THE SEMANTICS OF SCOPE IN ENGLISH

by

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TO MY DAUGHTER MIRIAM
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ABSTRACT

This thesis aims to present a descriptively adequate and revealing analysis of the scope order relations among logical operator words in English sentences. Prefatory to the analysis there is discussion of some philosophical issues in linguistic semantics, including a discussion of the correctness of translating natural language sentences into a formal language in order to produce semantic representations for them. It is concluded that such representations have obvious benefits as indicators of the truth conditions of sentences and that the objections that have been raised against them are not well-founded.

The body of the thesis consists in the derivation of a number of rules that capture the scope ambiguities of a wide range of sentences and the scope order preferences or incompatibilities of a number of English logical operator words. The rules themselves are of three kinds; a general surface ordering principle that fixes the initial scope order of the operator words in an English sentence according to their surface order; a set of scope readjustment rules that account for the scope ambiguities of English sentences; and a set of output filters that block or mark as unpreferred certain scope orders in the presence of certain operator words. In the final chapter of the thesis an analysis of plurality is given and integrated with the analysis of scope so that some differences in scope behavior between singular and plural quantifier words can be explained.
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CHAPTER ONE: INTRODUCTION

1.1 The semantics of scope in formal and natural languages

In order to understand the semantics of scope in natural language, we must first understand its semantic role in the formal languages of modern logic. We use the term "scope" in linguistics as an extension of its use in logic, an extension whose motivation is the existence of phenomena in natural language that parallel the scope relationships of formal languages. As a preliminary to our linguistic investigation, therefore, let us consider a standard first order formal language and define the notion of "scope" in that context.

The syntax of formal first order languages is extremely simple compared to that of natural languages. We list here the vocabulary and formation rules for well-formed formulas in one such language, call it L:

The grammar of L, a standard first order formal language\(^1\)

The Vocabulary: The expressions of the language L are strings (of finite length) of symbols, which in turn are classified as follows:

A. Variables. The variables are the lower case letters 'x' through 'z', with or without numerical subscripts (i.e., subscripts that are Arabic numerals for positive integers).
B. Constants.

(i) The logical constants are the eight symbols:

\[ \sim, \lor, \land, \rightarrow, \leftrightarrow, E, A \]

(ii) The non-logical constants fall into two classes:

(a) Predicates, which are capital letters 'M' through 'Z', with or without numerical subscripts and/or numerical superscripts.

(b) Individual constants, which are the lower-case letters 'a' through 'd', with or without numerical subscripts.

A predicate of degree \( n \) (or an \( n \)-ary predicate) is a predicate having as superscript a numeral for the positive integer \( n \).

An individual symbol is a variable or an individual constant.

The Rules of Syntax:

An atomic formula is an expression consisting (for some positive integer \( n \)) of an \( n \)-ary predicate followed by a string (of length \( n \)) of individual symbols.

A formula is an expression that is either an atomic formula or else is built up from one or more atomic formulas by a finite number of applications of the following rules:

(i) If \( \phi \) is a formula, then \( \sim \phi \) is a formula.

(ii) If \( \phi \) and \( \psi \) are formulas, then \( \lor(\phi, \psi) \), \( \land(\phi, \psi) \), \( \rightarrow(\phi, \psi) \), and \( \leftrightarrow(\phi, \psi) \) are formulas.

(iii) If \( \phi \) is a formula and \( \alpha \) is a variable, then \( (A\alpha)\phi \) and \( (E\alpha)\phi \) are formulas.

Further, an occurrence of a variable \( \alpha \) in a formula \( \phi \) is bound if it is within an occurrence of \( \phi \) of a formula of the form \( (A\alpha)\psi \) or of the form \( (E\alpha)\psi \); otherwise it is a free occurrence.

For any formula \( \phi \), variable \( \alpha \), and individual symbol \( \beta \), \( \phi \alpha/\beta \) is the result of replacing all free occurrences of \( \alpha \) in \( \phi \) by occurrences of \( \beta \).

Finally, a sentence is a formula in which no variable occurs free.
With the above syntax we can generate an infinite set of uninterpreted formulas. By themselves these formulas have no truth values. If, however, we assign a formal semantics to L consisting of an interpretation and truth valuation rule (i.e., a truth definition), then its sentences will make true and false statements about some domain of discourse. An interpretation of a formal language consists of a non-empty set, the domain of discourse, and an assignment function that associates with names in the language individuals in the domain of discourse and with predicates sets of ordered n-tuples (relations) in the domain of discourse. If \( \Pi \) is an n-ary predicate and \( \alpha_1, \ldots, \alpha_n \) is an n-tuple in the relation associated with \( \Pi \) by an interpretation \( I \), then \( \alpha_1, \ldots, \alpha_n \) is said to satisfy \( \Pi \) under \( I \). Given an interpretation \( I \) for the language \( L \) we can fix the truth value of any sentence of \( L \) under \( I \) by giving a set of rules for determining the truth or falsity of any well-formed formula on the basis of the constants and predicates it contains and its syntax. These rules are called the truth definition for \( L \) and can be stated as follows:

Let \( I \) be an interpretation of \( L \). \( I \) consists by definition of

(a) a non-empty set of objects, the domain of discourse

(b) an assignment function such that

(i) every individual constant \( \alpha \) in \( L \) is associated with one and only one object in the domain of discourse, \( I(\alpha) \).

(ii) every n-ary predicate \( \Pi \) is associated with a set of ordered n-tuples; i.e., a relation \( I(\Pi) \).
Let $\phi$ be any sentence of L and $\alpha$ a variable. Then:

1) if $\phi$ is atomic, then $\phi$ is true under I if and only if the objects that I assigns to the individual constants of $\phi$ are related (when taken in the order in which their corresponding constants occur in $\phi$) by the relation that I assigns to the predicate of $\phi$; and

2) if $\phi = \neg \psi$, then $\phi$ is true under I if and only if $\psi$ is not true under I; and

3) if $\phi = \forall (\psi, X)$ for sentences $\psi, X$, then $\phi$ is true under I if and only if $\psi$ is true under I or $X$ is true under I or both; and

4) if $\phi = \exists (\psi, X)$ for sentences $\psi, X$, then $\phi$ is true under I if and only if $\psi$ is true under I and $X$ is true under I; and

5) if $\phi = \neg (\psi, X)$ for sentences $\psi, X$, then $\phi$ is true under I if and only if either $\psi$ is not true under I, or $X$ is true under I or both; and

6) if $\phi = \leftrightarrow (\psi, X)$ for sentences $\psi, X$, then $\phi$ is true under I if and only if $\psi$ and $X$ are both true or both not true under I; and

Let I and I' be interpretations of L and let $\beta$ be an individual constant; then $I$ is a $\beta$-variant of I' if and only if I and I' are the same or differ only in what they assign to $\beta$. (This implies, be it noted, that if I is a $\beta$-variant of I, then I and I' have the same domain.) Let $\beta$ be the first individual constant not occurring in $\phi$ (where we suppose that the individual constants are listed in the following order: $a, b, c, d, a_1, b_1, c_1, d_1, a_2, b_2, \ldots \ldots$)

7) if $\phi = (A \alpha) \psi$, then $\phi$ is true under I if and only if $\psi \alpha/\beta$ is true under every $\beta$-variant of I; and

8) if $\phi = (E \alpha) \psi$, then $\phi$ is true under I if and only if $\psi \alpha/\beta$ is true under at least one $\beta$-variant of I.

Further, $\phi$ is **false** under I if and only if $\phi$ is not true under I.

As we can see from the above, a semantics for a formal language is simply a recursive method of assigning truth values to all of the well-
formed formulas of that language. The truth value of a formula of arbitrary finite length in L can be determined by applying to the formula the truth valuation rule for each of its logical constants in turn, starting with the leftmost one. Each application of the truth definition reduces the question of the truth of the formula to the question of the truth of simpler sub-formulas until finally the level of atomic sentences is reached. Then these are evaluated by clause 1) of the truth definition. For example, consider a sentence like (1) below under an interpretation I where the universe of discourse is the set of human beings, where P= 'has landed on Mars' and a = 'Spiro Agnew'.

(1) \( v((\forall x)P(x), P(a)) \)

In order to determine the truth of (1) according to the truth definition given for L we must first apply the truth definition for 'v', yielding

(2) '\( v((\forall x)P(x), P(a)) \)' is true if and only if either '\( (\forall x)P(x) \)' is true or 'P(a)' is true.

Then we must apply the truth definition for the universal quantifier, yielding:

(3) '\( (\forall x)P(x) \)' is true or 'P(a)' is true if and only if either under every interpretation I' such that I' is a 'b'-variant of I, 'P(b)' is true or 'P(a)' is true. ('b' is the first individual constant that does not appear in P according to the listing of constants we adopted earlier.)
Then applying the truth definition for negation we get:

(4) Under every I' such that I' is a 'b'-variant of I, \( \neg P(b) \) is true or 'P(a)' is true if and only if either under every I' 'P(b)' is false or 'P(a)' is true.

Then applying the interpretation I to the atomic formulas in (4) we get:

(5) Under every I' such that I' is a 'b'-variant of I, 'P(b)' is false or 'P(a)' is true if and only if either for every I' \( I'(b) \epsilon I'(P) \) or \( I(a) \epsilon I(P) \).

(6) For every I' such that I' is a 'b'-variant of I, I'(b) \epsilon I'(P) or I(a) \epsilon I(P) if and only if either for every I' I'(b) \epsilon \{x \mid x \text{ has landed on Mars.}\} or I(a) \epsilon \{x \mid x \text{ has landed on Mars}\} if and only if either for every person x, x hasn't landed on Mars or Spiro Agnew has landed on Mars.

Since the first disjunct in the rightmost clause of (6) is true, the whole disjunction is true and therefore the formula (1) is true under I.

As is clear from the above example, the left to right order of logical constants or operators is crucial to determining the truth of an interpreted sentence of L. Thus, even though they are made up of the same elements, the following sentences are not logically equivalent because the left to right order of their constituent operators and so the order of application of those operators is reversed:

(7) \((Ex)\neg P_1(x)\)

(8) \(\neg(Ex)P_1(x)\)
Sentence (7) could very well be true while (8) was false, as would be the case if, for example, the variable \( x \) ranged over the set of human beings and \( P_1 \) was the predicate "be female". Logicians refer to the ordering of a logical operator in a sentence with respect to other operators as its scope. The scope of a logical operator \( \Delta \) in a formula \( \phi \) of \( L \) is defined as the formula \( \psi \) such that \( \psi \) is included in \( \phi \) and such that \( \Delta \) is the leftmost element of \( \psi \). If two operators \( \Delta \) and \( \Sigma \) are included in the same formula \( \phi \), then \( \Delta \) is said to be inside the scope of \( \Sigma \) if and only if \( \Delta \) is included in the component sub-formula of \( \phi \) that is the scope of \( \Sigma \). If two operators \( \Delta \) and \( \Sigma \) are included in the same formula \( \phi \) and if \( \Delta \) is not inside the scope of \( \Sigma \), then \( \Delta \) is outside the scope of \( \Sigma \).

In natural languages like English we find that the truth conditions of sentences are influenced by the relative position of operator words in a way that corresponds at least roughly to the effect that the position of logical operators has on the truth conditions of sentences in \( L \). Compare, for example, these sentences:

(9) One of John's friends didn't see John's house.

(10) Not one of John's friends saw John's house.

Clearly, these sentences do not have the same truth conditions. In fact, under an interpretation of \( L \) in which the set of John's friends is the universe of discourse and \( P_1 \) is the predicate "saw John's house", the truth
The "scope" principles which determine the contribution of the syntactic position of operators to the truth conditions of sentences in English are more complex than the simple left-right scope principle of formal languages, although in simple cases like (9)/(10) that principle appears adequate. The elucidation of these principles is, in any case, as essential to the construction of an adequate grammar of English as the scope principle of left to right application of logical operators is to the grammar of formal languages like L. Some component of the grammar of English must contain such principles. Without them the grammar could not account for the native speaker’s ability to distinguish the truth conditions of sentences like (9)/(10) and to discern relations of logical consequence among sentences that depend on the syntactic relations among operators; for example, a speaker’s knowledge that sentence (11) follows from (10) but not from (9):

(11) John's friend Mary didn't see his house.

As we said, the relationship between syntactic position and contribution to truth conditions, which we have called "scope", is more complicated in English than in a formal language like L, and the unraveling of the complexities involved will form the subject matter of this thesis. In particular, our principles will have to allow for and explain the fact that English language sentences are often, or even generally, ambiguous in the scope of their operators; as, for example, in the sentences below:
(12) Each of Mary's relatives congratulated one of her parents.

(13) One of Mary's parents was congratulated by each of her relatives.

Both of these sentences are ambiguous as to the scope relations between the operators each and one. Under one reading the sentences are translatable into L by formula (14) while on the other reading formula (15) reflects their truth conditions:

(14) (Ax)(Ey)P(x, y)

(15) (Ey)(Ax)P(x, y)

Another complexity with which we shall have to deal is the fact that English has a much richer inventory of operators than does a standard first order language. Sometimes these operators differ from one another in their preferred scope orders with respect to other operators. Consider the following sentence pairs.

(16) a. Each of my roommates loves one of John's sisters.
     b. All of my roommates love one of John's sisters.

(17) a. The commission didn't resolve one of the disputes.
     b. The commission didn't resolve some dispute.

