibly different helper (ø/until it was the color blue/while it was damp).
   2b. All the shirts were dyed by the same helper (ø/until they were the color blue/while they were damp).
3. A janitor dusted each/every bookcase (Ø/spotless/empty).
   3a. Each bookcase was dusted by a possibly different janitor (ø/until it was spotless/while it was empty).
   3b. All the bookcases were dusted by the same janitor (ø/until they were spotless/while they were empty).
4. A gardener pruned each/every bush {Ø/short/frozen}.
   4a. Each bush was pruned by a possibly different gardener {ø/until it was short/while it was frozen}.
   4b. All the bushes were pruned by the same gardener {ø/until they were short/while they were frozen}.
5. An aide tied each/every package {Ø/closed/half-empty}.
   5a. Each package was tied by a possibly different aide {ø/so that it was closed/when it was half-empty}.
   5b. All the packages were tied by the same aide {ø/so that they were closed/when they were half-empty}.
6. A servant ironed each/every sheet {Ø/smooth/wet}.
   6a. Each sheet was ironed by a possibly different servant {ø/until it was smooth/while it was wet}.
   6b. All the sheets were ironed by the same servant {ø/until they were smooth/while they were wet}.
7. A teenager painted each/every chair {Ø/yellow/unsanded}.
   7a. All the chairs were painted by the same teenager {ø/so that they were yellow/when they were unsanded}.
   7b. Each chair was painted by a possibly different teenager {ø/so that it was yellow/when it was unsanded}.
8. A man cut each/every board {Ø/short/filthy}.
   8a. All the boards were cut by the same man {ø/so that they were short/when they were filthy}.
   8b. Each board was cut by a possibly different man {ø/until it was smooth/while it was filthy}.
9. A child froze each/every banana {Ø/solid/ripe}.
   9a. All the bananas were frozen by the same child {ø/until they were solid/when they were ripe}.
   9b. Each banana was frozen by a possibly different child {ø/until it was solid/when it was ripe}.
10. A boy sliced each/every carrot {Ø/thin/raw}.
   10a. All the carrots were sliced by the same boy {ø/into thin pieces/when they were raw}.
   10b. Each carrot was sliced by a possibly different boy {ø/into thin pieces/when it was raw}.
11. A woman stained each/every table {Ø/brown/dusty}.
   11a. All the tables were stained by the same woman {ø/until they were brown/while they were dusty}.
   11b. Each table was stained by a possibly different woman {ø/until it was brown/while it was dusty}.
12. A clerk crushed each/every box {Ø/flat/damp}.
   12a. All the boxes were crushed by the same clerk {ø/so that they were flat/while they were damp}.
   12b. Each box was crushed by a possibly different clerk {ø/so that it was flat/while it was damp}.
13. A boy scout filed each/every knife {Ø/sharp/dirty}.
   13a. All the knives were filed by the same boy scout {ø/until they were sharp/when they were dirty}.
   13b. Each knife was filed by a possibly different boy scout {ø/until it was sharp/when it was dirty}.
14. A cook mixed each/every batter {Ø/smooth/cold}.
   14a. All the batters were mixed by the same cook {ø/until they were smooth/while they were cold}.
   14b. Each batter was mixed by a possibly different cook {ø/until it was smooth/while it was cold}.
15. A girl squeezed each/every washcloth {Ø/dry/hot}.
   15a. All the washcloths were squeezed by the same girl {ø/until they were dry/while they were hot}.
   15b. Each washcloth was squeezed by a possibly different girl {ø/until it was dry/while it was hot}.
16. A volunteer folded each/every poster {Ø/flat/wet}.
   16a. Each poster was folded by a possibly different volunteer so it was flat/when it was wet}.
   16b. All the posters were folded by the same volunteer so they were flat/when they were wet}.
17. A girl toasted each/every muffin {Ø/crispy/unsliced}.
   17a. Each muffin was toasted by a possibly different girl {ø/until it was crispy/when it was unsliced}.
   17b. All the muffins were toasted by the same girl {ø/until they were crispy/when they were unsliced}.
18. A worker trimmed each/every wire {Ø/short/cold}.
   18a. Each wire was trimmed by a possibly different worker {ø/so that it was short/when it was cold}.
   18b. All the wires were trimmed by the same worker {ø/so that they were short/when they were cold}.
BIBLIOGRAPHY