Although the words all and each in (16) are both universal quantifiers, they differ in their preferred scope order with respect to the existential
quantifier word *one.* Thus on its preferred reading (16a) is equivalent to (14) (under the proper interpretation, of course) while (16b) is equivalent to (15). Similarly sentence (17a) is perfectly ambiguous with respect to the scope order of *not* and *one* and can be interpreted as equivalent to either of the formulas in (18) below. Sentence (17b), on the other hand, contains the determiner *some* in place of *one* and can only be interpreted as equivalent to (18a):

(18) a. (Ex)\(\neg P(x)\)

b. \(\neg(Ex)P(x)\)

A third aspect of the richness of natural languages which we must consider is that they contain operators which cannot be interpreted as simple reflexes of operators in \(L\), and these operators also have scope relations with other operators. Thus, the sentences of (19) seem to differ in truth conditions in a way analogous to (9)/(10).

(19) a. Many people didn't see the fight.

b. Not many people saw the fight.

Since, however, *many* does not correspond to any single quantifier of a standard first order language, an accurate formulation of this scope difference is not immediately available. Other English language operators that have no simple reflex in a standard first order language include the modals, quantifiers like *few*, etc. and the plural marker.

To sum up, our aim in this thesis will be to give an empirically adequate and revealing linguistic description of the scope relationships
among operators in English language sentences, that is to construct as part of an overall grammar a formal mechanism for associating with each sentence of English the truth conditions of that sentence, insofar as these truth conditions depend on the truth definitions of the operators it contains and the scope of those operators with respect to one another. Although this mechanism will of necessity be more elaborate than the mechanism described earlier for formal languages, it should make an analogous contribution to the determination of the truth conditions of well-formed sentences. The greater syntactic and lexical richness of natural languages in comparison with standard formal languages means that the scope mechanism for English will have to account for the following: 1) scope ambiguity, 2) scope order preferences of different operators, 3) scope behavior of operators without direct reflexes in a standard first order language.

In any component of the grammar the elaboration of a formal mechanism that simply describes the data, difficult though it may be to construct, is not sufficient. The formalism should be explanatory as well as being descriptively adequate. In other words, it should reveal the general principles underlying the organization of the grammar as well as generating the data. In our study of the grammar of scope, we hope to find some of the general principles determining scope relations in English, perhaps in all natural languages, in the course of elaborating a descriptively adequate mechanism for generating the scope relations among operator words in English language sentences.
1.2 General semantic theory and the semantics of scope

The framework we have established for treating the semantics of scope in English uses the semantics of standard first order formal languages as its model. This approach may make the reader uneasy for it conjures up visions of the truth conditional semantics associated with the name of Donald Davidson and the controversial philosophical problems inherent in that approach. Davidson (1969) claims that the entire semantics of the declarative sentences of a natural language can be reduced to a recursive specification of the truth conditions of sentences of the language. He claims further this specification will make no use of the meanings of words and expressions of the language but will rely entirely on their reference or extension in the extra-linguistic world. From his point of view there is no difference in principle between natural language semantics and the semantics of a formal language like L. As we shall see, this approach can be criticized on several grounds. What is crucial for us, however, is that both Davidson and his philosophical critics agree that natural language operators like negation and the quantifiers can be analyzed as analogs of the logical constants of a formal language. Thus, finding solutions to the vexing problems that currently preoccupy theorists of general semantics is not a necessary prerequisite to an analysis of the semantics of operator scope.

1.2.1 Traditionally, grammarians and philosophers have defined the goals of semantics as specification of how the meanings of sentences are
constructed out of the meanings of their parts. This goal has necessitated the undertaking of two separate investigations, first the creation of a dictionary of the meanings of the smallest sentence parts (roughly words) and second the recursive specification of the meanings of complex sentence parts and sentences out of the meanings of simpler parts. Davidson and others would alter this enterprise. They propose an analogous two part investigation linked to the specification of truth conditions. Corresponding to the concept of word meaning, they use the notion of denotation or extension where the extension of a term is the set of objects to which the term can be used to refer and the extension of an n place predicate is the set of n-tuples of objects that satisfy the predicate. Corresponding to the recursive specification of complex meanings they propose a recursive specification of truth conditions in the manner of the formal language semantics described in section 1.1. In other words, they propose that we know the meaning of a sentence when we know how to determine in a finite number of steps its truth or falsity from the denotations of its component terms and predicates. In summary, Davidson's approach to semantics claims that we know the semantics of a language when we know the following:

a. A finite list of the terms and predicates of the language along with their denotations.

b. A finite list of logical connectives and operators, along with the effect each has on the truth values of expressions to which they are applied.

Consider, for example, a language consisting of these basic components:
one predicate, the English verb **sneezed**; three terms, the English
common noun phrases, a **man**, a **woman** and a **child**; and one logical
connective, **and**, used only between sentences. Assuming more or less
standard English syntax, this language produces an infinity of sentences,
of which the following are samples:

(1) A woman sneezed.

(2) A woman sneezed and a woman sneezed.

(3) A man sneezed and a child sneezed.

(4) A man sneezed and a woman sneezed and a child sneezed and
    a man sneezed.

Now according to Davidson, semantic interpretation in our language requires
simply (1) knowing the extension of each of the terms; (2) knowing the
extension of the predicate **sneezed**; and (3) knowing the truth definition
for **and**, namely: "A and B" is true if and only if "A" is true and "B"
is true.

1.2.2 There are several objections to a Davidsonian conception of
semantics. First, some people have claimed that a semantics based on the
truth conditions of sentences and ignoring "meanings" will represent all
analytic sentences identically and all contradictory sentences identically
since all members of each category obviously have the same truth conditions.
In fact, goes the argument, such sentences need not be given any semantic
structure in a Davidsonian semantics. Because these sentences are necessarily
true or necessarily false, a semantics concerned only with truth conditions can simply assign them the appropriate truth value. Therefore, we must have at least some additional requirements on semantic representation besides capturing truth conditions to prevent this unacceptable consequence.

Davidson recognizes this argument but rejects it. He says that when the terms, predicates and operators of analytic sentences occur in non-analytic sentences, they will receive proper semantic analyses. Then once these analyses exist, the trivially unacceptable analysis of analytic sentences proposed above can be ruled out as less general than the analyses that are needed independently for the non-analytic contexts. In any case, Davidson admits that a proper semantic analysis must describe the role of each minimal semantic element in the sentence and not treat obviously complex expressions as unanalyzed. He simply claims that a semantics constructed without reference to "meanings" can do the job.

In one article (1969) Davidson suggests that any finite device which produces the truth conditions of the infinite set of sentences for a natural language will also give a correct compositional analysis of the sentences. Unfortunately, this claim that things will turn out right automatically seems overly optimistic, to say the least. As J.A. Fodor points out (Fodor, 1970:299-300):

To put it briefly, then, what Davidson wants is a theory which pairs each (declarative) sentence in a language with a representation of its truth conditions and which does so in a way that reveals whatever semantically significant structure the sentence contains. A theory does the first if and only if it entails all the formulae of the form 'p' is true iff p. A theory does the second if and only if it (a) pairs each
sentence with a formula which formally determines the entailments of the sentence and (b) effects the pairing by reference to whatever productive structures the sentence contains. Davidson appears to believe (what seems to me to be far from obvious) that a theory which entails all formulae of the form 'p' is true iff p cannot help but reveal the semantically significant structure of the sentences which it describes; that is, Davidson appears to believe that there is no trivial way of satisfying the constraints upon a truth definition.

Actually it remains to be shown that a truth definition must, ipso facto, reveal logical form. Say S is a syntax of L iff S recursively enumerates all and only the well-formed formulae (the grammatical sentences) of L. Every sentence in the range of S will be indentifiable with an ordered sequence of markers (say, for the sake of simplicity, words) and every such sequence will, presumably, be of finite length. It is trivial, given a well-formed formula F (\(=w_1, w_2, \ldots, w_n\)) to define a function which maps that formula onto a formula of the form "'w_1, w_2 \ldots w_n' iff w_1, w_2 \ldots w_n". If we now want a theory which entails all formulae of this latter form, we need only adopt the postulate that every well formed formula of that form is an axiom.

It will be objected (a) that this is a finite representation of the desired set of formulae, but not a finite axiomatization of that set and (b) that a theory so constructed will certainly prove to be inconsistent. But (a) though the fact that languages can be learned presumably proves that they can be finitely represented, it does not prove that they can be finitely axiomatized, and (b) the reasons for thinking that a theory constructed in the proposed manner would be inconsistent are just the reasons for supposing that any truth definition for natural language L would be inconsistent (e.g., the semantic paradoxes.) As Davidson says "... I think we are justified in carrying on without having disinfected this particular source of conceptual anxiety ... most of the problems of general philosophical interest arise within a fragment of the relevant natural language that may be conceived as containing very little set theory." (Davidson, 1969) To put it succinctly, for that wide portion of the language for which there is reason to believe that we can construct a consistent truth definition, it is unclear why the quite vacuous truth definition suggested above won't do.

Fodor's vacuous truth definition treats all sentences as unanalyzed, and it reflects the most general form of the problem raised above with
regard to analytic and contradictory sentences. In a later paper, Davidson (1970: 178) himself admits the existence of vacuous truth definitions that do not reveal logical form (i.e., account for the relation of logical consequence between sentences of related structure). He says, however, that such vacuous solutions can be ruled out and continues to maintain that the non-vacuous solutions will give correct compositional analyses of the sentences of the language.

A second, and basic, objection to Davidson's approach is that it would treat non-synonymous terms with identical extensions as equivalent. Thus pairs like "creature with a heart"/"creature with a kidney" or "unicorn"/"centaur" would not be distinguishable. The existence of co-extensive but non-synonymous terms has been recognized for a long time. Thus it forms the basis of the distinction between sense and reference made by Gottlob Frege, the founder of modern logic. The question of whether Frege was correct in saying that words must be assigned a sense (or intension) in addition to their extension is a difficult one and we cannot hope to solve it here. We can, however, note certain limits on the force of that objection, especially as far as our own enterprise is concerned.

Davidson, for instance, would deny (1969: 14) that phrases like "creature with a heart" and "creature with a kidney" would be treated as equivalent under his system. With an argument analogous to the one he uses in the case of analytic sentences, he would claim that these phrases would be analyzed into their parts and that the statement of truth conditions for the first phrase would contain some translation or representation of the
second phrase would contain in the corresponding slot in the structure some representation of the word "kidney". Such a formulation of truth conditions is insured by the following condition Davidson puts on an acceptable theory (1970:178-9).

A third condition is that the statements of truth conditions for individual sentences entailed by the theory should, in some way yet to be made precise, draw upon the same concepts as the sentences whose truth conditions they state.

This condition on the truth definition for a natural language is the one of theoretical simplicity mentioned earlier. Since the word "heart" or "kidney" makes the same semantic contribution in a number of different contexts, it should have the same representation in all of those contexts. In any case Davidson's condition does effectively bar the collapse of the above "creature" phrases into one semantic representation.

Davidson has more trouble with words like "unicorn" and "centaur", which have no extension. Clearly, these words are neither synonymous nor meaningless as one would expect if meaning were reinterpreted in terms of extension. Davidson gives no indication of how to handle this problem, which seems a serious one for an extensionalist account of meaning. However, he could finesse the problem simply by assigning different representations to the two words in the statements of truth conditions. Then sentences like (5) and (6) below would not be assigned the same representations. If sentence (5) were represented as in (7), for example, then (6) would be represented as in (8):
(5) All unicorns are white.

(6) All centaurs are white.

(7) \((Ax)(U(x)W(x))\).

(8) \((Ax)(C(x)W(x))\).

This solution is, however, only apparent for it simply shifts the problem of differentiating "unicorn" and "centaur" into the problem of differentiating \(U(x)\) from \(C(x)\); i.e., into the metalanguage.\(^5\)

The problem that arises in differentiating non-synonymous words that have no extension reappears with words that have the same extension but are not synonymous. Consider, for example, the pair "supervisor"/"boss". These two words might reasonably be said to have the same reference - the class of foremen and managers - but they may well not be synonymous. Let us suppose for the sake of argument that "boss" means "one who commands work organization" and that "supervisor" means "one who guides work organization". Then while in present day U.S. society the two words might have the same extension, there clearly are possible societies (e.g., socialist or pre-class societies) in which there are supervisors who are not bosses. The existence of this pair, like the pair "centaur"/"unicorn" is an argument that there is more to word meaning than extension. The problem of how a word specifies its extension remains and that problem is what the assignments of meanings or senses to words is supposed to solve.\(^6\)
Although Davidson certainly has not shown that the concept of word meaning is unnecessary, this limitation in his analysis does not undermine his approach entirely. Thus, while we cannot eliminate the need for word meanings by carrying words into the metalanguage, the maneuver does suggest that the logical form of sentences, including questions of scope, can be investigated independently of the problem of word meanings. In fact, defining the truth conditions of natural language sentences in terms of formulas of a first order formal language, as in (5)-(8) above, assumes an independence of logical form from the content, at least in extensional contexts of terms and predicates. In other words, the contribution of the logical operators to the truth conditions of formulae is unaffected by either the reference of terms and predicates or the manner in which this reference is determined (i.e., meaning). We turn now to the question of whether this assumption of independence of logical form from content is justified. Only if it is can the study of the truth conditional semantics of logical operators in natural language be undertaken on the model of the operators of formal languages.

1.2.3 An important objection to Davidson's semantics is that it fails to capture a significant subset of the logical consequences or entailments of natural language sentences (Davidson, 1967). Since making the entailments of sentences provable is one of the main goals of truth-conditional semantics, this objection is a serious one. Given that people can and do produce deductive arguments in natural language, a semantics
ought to capture entailments. Moreover, Davidson's main motivation for his truth based semantics is its ability to capture entailments. Therefore, he must be concerned to demonstrate that there is a motivated reason for separating the missed entailments from those successfully captured.

The entailments that Davidson's semantics fails to capture are, of course, those based on the meaning of a specific term or predicate. Thus, it appears that (10) follows logically from (9), but (12) does not follow from (11), although (11) and (12) are possible semantic representations for (9) and (10) respectively in our first order language L.

(9) a is larger than b and b is larger than c.

(10) a is larger than c.

(11) &(P(a, b), P(b, c))

(12) P(a, c)

The entailment of (9)/(10) depends on a specific property of the predicate "larger than", namely, its transitivity. If we replace "larger than" with an intransitive predicate, say "near to;", then the entailment disappears. Davidson explicitly declines to explain such predicate particular entailments. He admits that:

A theory of the kind proposed leaves the whole matter of what individual words mean exactly where it was. Even when
the metalanguage is different from the object language, the theory exerts no pressure for improvement, clarification or analysis of individual words, except when, by accident of vocabulary, straightforward translation fails. (1969:15)

What he wants to account for are such entailments as (14) following from (13), which supposedly hold no matter what predicate is substituted for "buttered the toast":

(13) John buttered the toast at midnight.

(14) John buttered the toast.

In other words, Davidson is saying that there is a general semantic structure to natural language that underlies general inference patterns and that this general structure can be studied independently of the inference patterns associated with particular words. To vitiate this approach requires more than showing that it fails to capture entailments like those of (9)/(10); it requires showing that no distinction between such entailments and those Davidson claims to treat is possible, an unlikely prospect.

There remains, however, a secondary problem in the distinction between logical form and content; that is, how to decide what part of the semantic content of a sentence to assign to its logical form and what to assign to its constituent predicates and terms. In his theoretical discussions, Davidson seems to assume that words are the semantic building blocks of language and that their entire lexical content should be
treated as basic and non-structural. This approach must be an oversimplification. Words are at once too small and too large to serve universally as basic semantic units. They are too small, for example, in the case of idioms like "kick the bucket" or verb-particle constructions like "call up". Although syntactically composite, such locutions are semantically not constructed out of the words which constitute them; they are semantically indivisible units.

On the other hand, words sometimes must be treated as structurally complex. Consider, for example, the following sentence pair:

(15) John is happy at midnight.

(16) John is happy.

If we treat words as the basic units out of which semantic structure is created, then we cannot explain why sentence (15) does not entail (16), given that (13) entails (14). The reason that this entailment fails is that part of the semantic structure of (15) and (16) is hidden in the verb. The sentences have the same truth conditions as the following ones.

(17) John is generally happy at midnight.

(18) John is generally happy.

Clearly, the reason that (18) does not follow from (17) is that the quantifier word generally has a restricted range in (17) and ranges over
all points of time in (18). Thus, the failure of (18) to follow from (17) is a consequence of the logical form of the sentences involved. If we want the absence of the entailment from (15) to (16) to have the same explanation as the absence of the entailment from (17) to (18), which we certainly do, then we must assume that a quantifier equivalent to generally is hidden somewhere in (15) and (16). This assumption is a reasonable one since simple present tense verbs have generic or usitative interpretations that can presumably be accounted for by the assumption that an appropriate quantifier over time is part of the semantic structure of finite verbs. But then one word finite verbs turn out to have a complex internal structure that is part of the logical form of the sentences in which they appear.

Davidson (1967) himself suggests that "verbs of action" be treated as structurally complex. He says that they should have an additional predicate place beyond those for the subject and object. This proposal would give a sentence like (19) a representation like (20), where "x" is a variable ranging over events:

(19) Shem kicked Shaus.

(20) (Ex)(kicked(Shem, Shaus, x))

Clearly the variable x and its existential quantifier are associated with the verb kicked. Stative verbs have no such event quantification. Therefore, the analysis makes the one word verb structurally complex since the event
quantification is introduced in order to capture structure based entailments.

The above examples show that words cannot be treated as indivisible wholes in the determination of logical form. They do not, however, vitiate the distinction between logical form and content. That distinction remains valid, but it cannot be made in advance of analysis. What belongs to structure and what belongs to content in semantics depends on what level of entailments a given analysis is designed to capture. If we are interested in describing the semantics of logical operator words, then we can safely view words as unstructured wholes up to the point that such a perspective prevents us from describing the role of the operators under study. Then to the extent necessary for our purposes we can revise the boundary between form and content.

1.3 The problem of opacity

The central problem of distinguishing sense and reference that arises in truth conditional semantics has given rise to a number of related philosophical analyses which go under the rubric of "intensionalism". Intensional theories have in common the property of assigning to terms and predicates abstract entities called "meanings" in addition to extensions in the real world. Most recently such meanings have been construed by philosophers like Montague (cf. Montague, 1970, 1973) and others in terms of what has been called "possible world semantics".
For these theorists the semantic universe consists of an infinity of possible worlds among which every conceivable state of affairs is represented. Only necessary or logical truths are everywhere preserved. Then the meaning of a term or predicate is defined as its extension in all possible worlds. Thus, terms with no referents or that are accidently co-extensive can be differentiated by their extensions in the possible worlds in which they have referents or are not co-extensive. While possible world semantics might seem to be a promising way out of the problems raised by Davidson's extensionalist approach, however, there are serious problems raised by it. In particular, Quine has argued that the notion "possible world" cannot easily be shown to be well defined because the notion of "necessary truth" on which it depends is extremely problematic. In fact, in Quine's opinion there are no necessarily true statements, only statements that are more or less central to our theory of reality.

Since the problem of word meaning is not central to our own enterprise, it might seem that we need not choose between an extensionalist and an intensionalist semantics. After all, the intensionalists and extensionalists agree that the characterization of the logical form of sentences is crucial and that this characterization must be given in terms of truth conditions. For example, Montague (1973:222) says, "When only declarative sentences come into consideration, it is the construction of truth and entailment conditions that should count as the central concern of syntax and semantics." Unfortunately, there are some
contexts in which the mere specification of truth conditions requires
or appears to require reference to the meaning or sense of expressions.
As we shall see, the problem of how to handle such contexts will not
crucially affect our enterprise, but it must be investigated.

So long as we restrict ourselves to what are called "extensional"
contexts (i.e., to sentences like those of (1)-(2) below) the
specification of truth conditions does not require reference to the sense
of expressions:

(1) John killed a unicorn.

(2) Kissinger is a liar.

In these sentences expressions with identical referents but different
meanings can be substituted for one another freely without change of
truth value. Thus, the truth conditions of (1)-(2) are identical to
those of (3)-(4), in which the non-synonymous but co-extensive
expressions "centaur" and "Secretary of State" have been substituted for
"unicorn" and "Kissinger".

(3) John killed a centaur.

(4) The Secretary of State is a liar.

This substitutivity of co-extensive expressions follows from the fact
that, for extensional contexts, word meaning makes no contribution to
truth conditions. There are, however, contexts in which the substitutivity
of identity (i.e., of coextensive expressions) fails, and in these contexts (which Quine calls "opaque") the specification of truth conditions without reference to meaning becomes problematic.

Consider the following pair of sentences:

(5) John believes that Kissinger is a liar.

(6) {John doesn't believe\textsuperscript{10} } \text{ that the Secretary of State is a liar.}

It's not so that John believes

Suppose that John doesn't know that Kissinger is the Secretary of State and suppose further that John is disinterested in politics and doesn't have any opinion about the veracity of public officials. Suppose finally that John hears a man identified on the television news as "Henry Kissinger" make an obviously outrageous statement. Under these circumstances it is perfectly possible for (5) and (6) to be true simultaneously, at least under the ordinary interpretation of belief.\textsuperscript{11}

Now if the complement of the verb "believe" were an ordinary extensional context, then sentence (7) below would follow from (5) by the substitutivity of identity:

(7) John believes that the Secretary of State is a liar.

But (7) is the direct contradiction of (6), so the substitutivity of identity fails.
This failure of substitutivity of identity in the complement of the verb "believe" generalized to an entire class of verbs called verbs of "propositional attitude" (Quine, 1956) including verbs like, "look for", "know", "expect", "want", etc. It also holds of certain modal predicates, for example, necessity. Consider the following sentence pair taken from Quine (1953):

(8) Nine is necessarily greater than five.

(9) The number of the planets is necessarily greater than five.

Since the truths of arithmetic are logical truths, and since logical truths are necessary truths if any truths are, let us take (8) as true. Since the fact that there are nine planets is only contingently or empirically true, (9) is clearly false. However, "the number of the planets" and "nine" are coextensive; i.e., refer to the same natural number. Therefore, substitutivity of identity fails here as it does for propositional attitude verbs.

Because of the failure of the substitutivity of identity, opaque contexts do not obey the same inference rules or have the same logical form as non-opaque ones. Consider, for example, the following sentence pair:

(10) Robert is forcing his daughter Mary to marry someone.

(11) Robert believes that his daughter Mary has married someone.
Sentence (10) is ambiguous as to the scope of the existential quantifier word "someone." On one reading there is a specific person whom Mary is being compelled to marry while on the other Mary is compelled to get married but not to any particular person. There is a similar ambiguity in (11). On one reading there is a specific person whom Robert believes Mary to have married while on the other reading Robert believes that Mary got married but may have no idea as to whom she married. The ambiguity of scope in (10) can be captured informally by assigning the formulas of (12) as its two readings:

\[(12) \quad a. \quad \text{(Ex) Force (Robert, Mary, Mary marry x)} \]
\[b. \quad \text{Force (Robert, Mary (Ex)(Mary marry x))} \]

Formulas equivalent to those of (12) can be constructed in a completely formal language; for example, by an extension of L that allows certain predicates to take sentences as arguments. On analogy with (12) we might expect that the ambiguity of scope in (11) could be captured by formulas like these:

\[(13) \quad a. \quad \text{(Ex) Believe (Robert, Mary marry x)} \]
\[b. \quad \text{Believe (Robert, (Ex)(Mary marry x))} \]

Indeed, the second reading of (11) is adequately represented by (13b). However, formula (13a) cannot represent the first reading of (11) because (13a), by definition of existential quantification in L, allows the free substitution of coextensive expressions for the variable "x"
and so does not reflect the opacity of the English verb "believe."
The point is that even if Robert has a particular person in mind as his daughter's husband, he might know the husband under one description, but not under another. Thus, it seems that an ordinary extensional formalism in which the meanings of terms and predicates do not play a role in logical form are not adequate to capture the truth conditions of opaque verbs.

The problem posed by assigning truth conditions to opaque contexts has led a number of philosophers, beginning with Frege, to conclude that meanings or intensions must be included in the statement of the truth conditions of such contexts. A number of such intensional solutions have been discussed, (cf. Montague, 1973, Sellars, 1969; Quine, 1956) but they all are based on the idea that the complements of opaque verbs and similar constructions are properly considered propositions, where propositions are the "meanings" of sentences derived combinatorily from the meanings of words. Thus, the truth conditions of a pair of sentences like (5) and (7) would not be the same because the complement sentences, since they contain non-synonymous expressions, do not express the same proposition. Furthermore, the introduction of propositions would explain why a formula like (13a) cannot express any reading of sentence (11). The existential quantifier at the head of (13a) ranges over the objects in the domain of discourse, in this case people, while the variable supposedly bound by the quantifier
ranges over meanings or concepts; i.e., sub-parts of the complement proposition. Thus, the formula (13a) is incoherent and would not be generated by a formal language.

The reading of (11) that (13a) was supposed to capture is the one under which there is a specific person whom Robert (opaquely) believes Mary to have married. The intensionalists would propose that this reading of (11) be captured instead by a formula something like (14) below:

\[(14) \quad (Ei)(Ex)(\Delta(i, x) \land \text{Believe}(\text{Robert, } [\text{Mary marry } i]))\]

where 'i' is a variable standing for an individual concept, 'x' is a variable standing for an object, \(\Delta(i, x) = "i \text{ denotes } x"\), and square brackets indicate that the material inside them is to be taken as a proposition or a propositional function.

If such an analysis as (14) turns out to be necessary, then a complete analysis of scope would have to encompass quantification over intensional objects (concepts) as well as extensional ones. This would not affect the truth conditions of extensional contexts, however, and would produce no material change in the representations that would have to be provided to capture their logical form (Cf. Montague, 1973:237 for an illustration of this point).

Having said that an intensional treatment of opaque contexts presents no essential difficulties for our projected analysis of scope, we must remark that the question of whether opaque contexts require such a treatment is by no means settled. A number of philosophers,
Quine foremost among them, believe that a purely extensional account of belief contexts is possible. For example, Quine has on one occasion (1956) proposed that belief be treated as a relation between a person and a sentence.¹³ Then a sentence like (15) would be interpreted on its opaque reading as in (16):

(15) John believes that Orttcutt is a spy.

(16) John holds that the sentence "Orttcutt is a spy" is true.

Under this analysis the objects of belief are not ideas (propositions), as they are for intensionalists, but linguistic objects; and a philosopher's attitude towards Quine's proposal is likely to hinge on whether he believes that ideas or sentences are the "real" objects of belief, at least in the usual cases. The failure of substitutivity of identity follows in this proposal from the fact that any change in the sentence contained in quotes changes the truth conditions of the matrix sentence. Indeed under this analysis a belief construction would not even allow the substitution of synonymous expressions salva veritate. Thus, this analysis implicitly challenges the assumption that opacity is somehow related to synonymy and that the existence of opaque constructions shows that the statement of truth conditions requires an appeal to meanings.

Some evidence for Quine's proposal and for the objects of belief being linguistic entities, at least in some instances, is provided by
the following sentence pair:

(17) John believes that sauna baths are sudorific.

(18) John believes that sauna baths are sweat producing.

Now it happens that "sudorific" means "sweat producing" so that the complement sentences in (17) and (18) are entirely synonymous. Suppose, however, that John like most people does not know the meaning of "sudorific". Suppose further that he does not know much about sauna baths and that (18) is, therefore, false. Suppose finally that John's friend Paul, whom John trusts implicitly, has said to him in passing: "John, I discovered last week that sauna baths are very sudorific". It would appear that under such circumstances and under the opaque interpretation of belief, sentence (17) might be true even though (18) is by hypothesis false. A similar point has been made by Chomsky (1970) who suggests that even different transformational variants of a sentence may not be freely substitutable in some opaque contexts. Of course, if there were even one opaque context that allowed the free substitution of synonymous expressions, then one could argue that the notion of synonymy (therefore meaning) was essential to capturing truth conditions. So the above argument even if sound cannot be conclusive. 14

Finally, we should indicate how a formula like (13a) could be reformulated in an extensional analysis. We might suggest a form like
the following:

(19) \((\exists x) (E e_x)\) Believe (Robert, "Mary has married \(e_x\)).\)

The symbol "\(e_x\)" in (19) is a variable standing for an expression that
denotes \(x\). In other words, in quantifying into an opaque context
not only the object picked out but also the expression used to refer
to it must be specified. Thus, an extensional analysis seems to
require quantification over linguistic expressions as the price of
avoiding quantification over concepts. There are, of course, problems
inherent in this approach (cf. Church, 1950) but they seem no more
imposing in advance than those surrounding the use of propositions and
other intensional objects. In any case a detailed investigation of the
merits of alternative theories of opaque contexts is certainly beyond
the range of this work (but cf. Kaplan, 1969). We must be satisfied
with the expectation that our analysis of scope will be compatible with
whatever turns out to be the correct solution to the problem of
opacity.
FOOTNOTES TO CHAPTER ONE

1. The grammar of L has been adopted, with minor modifications, from Mates (1965).

2. The truth definition for L has been adopted, with minor modifications, from Mates (1965).

3. Left to right order is the standard way of indicating scope in a formal language; but, of course, any linear, transitive ordering could be used. In natural language, as we shall see, the basic scope order of a sentence follows its surface structure order, which for spoken language is a temporal ordering.

4. Both Davidson and we restrict ourselves to declarative sentences. Other sentence types, like questions and imperatives, cannot be described semantically in terms of truth conditions since they are not true or false. However, there are conditions, derivable from truth conditions in terms of which non-declarative sentence types can be analyzed. The semantics of questions can be analyzed in terms of truth conditions of a correct answer to a question. The semantics of imperatives can be analyzed in terms of the truth conditions of a sentence that is true if and only if the command is fulfilled.

5. A metalanguage is a language in which the truth conditions of another language, the object language, are stated. The reason that the problem is only shifted into the metalanguage is that the two terms in the metalanguage that correspond to "unicorn" and "centaur" have to be distinguishable if the metalanguage is to represent adequately the truth conditions of the object language English.

6. In particular, this problem is what Frege had in mind when he established the distinction between "sense" and "denotation" (extension).

7. An "extensional context" is one in which expressions with the same reference can be substituted freely for one another with no change in truth value. The problems raised by the existence of non-extensional contexts are discussed further in section 3 of this chapter.

8. Putnam (1970) argues that at least for "natural kind" words (e.g., lemon, gold, etc) the characteristics specified in the meaning of a word are not true of necessity of the objects which the word denotes. Therefore, there can be no entailments based on word meaning.
9. This problem was brought to my attention by Paul Kiparsky.

10. The reading of "John doesn't believe S" that we are using here is the one synonymous with "It's not the case that John believes S", not the one synonymous with "John believes that not S."

11. Apparently, there is also a transparent sense of belief (cf. Sellars, 1969). Its existence is, however, irrelevant to our concerns.

12. There are, of course, many intensional analyses of belief, and (14) is only intended to give a general idea of what such analyses look like. Thus, it is not fully worked out and is undoubtedly subject to objections that a serious intensionalist analysis could avoid.

13. In a later treatment of this question (1960) Quine took a somewhat different view.

14. Janet Fodor (personal communication) argues that belief is an opaque context that allows such free substitution of synonymous expressions. One obvious candidate for such a context, necessity, cannot be used since the existence of necessary truths is itself in question.
CHAPTER 2: SOME LINGUISTIC ANALYSES OF SCOPE RELATIONS

2.0 Introduction

In the preceding chapter we outlined an approach to natural language semantics based on the semantics of formal languages. This approach is an old one and has been familiar to logicians at least since Frege. Some logicians (e.g. Reichenbach (1947)) have believed that all, or essentially all, of natural language could be modelled on formal language. Others (e.g. Tarski (1956)), while holding that natural language as a whole is too ill-defined for systematic treatment in formal terms, believed that at least those parts of natural language necessary for scientific inquiry could be adequately described with the semantics of formal languages.

All of this philosophical discussion has until recently exercised too little influence on linguistic theory and practice, as a result of which linguistic semantics has been somewhat unsure of its goals and methods. There are for every semantic phenomenon a plethora of competing analyses and there is not even agreement on what the general framework of such analyses should be. In this chapter we shall analyze some current linguistic analyses of scope phenomena. Many such analyses ignore, reject, or misunderstand the usefulness of
formal language as a model for natural language semantic structure. We hope to demonstrate that their reasons for rejecting the formal language model are weak and the alternative analyses proposed are inadequate. In section four of the chapter we shall discuss some recent work on the scope of any by Lasnik (1972) and Horn (1972). These authors use a notion of scope borrowed directly from the logicians, Quine and Reichenbach. As we shall see, these analyses are much more successful that the others discussed and give hope that formal language structure can be the model for scope phenomena in natural language.

2.1 Dougherty. Feature analysis of a scope ambiguity

One early approach to describing the semantics of natural language within the framework of generative grammar was the approach of feature analysis, as formulated by Katz and Fodor (1963). This method was applied to describing the scope of English language universal quantifier words in Dougherty (1970, 1971) as part of his analysis of semantically non-singular constructions, especially coordination. Dougherty's analysis of the quantifiers was designed basically to account for their co-occurrence restrictions with respect to adverbs and verbs. The description of scope relations is a derivative part of the analysis and Dougherty does not even use the word scope in discussing it.

In Dougherty's analysis:
the interpretation of a coordinate conjunction is determined by features assigned to the coordinated node. Two of these features [+individual] and [+totality] are defined in terms of the properties of the distributive quantifiers each, all, and both. (1970:868)

In other words, the quantifiers' selectional restrictions (and, since Dougherty's selectional restrictions are semantic, their meanings) are determined by the feature values associated with them. According to Dougherty's feature analysis, each is defined by the features [+individual], [+totality]; both is defined by the features [+individual], [+totality]; and all at some times has the same features as both while at others it has the features [-ind], [+tot]. The fourth possible combination [-ind], [-tot] has no quantifier associated with it.

Dougherty defines his features as follows:

[+individual]: the adverbs alone, singly, individually, and independently can occur with a quantifier having this feature. This feature emphasize the independent, individual action of each of the constituents of the conjunction, and suggest that a conjoined sentence paraphrase exist.

[-individual]: The adverbs alone, singly, individually and independently cannot occur with a quantifier having this feature. No conjoined sentence paraphrase exists. The elements of the conjunction are like the elements in a series bound together by plus signs. Often and and plus . are interchangeable conjunctions with [-individual] quantifiers. Two plus/and two is four.

[+totality]: The adverbs together, simultaneously, en masse, at once, in chorus, etc. can occur with a quantifier bearing this feature. The surface structure quantifier is all. The feature emphasizes that the conjunction is to be considered as a unity; the conjuncts act mutually.
[-totality]: The adverbs *simultaneously*, *en masse*, etc. do not occur with a quantifier having this feature. The conjunction is not to be considered as a unity; the conjuncts do not act mutually. (1970:868)

Dougherty claims that his feature analysis of the universal quantifier words can explain why the following sentences are not equivalent:

(1) [Dougherty, 1970's 186] I called the police after all of the men left.

(2) [187] I called the police after each of the men left.

He describes the difference between the sentences, correctly, in these words:

Sentence 186 has a reading which 187 does not have: in sentence 186 either the police are called only once, or they receive several calls; in 187 the police receive several calls. Notice that 186 says nothing about HOW the men left, i.e., it is not specified if they left together or singly. The sentence only specifies that the totality of the men has completed the action. (1970:869)

For us this semantic difference is easily describable as a difference in scope relations. Sentence (1), being ambiguous, can be interpreted by either of the formulae below, while sentence (2) can have only the reading of (4), where *all* has wide scope with respect to the quantifier over time that is associated with *after*:

(3) \((Et)(Ax) \& (t \text{ is a time after } x \text{ left, I called the police at } t).\)
(4) \((Ax)(Et) \& (t \text{ is a time after } x \text{ left, I called the police at } t)\).

Dougherty, on the other hand, claims that the difference between (1) and (2) is due to the different value of the totality feature associated with each and all. Of the two possibilities in Dougherty's analysis, the all in (1) has the features [+ind], [+tot] rather than [-ind], [+tot] because predicates like leave, that can take singular subjects require [+ind] quantifiers selectionally. Each, of course, has the features [+ind], [-tot] as always.

Aside from the passage quoted above, however, Dougherty does not explain how the difference in the totality feature assigned to each and all brings about the difference between (1) and (2). In that passage, he seems to be saying that the ambiguity of (1) is due to the presence of the feature [+tot] on all while the non-ambiguity of (2) is due to the feature [-tot] on each. Now it may be clear what it means to assign the reading of a sentence to the value of a feature; but surely one cannot associate the existence of an ambiguity with the presence of one feature value.

Dougherty might claim that one reading of (1)(the reading shared by (2)), is due to the presence of the feature [+ind] on all (and each) while the other reading of (1) is due to the feature [+tot] on all. Then the lack of a second reading for (2) would result from assigning a null interpretation to the feature [-tot] on each. Such an interpretation of the feature system would, however, be untenable. The semantic features
assigned to a word are a bundle of semantic information that, taken together, define the meaning of the word just as the phonological features of a sound segment, taken together, define the articulation of the segment. Therefore, variation in semantic content, like variation in articulation, must be captured by variation in feature content, if the feature system is to mean anything. Under the proposed interpretation, the ambiguity of (1) is clearly not captured as a variation in its underlying semantic or syntactic structure.

Suppose for a moment that we reinterpret Dougherty's analysis and claim that the ambiguity of (1) is due to an ambiguity in the feature content of all and thereby try to preserve the coherence of the feature system. The ambiguity of (1) cannot be due to a variation in the feature [+ind] because that variation, as noted above, is reserved for capturing certain selectional restrictions among quantifiers and verbs or adverbs. Thus, the two quantifiers all and both are labelled [+tot] to explain why they, but not the [-tot] quantifier each, can occur with adverbs like simultaneously, as in (5):

(5) a. The men all sneezed simultaneously.

b. The men both sneezed simultaneously.

c. * The men each sneezed simultaneously.

But then both must be labelled [+ind] and all [+ind] to explain why all can occur in both (6) and (7) below but both can only occur in (6):


(6) \{\text{All}\ \{\text{Both}\}\} \text{ of the men arrived in New York.}

(7) [197] a. John, Bill and Tom all met in New York.

Since the verb leave, of which the phrase "all of the men" is the subject in sentence (1), is a verb that allows the quantifier both in its subject, all in that sentence must be [+ind]. Thus, the feature to be varied must be [±tot], leading us to the conclusion that all can be associated with three out of the four possible combinations of feature values. In other words, these features do not delimit the meaning of all. This is especially true since all can even occur with the values [-tot], [-ind], at least in some cases. Dougherty claims that this does not happen, but at least two of his [-tot], [-ind], predicates (scatter, and disperse) do co-occur with all, as in (8) below:

(8) a. The men all scattered when the storm hit.
    b. The men all dispersed when the storm hit.

Clearly an analysis which now needs two features to distinguish two quantifiers (each and both) leaves much to be desired.

Let us continue to assume, however, that each differs from all in feature content as we postulated above: Each is obligatorily [-tot] and all freely takes both values of the feature. This analysis would imply that the interpretations of (1) and (2) are somehow related to the function of the feature [±tot] in fixing selectional restrictions. If
not, the feature mechanism would be nothing more than an ad hoc notation for indicating that sentences (1) and (2) differ in their interpretations and would be devoid of explanatory content.

In distinguishing each from both and all and explaining the differential acceptability of the sentences of (7), Dougherty assigns the concept of joint or mutual action to [+tot](cf. infra.). For a feature analysis of (1) and (2) to be convincing, the difference in meaning between these sentences would have to follow from the same semantic difference used to explain the facts of (7). As Dougherty himself says, however, the unshared reading of (1) does not depend on any joint, simultaneous, unified or mutual action by the elements of the quantified NP, "the men". The feature analysis, therefore, is ad hoc and unmotivated as a description of the scope relations in (1) and (2), whether or not it adequately describes the selectional restrictions of the different quantifiers.¹

In fact, as Fodor (1970), Baker (1966) and Bach (1968) have pointed out, no feature analysis can adequately capture the scope of operators. Consider the following sentences:

(9) John wants to find one of his friends.

(10) Mary believes that John wants to find one of his friends.

As was discussed in section 3 of chapter 1, a sentence like (9) is ambiguous as to the scope of the existential quantifier word one. On one
reading John has a specific friend in mind while on the other any friend will do. Ignoring the difficulties posed by the opacity of \textbf{want}, the two readings of (9) can be represented as in (11):

\begin{enumerate}
\item[(11)] a. (E friend, x)(John wants to find x).
\item b. John wants (Ex)(John finds x).
\end{enumerate}

In a standard feature analysis this ambiguity would be captured by assigning the feature [+specific] to the noun phrase "one of his friends" to get reading (11a) and the feature [-sp] to the same NP to get reading (11b). When we attempt to account for the readings of (10) with features, however, we run into trouble. Sentence (10) is three ways ambiguous and its readings are given in (12), again ignoring the difficulty posed by the referential opacity of the verbs \textit{want} and \textit{believe}:

\begin{enumerate}
\item[(12)] a. (E friend, x)(Mary believes that John wants to find x).
\item b. Mary believes (Ex)(John wants to find x).
\item c. Mary believes that John wants (Ex)(John finds x).
\end{enumerate}

Since the feature [±] has only two values, it cannot capture such a three way ambiguity. The standard formalism of logic, on the other hand, captures the ambiguity naturally.

2.3 Heny's analysis of scope ambiguity

2.3.0 We have been arguing that scope relationships in English should be treated as parallel to scope relationships in formal language. As
partial evidence for the validity of this approach, we have given examples of scope ambiguities in English that could be represented by pairs of formulas in a formal language where those pairs differ only in the scope of their logical operators. This suggests that the truth conditions of English language sentences can be captured by a mechanism that translates every sentence of English into a set of logical formulas, one for each of its structurally distinct readings. Then the task of linguistic analysis of scope becomes defining the mapping from English to the formal language with the simplest and most general rules that are descriptively adequate. Hopefully then these rules will correctly represent the linguistic competence underlying an English speaker's ability to interpret scope relationships. That is the task we are setting ourselves in this work. To the extent that such rules turn out to be language universal rather than particular to English, they may be supposed to be part of innate linguistic competence or, following Putnam (1967) part of the general mental ability underlying linguistic and other cognitive functions.

In his paper "English as a Formal Language" (1968), the philosopher Montague demonstrates that the translation of English into a formal language is not strictly necessary in order to define the truth conditions, including scope relationships, of English sentences. Montague shows that English, to the extent that it can be translated into a formal language, can itself be treated as a formal language; that is, a truth definition
parallel to those of formal languages can be constructed directly in
terms of English vocabulary and a recursive English syntax. Montague's
demonstration is useful because it makes clear that the logical formulae
used to express the truth conditions of natural language sentences
are not theoretically necessary. However, as Montague himself
admits, a system which employs translation into some formal language
is, as far as semantics goes, simply a notational variant of his own
system. Indeed, in some of his later work (e.g. 1972) Montague
himself uses such a translation scheme on the grounds that it is easier
to follow. In any case, the two systems can be translated into one
another quite mechanically.

2.2.1 Frank Heny, a linguist interested in applying the work of Montague
to current linguistic theory, has written a thesis (1970) which claims
that direct semantic interpretation of English sentences is descriptively
superior to an approach that relies on mapping sentences onto readings
expressed in a formal language. In making this argument he apparently
goes beyond what Montague himself would claim. We will now examine Heny's
analysis in hopes of demonstrating the following points: first, that
where Heny's system is well defined it is equivalent to an analysis based
on translation into formal language and second, that the criticism
Heny makes of a translation analysis are unfounded.

Heny's presentation of his system is extremely technical and
abstruse so before we proceed to examine it critically, we shall try to
present its main features in some simple examples. We shall not concern ourselves with the overall adequacy of the system but only with its treatment of a few illustrative logical operators.

To each singular NP of English there corresponds a set of individuals $\{NP_\alpha\}$ defined as those individuals denoted by $NP_\alpha$. Corresponding to each simple transitive verb (two-place predicate) $V_\beta$ there is a set of ordered pairs $\{(a,b)_\beta\}$ defined as follows:

$$(x,y) \in \{(a,b)_\beta\} \text{ if and only if it is true that } xV_\beta y.$$ 3 Depending on the character of its subject and object NP's, a sentence is true if and only if the Cartesian product of the two set corresponding to those NP's contains an appropriate subset of the set of ordered pairs corresponding to the verb. For instance, consider (1) below:

(1) A dog chased a cat.

\[ NP_\alpha \ V_\beta \ NP_\gamma \]

The set $\{(a,b)_\beta\}$ is the set of all pairs of pursuer and pursued. $\{NP_\alpha\}$ is the set of all dogs and $\{NP_\gamma\}$ is the set of all cats. Sentence (1) is true if and only if there exists an ordered pair $(x,y)$ in the Cartesian product $\{NP_\alpha\} \times \{NP_\gamma\}$ such that $(x,y)$ is also an element of $\{(a,b)_\beta\}$. In other words, sentence (1) is true just in case $\{(a,b)_\beta\}$ contains an ordered pair $(x,y)$ such that "x" denotes a dog and "y" denotes a cat.

It is clear that the determiners of the NP's in a sentence will decide what subset of $\{NP_\alpha\} \times \{NP_\gamma\}$ must be included in $\{(a,b)_\beta\}$ for a given
sentence to be true. Suppose we replace "a dog" by "every dog" and
"a cat" by "every cat" in (1). Then in order for the resulting
sentence ((2) below) to be true, the whole Cartesian product \( \{NP_\alpha\} \times \{NP_\gamma\} \)
must be a subset of \( \{(a,b)_{\beta}\} \).

(2) Every dog chased every cat.
\[
NP_\alpha \quad \lor \quad NP_\gamma
\]

The interest of Heny's analysis stems, of course, from his claim
that his approach provides a real alternative to a translation analysis.
He gives as an example supposed differences in the treatment of sentences
like (3):

(3) Some dog chased every cat.
\[
NP_\alpha \quad \lor \quad NP_\gamma
\]

A standard scope analysis of (3) would say it is ambiguous and might
represent its readings as in (4):

(4) a. \((\text{Ex} \in \{NP_\alpha\}) (\text{Ay} \in \{NP_\gamma\}) (x \text{ chased } y)\)

b. \((\text{Ay} \in \{NP_\gamma\}) (\text{Ex} \in \{NP_\alpha\}) (x \text{ chased } y)\).

Heny proposes to handle this ambiguity by defining two different
cross-product subsets of the Cartesian products, each of which would make
(3) true if it were a subset of \( \{(a,b)_{\text{chased}}\} \).

These two subsets are defined by two schemata for the interpretation
of quantification, P and Q. P is defined as indicated in figure (1) and
Q as in figure (2):
Figure 1 - F

Figure 2 - Q
Schema P is to be interpreted as associating in turn each of the individuals in \{NP_\alpha\} (after they have been arranged in an ordered sequence) with an ordered sequence of the individuals in \{NP_\gamma\}. Schema Q is to be interpreted as associating in turn each of the individuals of \{NP_\gamma\} with an ordered sequence of the individuals in \{NP_\alpha\}. The ordering of the sequences is arbitrary. If \{NP_\alpha\} is \{dog\} and \{NP_\gamma\} is \{cat\}, the schemata P and Q can be used to define the truth conditions of the two readings of (3). Let \( n \) = number of dogs and \( m \) = number of cats in the universe of discourse. Then the truth conditions would be defined as follows: First, we run down the first column of P checking each pairing of an \( a_j \) with the arbitrary ordered sequence \( \{b_k\}_1^m \) of individuals in \{NP_\gamma\}. Then:

\[(5) \quad \text{If there is an } a_j \text{ such that the ordered pair } (a_j, b_k) \in \{(a, b)_{\text{chase}}\} \text{ for every value of } 1 \leq k \leq m, \text{ then the sentence is true on the reading given in (4a).}\]

For the second reading we run down the second column of Q and check each pairing of \( b_j \) with the arbitrary ordered sequence \( \{a_k\}_1^n \) of the individuals in \{NP_\alpha\}. Then:

\[(6) \quad \text{If for each } b_j \text{ the ordered pair } (a_k, b_j) \in \{(a, b)_{\text{chase}}\} \text{ for some value of } 1 \leq k \leq n, \text{ then the sentence is true on the reading given in (4b).}\]

This procedure certainly works to specify the truth conditions of sentences like (3), at least where the NP's refer to countable sets.
The problem is that it does not differ from the formulations in (4). Actually, the procedures outlined in the preceding paragraph are nothing but a statement of the truth conditions of the formulas in (4). In other words, Heny's, like Monatgue's, semantics directly associates truth conditions with English sentences but it is only notationally different from an analysis based on translation into sentences of a formal language. The fact is the actual arguments Heny gives in support of his system as compared to a translation analysis never actually deal with that question. What they do is argue for treating semantics as the specification of truth conditions, as in (5) and (6), instead of as the specification of what Heny calls "readings". But we can agree to a truth conditional conception of semantics and at the same time use translation into a formal language as the notation for specifying truth conditions.

2.2 In the critical section of his thesis Heny presents certain arguments against any analysis of quantification and/or specificity that treats ambiguities of quantifier interaction and/or specificity as due to varying scope of logical operators in a formal language into which English is translated. But his arguments against such an analysis, which he calls a "scope" analysis, don't hold up under scrutiny. Let us consider two such arguments, those concerning the analysis of specificity and the analysis of the quantifier word any. As Heny recognizes, a "scope" analysis of specificity requires a mechanism for varying the
scope of the indefinite determiner, giving it wide scope when specific
and narrow scope when non-specific. He tries to show that such an analysis
of specificity is descriptively inadequate by finding a case in which
a semantically specific NP determiner must be given narrow scope. The
example he uses is (7) below (his (30)):

(7) Two men love each of those [three] women; namely Harry
and Bill, Sam and Joe, and Freddy and Mike, respectively.

Now, the first clause of (7) is ambiguous when taken along and a "scope"
analysis would give (7) the following two readings:

(8) a. (E₂ man, x)(A women, y)(x loves y)
     b. (Ay)(E₂x)(x loves y)

The second clause of (7) is incompatible with (8a), leaving (8b)
as the correct reading for (7). Heny points out that in (8b) the indefinite
determiner two has narrow scope, but the noun phrase two men is
referential and specific, apparently a contradiction. The problem with
this argument is that no reasonable "scope" theory would claim that
determiners with a specific interpretation must have wide scope with respect
to every other type of quantifier. In fact, an indefinite determiner
that is inside the scope of a universal quantifier must have specific
reference, and the truth definition for logical formalism insures that
this will be the case.
As far as Heny's alternative analysis of any is concerned, it requires only a brief mention. In section 2.4 we shall discuss Lasnik and Horn's arguments that any is a form of the universal quantifier (cf. also Quine (1960)) which differs from other forms in two ways: 1) in being restricted to certain irrealis contexts and 2) in having obligatorily wide scope with respect to the irrealis operator. Heny, on the other hand, argues against this analysis of any. The point about his discussion, however, is that he gives no evidence against the analysis. All he says on the subject is that any need not be analyzed in this way and that his mechanism can be extended to account for its semantics. The fact is, of course, that Heny's treatment of any is simply a notational variant of the analysis he attacks. The argument needed to establish this point is entirely analogous to that given in section 2.2.1 with respect to the interpretation of sentence (3) and shows once again that Heny's formulation of scope ambiguities constitutes no real alternative to a standard analysis based on semantic representations written in logical formalism.

2.3 Jackendoff's objections to logical formalism

In an article entitled "Modal Structure in Semantic Representation" (1971) and in his more comprehensive work, Semantic Interpretation in Generative Grammar (1972), Ray Jackendoff presents several arguments against representing scope relationships with formulas of logic. He proposes instead a novel formalism which avoids the problems supposedly
associated with logical formulas. What we hope to do in this section is first to answer Jackendoff's arguments against logical formalism and then to point out a serious weakness in his own formalism that makes it unattractive as an alternative to standard formal languages.

2.3.1 Jackendoff's first argument is that logical formalism gives the wrong interpretation for sentences like (1):

(1) [Jackendoff (1972)'s 7.9] Bill is trying to find a pretty girl.

As Jackendoff points out, sentence (1) is two-ways ambiguous. On one reading there is a specific pretty girl that Bill is looking for while on the other, any pretty girl will do. He suggests that an attempt to capture this ambiguity in logical formalism would look like (2):\(^6\)

(2) = [7.10]
   a. (Ex)(x is a pretty girl and Bill is trying (Bill finds x))
   b. Bill is trying ((Ex)(x is a pretty girl and Bill finds x)).

He says:

(7.10b), the putative nonspecific reading does not convincingly represent this reading: its most direct paraphrase is the nonsensical sentence Bill is trying for there to be an x such that x is a pretty girl and Bill finds her. Even the more natural realization Bill is trying to cause there to be an x such that... is not an accurate paraphrase of (7.9), since in (7.9) Bill is not trying to make someone exist. Hence it is not clear that (7.10b) can function as a semantic representation of (7.9). (1972:202).
Clearly, Jackendoff is correct in saying that the only action Bill should be interpreted as performing in (1) is looking for something; he is not trying to bring anything into existence. What seems dubious is his contention that formula (2b), if coherent, must be interpreted as asserting that Bill performed both actions. Jackendoff gives intuitive English language paraphrases for (2b) that are incoherent or at least are not readings for the sentence (1); and on the basis of these he claims that (2b) cannot represent the non-specific reading of (1). This argument shows that Jackendoff thinks that the meaning of a logical formula like (2b) can be determined by intuition or by analogy to a corresponding construction in English. In fact, of course, logical formulae gain their interpretations entirely from the formal truth definitions of their components. Intuitive paraphrases have no standing at all in determining the meaning of logical formulae. In actuality, if try as it appears in (2) is properly defined, the correct readings for (1) can be represented in the formulae of (2). Such a definition might look roughly like (3):

(3) "NP\text{animate} \text{try (3)}" is true if and only if NP puts forth effort with the intention of causing a situation in which "S" is true.

If we apply (3) to (2b), the formula "S" is "(Ex)(x is a pretty girl and Bill finds x)". Clearly Bill's acting with the intention of causing
a situation in which "(Ex)(x is a pretty girl and Bill finds x)" is true does not entail that Bill is trying to make someone exist, which Jackendoff's paraphrase of (2b) supposedly does entail. Therefore, under definition (3) formula (2b) correctly represents the non-specific reading of (1) and Jackendoff's argument is undermined.

2.3.2 Jackendoff's second argument that logical formalism cannot handle English language scope phenomena is that it supposedly cannot handle certain phenomena of pronominalization. He notices that her in (5) below can be coreferential with a pretty girl in (1) only if the noun phrase is interpreted as specific.

(5) [7.11] Have you met her yet?

He then demonstrates that her cannot be given a semantic representation that captures its coreferentiality with a pretty girl. Her cannot be represented as x, the variable bound by the existential quantifier in (2a) because "it is outside the scope of the quantifier and bound variables are meaningless outside the scope of the quantifier that binds them. (1972:283)" He points out that it is hard to see how one would extend the scope of a quantifier beyond the sentence in which it occurs, especially to cover a question that might even be uttered by another speaker, as in (5). He further shows that the only other coreference capturing representation for her also will not work. This representation would be "the x such that x is a pretty girl and Bill is trying to find
her." As Jackendoff says, the use of this form necessarily leads to an inconsistent treatment of pronominalization. Such a form for the pronoun is impossible within sentences such as (12a), since an infinite regress of the form (12b) would result.

(7.12) a. John wants to show a pretty girl that he likes her.
       b. (Ex)(x is a pretty girl and John wants to show x that he likes x such that x is a pretty girl and John wants to show x that he likes the x such that....)(1972:283)

The problem with these arguments, of course, is that there is no reason to insist that pronominal co-reference be represented in the semantic representation of the pronoun. Why not handle co-reference by imposing external constraints on coreference? This, in fact, is the heart of the interpretive theory of pronominalization which Jackendoff himself supports, and he develops just such constraints in his own analysis of specificity. What Jackendoff fails to note is that constraints on coreference will work just as well for the analysis he is criticizing.

In the example under discussion the coreference of her and a pretty girl is subject to the condition that the quantifier representing the indefinite determiner must be outside the scope of the modal operator in order for the NP to be coreferential with the pronoun. More generally, a definite pronoun can be coreferential with an indefinite noun phrase if and only if either 1) both are outside the scope of any modal (irrealis) operator or 2) both are inside the scope of the same irrealis operator. (With some operators "same" means "same type", with
others "same token". This condition is exactly the one which Jackendoff formulates, using his concept of "dependence in place of scope.

2.3.3 Jackendoff's final argument against using logical formalism to capture scope phenomena involves the ambiguities of scope found in sentences like the following:

(6) [7.55] I told three of the stories to many of the men.

(7) [7.56] I told many of the men three of the stories.

As Jackendoff points out each of these sentences is ambiguous. While they share one reading, moreover, each has a reading which it does not share with the other. The readings of (6) and (7) are given below:

(8) (6 only) There were three stories and for each story there was a group of many men that I told the story to.

(9) (6 & 7) There were three stories and a group of many men and I told all of the stories to all of the group.

(10) (7 only) There was a group of many men and for each man there was a set of three stories that I told him.

Jackendoff argues that since there are only two possible scope orders for two quantifiers in a logical formalism, no such formalism can capture the three readings of (6) and (7) combined. This argument is ingenious and must be answered. We shall, however, delay consideration of it until section 3 of chapter five where we shall have available the
formalism to deal with it adequately.

2.3.4 Not only do Jackendoff's arguments against logical formalism fail, but also there is a serious weakness in his own formalism. Consider sentence (11):

(11) = [7.1] John wants to catch a fish.

Jackendoff proposes to redefine their term scope so that the scope of a verb like want is the part of a sentence where an indefinite NP is subject to what, in ordinary terminology is a "scope ambiguity". When the indefinite is inside the scope of want in the ordinary sense, Jackendoff says that it is dependent on want; and when it is outside the scope of want, Jackendoff says that it is not dependent on want. Then he proposes to capture this "dependence" ambiguity in the formalism of (12):

(12) - [7.15] a. John, a fish, want ( )

b. John, want (a fish)

Formula (12a) represents the wide scope or specific or non-dependent interpretation of "a fish" and (12b) represents the narrow scope, non-specific or dependent interpretation.

This formalism runs into trouble with sentences like (13):

(13) = [7.6] Fred wants a man to ask him for a cigar.
Jackendoff correctly notes that (13) has six readings based on differences in the scope of the two indefinite NP's "a man" and "a cigar."

These six readings are given below in logical formulae. We ignore, as does Jackendoff, the problems posed by the opacity of \text{want}.

(14) a. Fred wants (E man x)(x asks of Fred that (E cigar, y) (Fred gives y to x)).

b. Fred wants (Ex)(Ey)(x asks of Fred that Fred gives y to x).

c. (Ey)(Fred wants (Ex)(x asks of Fred that Fred gives y to x)).

d. (Ex)(Fred wants (x asks of Fred that (Ey)(Fred gives y to x)).

e. (Ex)(Fred wants (Ey)(x asks of Fred that Fred gives y to x)).

f. (Ex)(Ey)(Fred wants x asks of Fred that Fred gives y to x).

Unfortunately, Jackendoff's formalism generates either readings for sentence (13). It generates two scope positions for the NP "a cigar" with respect to the verb \text{ask} and four scope positions for the NP's "a man" and "a cigar" with respect to the verb \text{want}:

(15) = [7.21] a. Fred, a man, him, a cigar, ask ( )

b. Fred, a man, him, ask (a cigar)

(16) = [7.22] a. Fred, a man, him, a cigar, want ( )

b. Fred, a man, him, want (a cigar)

c. Fred, him, a cigar, want (a man)

d. Fred, him, want (a man, a cigar)
Since each of the formulae in (15) can be associated with each of the formulae in (16), a total of eight readings is produced. The two wrong readings generated are, of course, those in which "a cigar" is dependent on ask but not on want (15b + 16a or 16c). Jackendoff points out that these readings cannot exist, but he does not seem to recognize that there is a problem for his formalism in that fact that it generates these ill-formed semantic representations. With the formalism of logic this problem does not arise since scope is there a linear, transitive relation. Transitivity guarantees that any NP within the scope of ask will also be within the scope of want, as is evident from the representation in (14).

Toward the end of his discussion Jackendoff, for reasons that will not concern us here, proposes to allow whole complement sentences to be dependent on their matrix verbs. Often he says, this dependency is obligatory and in particular it is so in the case of want. This dependency of complement sentences is formalized by placing the verb of that sentence inside parentheses, as in (17):

\[(17) = [7.71] \text{ want (ask)}\]

Given this configuration, only three scope positions are possible for "a cigar" in (13), as is shown by (18):

\[(18) = [7.72] \begin{array}{l}
a. \text{ want (ask (a cigar))} \\
b. \text{ want (a cigar, ask ( ))} \\
c. \text{ a cigar, want (ask ( ))}
\end{array}\]
Thus, in its revised form Jackendoff's formalism no longer generates semantic representations in which "a cigar" is dependent on ask but not on want. In exchange for solving this problem, however, the formalism leaves us with the puzzling question of why ask (or the sentence of which it is the main verb) should be obligatorily dependent on want when other elements are only optionally dependent. This question arises because ask is treated by the modal structure just as indefinite NP's are; and since modal structure is supposed to describe scope relation, we would expect ask to be similarly ambiguous in scope with respect to want. Jackendoff recognizes this question but does not answer it. In the logical formalism of (14) the question does not arise because ask, like want, is treated as a predicate; and since only operators (quantifiers, etc.) can vary their scope positions, ask, of course, cannot.

2.4 Recent linguistic analyses of any

In a forthcoming article (Lasnik, n.d.) Lasnik argues that any should be treated as a form of the universal quantifier and adopts Quine's analysis of any. This same analysis is discussed at length in Horn (1972) and adopted by him. Quine (1960) treats any as a universal quantifier that takes wide scope with respect to certain irrealis operators. Thus compare (1) and (2) below:
(1) = [Lasnik's 79] I didn't solve all of the problems.

(2) = [Lasnik's 80] I didn't solve any of the problems.

These sentences are adequately paraphrased by (3) and (4), formulae that differ only in the scope of the universal quantifier:

(3) = [79'] Not for all X (X is a problem → I solved X)

(4) = [80'] For all X (X is a problem → I didn't solve X)

A similar difference in the scope of the universal quantifier will capture the difference in meaning between the sentences in (5) and (6):

(5) = [81] If everyone passes the test, I'm quitting.

(6) = [82] If anyone passes the test, I'm quitting.

After presenting Quine's analysis, Lasnik shows that Vendler's argument (repeated in Jackendoff, 1971) against analyzing any in this way is fallacious. Vendler points out that the variants of (7) with any words are not synonymous with the other variants:

(7) = [85] I have here some apples: you may take \( \left\{ \begin{array}{l} \text{every or e} \\ \text{all} \\ \text{any one} \\ \text{any} \end{array} \right\} \) of them.

He remarks that an offer to take all of the apples is an offer to take them, not one by one but "en bloc", while an offer to take any of the
apples is freer and does not specify how the apples are to be taken. This difference in the meanings of the variants of (7), Vendler argues, shows that *any* cannot be a form of the universal quantifier for then it should be synonymous with *all*.

Lasnik accepts Vendler's factual claims about the meaning of the variants of (7) and even extends them, saying "it seems to me that an offer to take all can generally be construed as allowing the hearer to take all or none, but not some intermediate number."(34). Then, however, Lasnik shows that this difference between *all* and *any* can be analyzed simply as a difference in the scope of a universal quantifier:

\[
(8) = [86] \text{ You have permission (for all } x, \text{ you take } x)\\
(9) = [87] \text{ For all } x \text{ (you have permission to take [or not take] } x)\\
\]

Lasnik continues his analysis of (7) as follows:

The other two cases in 85 are more complex. Superficially, *any one* and *every one* are parallel, but a closer examination reveals basic differences between them. In the former case, *one* is a numeral, and other numerals can be substituted for it: *any two*, *any three*, etc. In *every one*, *one* appears to be not a numeral but a pronoun. The substitution of numerals is impossible - *every three of them*. If this is correct, then *every one* will be expected to behave like *every* or *all* in 85, in its scope relations. Since the sentence with *every one* can reasonably be paraphrased by 86, the prediction is borne out. Assuming that *one* is a numeral in *any one*, 85 with that phrase can be represented as 88.

\[
88 \text{ For all } x \text{ (you have permission you take } x) \text{ condition: }\\
\quad A x A y \text{ (you take } x \text{ & you take } y + x = y)\\
\]

88 like 87 gives permission to choose from the entire set of apples, but the numeral (represented in the condition) requires that only
one apple can be taken. A similar representation could be
given for any two, in which only the condition would differ.

Lasnik concludes his discussion of any by making two points:
First, any is marked to take wide scope with respect to certain operators
and can only occur in sentences containing such operators; and second,
the common factor among the operators that allow any is an ability to
"induce a meaning affecting scope ambiguity with respect to the universal
quantifier (37)"
Thus, a sentence like (10) below would be acceptable
because (11a) and (11b) are not logically equivalent; and sentence (12)
is unacceptable because (13a) and (13b) are logically equivalent:

(10) = [84] Anyone might be elected.

(11) a. For all x (it might be that x is elected).
    b. It might be that (for all x, x is elected).

(12) * Anyone must do the dishes once a week.

(13) a. For all x (it must be that x does the dishes once a week).
    b. It must be that (for all x, x does the dishes once a week).

We find Lasnik's analysis of any to be extremely convincing,
though some linguists would argue that any corresponds to the existential
quantifier in negative contexts and to the universal quantifier only in
modal and some conditional contexts (Karttunen, personal communication).
We know of no factual grounds for choosing between these analyses⁹ and
it may be that there can be none since the scope order of operators
required by Lasnik's analysis, A \sim, is logically equivalent to the scope
order required by the existential quantifier analysis, \sim E. Under
these circumstance the analysis which treats any in a unitary way would
seem to win out on grounds of simplicity. Furthermore, as was mentioned
earlier, the universal quantifier analysis of any begins to explain
why that lexical item exists. It is simply a marked variant of all or
every that takes wide scope with respect to operators that these
quantifiers tend to have narrow scope with respect to. We shall return
to the significance of this opposition between any and all/every at
the end of chapter four.

The most significant aspect of the preceding analysis for our
purposes is that it illustrates the linguistic usefulness of studying
natural language semantics through translation into a formal language.
In effect, what Quine and Lasnik have done in their analyses is first
to create a mapping between a fragment of English and a first order formal
language and then to show that the seemingly bizarre syntactic and
semantic characteristics of any actually reduce to a simple constraint on
that mapping. The constraint is, of course, a restriction of the universal
quantifier associated with any to wide scope with respect to its "trigger"
irrealis operators. In this thesis we hope to provide, on a more compre-
hensive scale, an analysis of the same type as this one of any.
2.5 Summary

In the course of this chapter and the previous one we have developed and defended a certain conception of how to describe and explain "scope" phenomena in English and in natural languages, generally. Since this conception will form the basis of the description and analysis to be presented in the chapters to follow, we shall here give an explicit and succinct summary of it.

The basis of our approach is the hypothesis that the truth conditions of English sentences can be captured in a first order formal language and that the accurate description of these truth conditions is the empirical basis of the linguistic semantic interpretation of sentence structure. From this starting point we argue that the most fruitful way (pace Montague) to describe and eventually to explain the structural aspects of natural language semantics is to translate the set of natural language sentences into a set of equivalent formulae in appropriate formal language and to create an algorithm or set of rules that will produce this translation automatically. Then the properties of this algorithm can be studied in hopes of gaining insight into the psychological mechanisms that cause the sentences of natural language to convey truth conditions in the particular way that the translation algorithm specifies. Naturally, the analyst has no guarantee that he has devised a psychologically revealing algorithm even if it accounts for a substantial fragment of the language. The problem
here is the same as in other areas of grammar construction. The algorithm can be evaluated internally according to criteria of generality and formal simplicity, but we must always hope for independent evidence (from language acquisition, language change, etc.) of psychological reality.

In constructing a grammar of scope for English we can expect, based on our intuitive grasp of the language, the translation algorithm (or "scope component" as we shall call it) to have certain specific characteristics. For example, we expect that in many cases the algorithm will associate a single English sentence with more than one formal language sentence because we know that English sentences often contain scope ambiguities. Also, we expect that corresponding sentences containing nearly synonymous logical operator words will nevertheless be mapped onto different logical formulae because we know that different operator words have different scope order preferences or requirements (e.g. any/all). On the other hand, we expect that in many cases variant sentences containing related operator words will be translated identically by the scope component. After all, there can be many reasons besides differences of scope behavior for a natural language to have sets of nearly equivalent lexical items. Further, we expect that the formal language into which English is translated will be expanded beyond a standard language like the language L defined in chapter one. In order to handle in a natural way operator words that do not correspond
to the standard logical operators, new formal operators will be introduced (via truth definition) that do correspond to these natural language operators. Finally, other characteristics of the scope component will, of course, become evident as the analysis is developed.

As the reader will see, we are going to define our scope component for English within the framework of an interpretivist approach to syntax and semantics, rather than a generative semantics approach. Thus, the scope component will be a translation from surface structure to logical formulae; and in a generative semantics grammar (as proposed by McCawley, for example) logical formulae are related to surface structure through transformations rather than through interpretation rules. In spite of this choice, however, our analysis does not bear very directly on the current debate in linguistics over the generative and interpretive frameworks. The reason for this is that the interpretive rules we shall formulate can easily be reformulated as derivational constraints between base structures written in a formal language and surface structure. We shall not carry out such a reformulation because the details of it are not important to our enterprise, but the reader should keep in mind that it is possible.

Before we leave this summary discussion, we would like to comment briefly on a difference between the analysis we are about to present and the analyses of natural language semantics generally produced by philosophers. When philosophers translate natural language into formal language, they seem to do so for one of two reasons. Sometimes they are
interested in clarifying the truth conditions of one or more particular natural language constructions or the role in determining truth conditions of one or more particular lexical items. Other times they are interested in demonstrating that a translation of natural language into formal language is possible. Of course, both of these interests are legitimate. What the philosophers seem not to concern themselves with, however, is the creation of a translation algorithm that is at once descriptively adequate for the myriad variations of linguistic structure and also composed of principles that are as general as possible. It will become evident in the course of our analysis that these latter requirements are precisely the ones that most interest us. The reason for this is, of course, that unless an algorithm is both descriptively complete and based on the sort of principles that either are learnable in language acquisition or make good candidates for being innately specified, it cannot hope to capture the human linguistic competence that a linguist tries to explicate.
FOOTNOTES TO CHAPTER TWO

1. In chapter five we incorporate some of the selectional facts discussed by Dougherty into our own analysis in a natural way.

2. We should note that from the point of view of syntax Montague's grammar is hardly equivalent to Chomsky's revised standard theory. By claiming that English should be treated as a formal language, Montague is saying that the syntax of English should directly produce all of the non-lexical semantic structure of the language, just as the syntax of a formal language directly produces all of its semantic structure. In other words, there is no independence between syntactic structure and semantic structure and the possibility of purely syntactic generalizations is implicitly denied. Montague's grammar might, therefore, be considered akin to generative semantics, though it is much more rigorously presented.

3. In our exposition of Heny's system we have omitted a crucial aspect of his analysis because it is irrelevant to our discussion. The reader should note, however, that Heny's analysis has a "possible world" semantics and is thus actually intentional. All of the sets and relations defined in our exposition are subscripted in Heny's own work with the variable "i" to indicate that they are defined relative to a possible world. Because in the examples we discuss the "possible world" is the actual world, we need not consider Heny's intentionalism in our discussion.

4. It is not clear to us what Heny means by the contrast between his semantics and one based on readings. Perhaps he is identifying the notion of "reading" of a sentence with the notion "propositional content" of a sentence; but since his semantics is intention- al (c.f. note 3) he should have no real objection to propositions as entities.

5. "E₂", the operator that translates "two", can be defined in terms of standard logical operators as follows:

"E₂(x)Px" is true if and only if "(E(x)(E(y)((x \neq y) \& (Px \& Py)))" is true.

6. We have modified the representations given by Jackendoff slightly to clarify their import.

7. It is actually unclear to us as well as to others we have asked whether Jackendoff's rather odd sounding paraphrase has the entailment he claims for it.
8. An analysis basically similar to this is put forward in Reichenbach (1948).

9. Karttunen (personal communication) has suggested that if any is sometimes to be translated by an existential quantifier then the pronominalization in (i) and (ii) below could be handled by the same mechanism:

   (i) If anyone comes, let him in.
   (ii) If someone comes, let him in.

Otherwise, (i) will be a case of bound variable pronominalization, which (2) cannot be. We see no particular advantage, however, in handling (i) and (ii) in the same way since bound variable pronominalization is anyway needed for other cases (e.g. reflexives).

10. We have not, of course, demonstrated that first order logic is sufficient for capturing the truth conditions of natural language sentences. It is, however, adequate for all examples that we know of, including the supposed counter-examples in Hintikka's paper "Quantifiers vs. Quantification Theory" in Linguistic Inquiry. vol. V, no 2, Spring, 1974.
CHAPTER 3: THE SCOPE OF UNIVERSAL QUANTIFIERS, INDEFINITE NOUN PHRASES, AND NEGATION

3.0 Introduction

Consider the following sentence:

(1) All of these symbols represent one of the chemical elements.

This sentence is ambiguous. On one interpretation it is roughly synonymous with (2a) below and on the other (preferred) interpretation it is synonymous with (2b)

(2) a. Each of these symbols represents a different one of these chemical elements.

b. There is a certain chemical element that all of these symbols represent.

Suppose that we translate the indefinite determiner one into the existential quantifier of logic, in line with our previous discussion. Suppose further that all is translated into the universal quantifier. Then the ambiguity of (1) can be captured as a difference in the relative scope order of the universal and existential quantifiers in a logical formula roughly as in (3) and (4):¹

(3) (A x ∈ {these symbols})(E y ∈ {the chemical elements}) represent (x, y)
the sentences of (6) might be interpreted as in (8) and those of (7) as in (9):

(8) a. \( \lnot (E \text{ man } x)(\text{Meet for dinner } (\text{John, } x)) \)

b. \( (E \text{ man } x)\lnot (\text{Meet for dinner } (\text{John, } x)) \)

(9) a. \( (A \ x \in \{\text{the horses}\}) \text{ May } (\text{Win } (x, \text{ the race}) \)

b. \( \text{May } (A \ x \in \{\text{the offices}\})(\text{Go to } (x, \text{ the Democrats}) \)

The contrast between (6a) and (6b) suggests that the semantic differences between similar quantifier words like \textit{some} and \textit{a(n)} might be partly a function of differences in their preferred scopes relative to other semantic operators. The contrast between (7a) and (7b) shows that ambiguity of scope is endemic within single syntactic constructions of natural language. Our purpose in this chapter and the next will be to analyze the scope behavior of different quantifier words and operators in line with the principles laid out earlier in hopes of developing a general explanation of how scope relations are determined in English sentences. We shall provisionally ignore the effects of number marking on the behavior of quantifiers so our account will of necessity be incomplete, but in chapter 5 we will remedy this defect. Thus, we hope in the end to arrive at not only a general understanding of scope determination but also an explanation of the differences between variant quantifiers in terms of well-motivated lexical markings, including number.
(4) \((E \ y \in \{\text{the chemical elements}\})(A \ x \in \{\text{these symbols}\})\) represent \((x, y)\)

This formalism, in fact, does a better job of representing the readings of (1) than do the paraphrases of (2). In particular, it is not precisely true that each symbol is associated with a different chemical element in the first reading. The acceptability of sentence (5) below shows that there could be only one element involved even in a situation where the first reading is appropriate.

(5) All of these symbols represent one of the chemical elements, and they may (or may not) represent the same one.

What that reading does entail is that the elements represented by different symbols could all be different. An attentive examination of the formula (3), moreover, reveals that it is similarly non-committal as to whether the elements are the same or different.

Consider now the following pairs of sentences:

(6) a. John didn't meet a man for dinner.
   b. John didn't meet some man for dinner.

(7) a. All of the horses entered may win the race.
   b. (Because of Watergate) all of the offices may go to the Democrats.

The differences within these pairs of sentences can also be expressed as differences in the scope of operators. On their dominant readings,
3.1 The universal quantifier and the indefinite noun phrase

3.1.1 Each and the indefinite noun phrase

The sentences of (1) below suggest that each should be marked lexically as having wide scope with respect to the indefinite determiners a(n) and one:

(1) a. John wrote each of his mistresses a love ballad.
    b. Each of the children drew a picture.
    c. Each of these artists painted one of the portraits.

The sentences of (2) appear to show that each is interpreted as having wide scope with respect to indefinites even when it is to the right of them in deep and/or surface structure:

(2) a. John has written a play about each of those presidents.
    b. A calculated manœuvre started each of those wars.
    c. One of the pictures was drawn by each of the children.

The data presented so far would be accounted for by a lexical marking on each which assigned it wide scope with respect to indefinites in the same simplex sentence. Interestingly enough, the deep and surface orders of the quantifier words appear to be irrelevant. As sentence (2a) shows, moreover, the constituent structure relationship between the quantified noun phrases also does not affect the scope relationship.
Even though the universally quantified noun phrase about each of those presidents both follows and is embedded within the indefinite noun phrase head a play, it still has wide scope with respect to the indefinite.

The apparent regularity of (1) and (2) is, however, a false one. Further data can be found in which the each quantifier is optionally interpreted as lying within the scope of the indefinite. Thus, all of the sentences of (3) are ambiguous, as are those of (4). Neither syntactic order of quantifiers nor embedding can eliminate the ambiguity of the sentences.

(3) a. Each of my brothers loves a woman from Kansas (named Joanna).

b. Each of my brothers was treated by one of the Mayo clinic doctors (who had won a Nobel prize).

c. The gangsters are each chasing a (particular) man from New York.

d. John showed each child a picture (of the S.S. France).

e. John showed each picture to the child of one of his friends.

f. Cassatt painted each of those pictures of a woman with her child.

g. Each of the students was confused by the teacher's proof of one of the theorems.2

(4) a. A man from Kansas (named Smith) was seen by each of my brothers.

b. One of the Mayo doctors (who had won a Nobel prize) treated each of my brothers.
c. A particular man from New York is chasing each of those gangsters.

d. John showed a child each of the pictures.

e. John showed one of his pictures to each of the children.

f. John praised an actress from each of his favorite movies.

g. One nurse misunderstood the doctor's instructions on each patient. ²

That the sentences of (3) and (4) are ambiguous may not be immediately obvious. It is clear that they can all be interpreted so that the indefinite NP refers to a single entity. This interpretation, while always present, is favored when the indefinite is to the left of each in surface structure. It also seems stronger when the indefinite NP contains a relative clause or other descriptive material that narrows its range of possible referents. The mere existence of this interpretation, however, is not sufficient to guarantee that the sentences have a scope ambiguity with a reading in which the indefinite has wide scope with respect to each. As we noted in our discussion of (3.0.1)/(3.0.3), the narrow scope reading for the indefinite is vague as to the number of entities involved. It is perfectly compatible with a situation in which the wide scope reading for the indefinite holds. The difference between saying that (3)-(4) are ambiguous and saying that they are unambiguous but vague is, therefore, quite subtle. We can determine whether (3) and (4) are ambiguous only if we can find a
test which differentiates between definite reference to a single entity and possible reference to a single entity.

As it happens, there are good arguments for calling (3) and (4) ambiguous. Perhaps the strongest one is based on some facts about coreference. Consider the sentences of (5). They both contain syntactic constructions in which the order of quantifiers is fixed with each having wide scope. Both are incompatible with sentence (7). The sentences of (6), on the other hand, have the form of (3) and (4) and are compatible with (7):

(5) a. For each of my friends, there is a woman whom he loves.
   b. Each of the men in the room who met a woman from Ohio was happy.

(6) a. Each of those men loves a woman from Ohio.
   b. Each of those men is loved by a woman from Ohio.
   c. A woman from Ohio loves each of those men.
   d. A woman from Ohio is loved by each of those men.

(7) She is beautiful.

Sentence (7), when tacked on the the sentences of (6), forces the indefinites in the latter to be interpreted specifically; i.e., as referring to a single entity. Let us suppose that this interpretation is merely a constrained version of a single vague (wide scope for each) reading of an unambiguous (6a), (6b), (6c) or (6d). Under this assumption
we cannot explain why (7) is incompatible with (5) since the sentences of (5), though unambiguous, are just as vague as those of (6) in respect to the number of different entities referred to by their indefinite NP's. On the other hand, if we assume that the interpretations of (6) forced by (7) are truly autonomous readings of ambiguous sentences, then the incompatibility of (7) with (5) follows from the latter's lack of a reading where each has narrow scope. Thus, the compatibility of (6) with (7) is strong evidence for the ambiguity of (6), hence of (3)/(4).

A second argument in favor of the ambiguity of (3)/(4) can be derived from a standard vagueness/ambiguity test, the conjoined repetition test. This test is based on the fact that two structurally parallel ambiguous sentences must have the same interpretation when conjoined, while two vague sentences are still interpreted independently when conjoined. Consider the following sentences:

(8) John likes Mary as well as Harry and Bill likes Sue as well as Sam.

(9) John likes his uncle and Bill likes his.

Each of the conjuncts of (8) is, of course, two ways ambiguous by itself, but the conjoined sentence is: only two ways ambiguous instead of four ways. In other words some principle requires that the same reading of the ambiguity be assigned to both conjuncts. This Principle does not apply in cases of vagueness, however. Thus, in
sentence (8) the phrase *his uncle* is vague in reference: It can refer to a father's brother, a mother's brother, a father's sister's husband or a mother's sister's husband. There is in this case no requirement that if *his uncle* in the first conjunct refers to a mother's brother, the corresponding phrase in the second conjunct must also refer to a mother's brother. Thus the conjunction has twice as many interpretations as each conjunct taken separately.

Now consider sentence (10) below:

(10) Each of my brothers knows someone from Kansas and so does each of my roommates.

i. The person my brothers know is a football player for the Kansas City Chiefs and the person my roommates know is a professor at Kansas State University.

ii. The people my brothers know are football players for the Kansas City Chiefs and the people my roommates know are professors at Kansas State University.

iii. * The person my brothers know is a football player for the Kansas City Chiefs and the people my roommates know are professors at Kansas State University.

iv. * The people my brothers know are football players for the Kansas City Chiefs and the person my roommates know is a professor at Kansas State University.

The sentences (i) and (ii) are compatible with the test sentence (10) and they force the same interpretation on each of the conjuncts of (10). The sentences (iii) and (iv) are incompatible with (10) and they force opposite interpretations on the conjuncts of (10). Therefore,
the difference in meaning under study, illustrated by (10i) versus (10ii) is a true ambiguity, not a vagueness.

The conclusion that the sentences of (3)-(4) and similar sentences are ambiguous seems, of course, to contradict the fact that sentences of (1)-(2) are univocal. The contradiction disappears, however, when we realize that (1)-(2) are special cases in which the character of the predicate is such as to eliminate the narrow scope reading of each with respect to the indefinite. In (11) and (12) below we have represented the narrow scope readings of each for the corresponding sentences of (1) and (2).

(11) a. *(E ballad, b)(A the mistresses, m)(John wrote b for m)
   b. *(E picture, p)(A the children, c)(c drew p).
   c. *(E portrait, p)(A artists, a)(a painted p)

   b. *(E manœuvre, m)(A those wars, w)(w was started by m).
   c. *(E picture, p)(A the children, c)(p was drawn by c).

All of these readings are anomalous for the same reason. They assert that a number of different people or entities are independently associated with a single object or entity by a relation which the object can only enter into once. Thus, for example, if John writes a ballad for one of his mistresses, he cannot again write that same ballad for another one. Similarly, if one child draws a certain picture, that
picture cannot again be drawn by anyone. In other words, due to their lexical content, the verbs of (1) and (2) obey the following axiom:

\[(12) \quad (A \, x, \, y)(\text{Verb} \, (x, \, a) \, \text{and} \, \text{Verb} \, (y, \, a) \, + \, x = y)\]

where 'a' is a constant referring to some fixed single entity.

Now it follows directly from (13) and the representations in (11) and (12) that the noun phrases governed by each in (1) and (2) must refer to single individuals if the indefinite has wide scope. Consider, for instance, (11a). If \(b_o\) is the ballad whose existence is asserted by (11a) and if \(x\) and \(y\) are two of the mistresses referred to by the universally quantified noun phrase, then something like "Write for \((x, \, b_o)\) ... Write for \((y, \, b_o)\)" must hold. From this and the fact that write for obeys the axiom (13), it follows that \(x = y\). But if \(x = y\), then the plural noun phrase "his mistresses" in (1a) refers under the interpretation (11a), to a single individual. Therefore, the anomalousness of (11a) is explained, since a plural noun phrase under ordinary circumstances cannot refer to a single individual. Exactly parallel arguments explain the anomalousness of the other interpretations in (11) and (12).

We should point out here that the above arguments cannot apply to sentences like (14) below, in which each is replaced by all:

\[(14) \quad \text{John wrote a ballad for all of his mistresses.}\]
Clearly in such a sentence the wide scope or specific reading for the indefinite noun phrase is perfectly acceptable. What the argument we presented shows is that (11a) cannot be the semantic representation for (14) in this reading. We must leave for chapter 5 the proper statement of the reading as it requires an understanding of the interaction between quantification and plurality.

Notice that once we replace a predicate of (1)-(2) by one which can be true repeatedly of the object governed by the indefinite determiner, the narrow scope reading for each immediately becomes acceptable. Thus (15) can perfectly well have the reading (15).

(15) John sent each of his mistresses a love ballad.

(16) (E ballad, b)(A his mistresses, m)(John sent b to m.)

* * *

Although it involves a short digression from our principle theme, we would like to point out here that the axiom (13) which we used to explain the univocality of (1)/(2), need not be an ad hoc descriptive device. Axiom (13) is actually a particular case of a widely useful device called a meaning postulate (cf. Carnap, 1952; Goodman, 1951:48-51). This device has been proposed as a general way of describing the contribution made by the lexical content of terms and predicates to the truth conditions of sentences.
To clarify the significance of the device let us consider how axiom (13) might be incorporated in a fragment of a description of the semantics of English verbs. There is a class of verbs, let us call them the creative verbs, which denote events in which something is brought into existence. One characteristic of these verbs is that, as with other "change of state" verbs, the specified agent of the predicate is the exhaustive agent, at least when the object has definite reference. With creative verbs the same restriction seems to hold for terms in the other (non-agentive) predicate places as well. We illustrate this restriction by the contrast between (17) and (18):

(17) John and Mary pushed the carriage and so did little Jack. (In fact, they all pushed it together.)

(18) *John and Mary wrote the play and so did Sam. (In fact, they all wrote it together.)

The fact that a given entity can only come into being once, when combined with the exhaustiveness restriction on the terms to which a creative predicate applies, leads to the following meaning postulate for creative verbs, which is simply a more general version of (13):

(19) \((A \ x, y)(CV \ (x, a_1 \ldots a_n) \text{ and } CV \ (y, a_1 \ldots a_n) + x \equiv y)\)

where 'CV' is any \(n+1\) place creative verb. 'a_i' is a constant term.
This postulate is, of course, directly contradictory to the interpretations in (11) and (12), since the use of the universal quantifier words in English always suggests that the range set of the variable bound by the universal quantifier contains more than one member.

Postulate (19) is a special case of a meaning postulate which applies to all change of state predicates. Since the exact formulation of this more general meaning postulate is not necessary to our purposes, we will not work it out here; but it can't be very different from (19) itself. The meaning postulate does not apply to creative verbs because of their syntactic, morphological or other linguistic or formal properties. Meaning postulates hold of words because of the empirical and logical nature of the objects or events to which the words refer. For example, the sentence (20a), which is ruled out by (19), would be acceptable under certain unlikely empirical conditions.

(20) a. ? Homer and my friend Bill each wrote The Iliad.

b. Homer and my friend Bill each wrote the original Iliad.

If by some fluke my friend Bill, not knowing the Iliad, wrote an epic poem that turned out to be identical to the Iliad then (20a) would accurately and acceptably refer to a real situation. Of course, (20b) would still be unacceptable even under these circumstances since it is logically and not just empirically impossible for there to be two "original Iliads"
We should note that the use of the meaning postulates like (19) do not require us to take a position on whether the intrinsic semantic structures of lexical items are part of an intentional apparatus, although Carnap, the originator of the device, gave it an intentional interpretation. He intended meaning postulates to capture all and only the analytic entailments associated with particular lexical items. If intentional word meanings and analytical entailments exist, then meaning postulates will be interpreted as describing them. But even if they do not exist, meaning postulates can still be useful and can be interpreted as descriptions of psychological rules governing a speaker's use of given lexical items.  

* * * 

The ambiguity of sentences containing each and an indefinite noun phrase is a matter of dispute in the linguistic literature. In Syntactic Structures Chomsky implies that active and passive sentences containing the quantifier every (which is very similar to each) and an indefinite are not synonymous. In the interpretation of such sentences, Chomsky seems to take the quantifiers in their surface order. Describing the interpretation of one such example he says:

We can describe circumstances in which a 'quantificational' sentence such as 'everyone in the room knows at least two languages' may be true while the corresponding passive 'at least two languages are know by everyone in the room' is false, under the normal interpretation of these sentences - e.g., if one person in the room knows only French and German, and another only Spanish and Italian. This indicates that not even the weakest semantic relation (factual equivalence) holds in general between active and passive. (pp. 100-101)
On the other hand, Katz and Postal argue in *An Integrated Theory of Linguistic Descriptions* that these example sentences are ambiguous.

They say:

Although the facts are far from clear, the active seems to be open to the same interpretation attributed to the passive, and conversely, the passive is open to the same interpretation attributed to the active. Both can mean either 'everyone in the room knows the same two particular languages, Persian and Hottentot' or 'everyone in the room knows two languages, different for different people'. Thus it seems that both actives and passives containing quantifiers and pronouns are ambiguous in the same way and so are full of paraphrases of each other. (p. 72)

We agree with Katz and Postal's judgment; but this interpretation of the facts produces an interesting question of description which neither Katz and Postal nor other writers seem to have discussed. The question is quite simply how to capture this ambiguity.

If the facts were as Chomsky first stated them, then we would have a strong argument for a simple surface structure order interpretive rule. In fact, some people who accept the ambiguity have argued that surface order does play a determinant role in the interpretation of sentences involving *each* or *every* and the indefinite. They argue that surface structure order of quantifiers provides the preferred reading for the sentence and that the other reading is secondary and marginal. This position is undermined by the sentences of (2) and others in which the reading that follows surface structure is unacceptable.
Needless to add, the full ambiguity of the sentences under consideration makes a deep structure order interpretation as untenable as a surface structure one.

Having demonstrated the ambiguity of sentences containing each and an indefinite, we must point out that a sentence or sentence reading in which each has an indefinite determiner inside its scope is generally more idiomatic than one in which there is no such narrow scope indefinite. Thus, the sentences of (21) are more idiomatic than their counterparts in (22):

(21) a. On each of Max's world trips, a disaster happened to him.

b. Each cat pounced on one of the mice.

c. A friend of mine, Mary Smith, has been married to each of those stars at some time or other.

(22) a. On each of Max's world trips, he was robbed.

b. Each cat pounced on the ball of yarn.

c. A friend of mine, Mary Smith, has been married to each of those stars.

These facts suggest that there is a lexical marking on each that indicates a preference for having an indefinite inside its scope. This preference does not affect the ambiguity of sentences containing each plus an indefinite, but it does help to determine the relative prominence of the alternate readings.
In summary, sentences containing each and an indefinite NP are fully ambiguous. One reading each has wide scope while on the other the indefinite has wide scope. The strength of these two readings differs from sentence to sentence in accordance with the following factors: All other things being equal-

1) An interpretation in which scope order follows surface order is more available.

2) An interpretation in which there is an indefinite inside the scope of each is more available.

3) An indefinite NP with more restrictive descriptive content is more likely to have wide scope with respect to each.

Naturally, this description applies only to sentences in which each and the indefinite are in the same simplex sentence. As the non-ambiguity of (5b) shows, when the two quantifiers are in different sentences the quantifier in the matrix sentence has wide scope with respect to the other. The above factors are independent and they can have contradictory effects in any given sentence. If the reader will go back over the sentences of this section, he will see that the most idomatic sentences and interpretations are those in which the largest number of factors operate in harmony.
3.1.2 Every and the indefinite noun phrase

The quantifier word every behaves very much like each in its scope relations, especially with indefinite noun phrases. Sentences (23) and (24) below are completely synonymous with corresponding sentences containing each. Even the factors which determine the strength of the possible readings are similar.

(23) a. Every brother of mine knows one of the congressmen from Kansas.

b. Every one of my brothers was treated by a doctor from Kansas (named Smith).

c. John showed every child a picture (of the Titanic).

d. John showed every picture to a child of a friend of his.

e. Martinez painted every one of those pictures of a woman from Toledo.

(24) a. A man from Kansas (named Smith) saw every one of my brothers

b. A man from Kansas was seen by every one of my brothers.

c. John showed one of his children every picture.

d. John showed a picture to every child.

e. John praised an actress from every one of his favorite movies.

The description we gave of the interaction between each and the indefinite will do for every as well, except for one factor. While sentences with
each seem more idiomatic when there is an indefinite inside the scope of the universal quantifier, sentences with every are completely idiomatic even when no indefinite is present. Thus, the sentences of (25) and (26) are equally acceptable although those of (21) and (22) show a difference in acceptability.

(25) a. Every child has a favorite toy.
    b. Every person in the room is moving to some place in California.

(26) a. Every child loves candy.
    b. Every person in the room is moving to California.

This difference between each and every appears to be idiosyncratic and it can be captured only with idiosyncratic markers on the two lexical items. This is hardly surprising. English is perhaps the only language with two separate singular universal quantifier words like each and every. French, German, and Spanish, for example, have only one such quantifier; chaque, jeder, and cada respectively.

The similarity between each and every is universally recognized but there are, of course, differences in the usage of the two words. These differences have led Zeno Vendler (1967) to argue that the words cannot be considered as synonymous or as variants of the universal quantifier. Since we are considering each, every, all and any as all being variants of the universal quantifier, we ought to look into what Vendler says. His first observation is that:
While the expression of each of them is correct, every of them sounds ungrammatical; one has to say every one of them. On the contrary, each one of them is somewhat redundant. It looks as if each already implied one and drew our attention to the individual elements in a peculiar way. (p. 76)

He further asserts that:

while the sentences

(27)  a. He came every day.
       b. He came each day.

are both correct (yet we feel some difference),

(28)  i. He came each second day.
       b. He came each three days.

sound odd, the usual forms being

(29)  a. He came every second day.
       b. He came every three days.

Vendler concludes from these examples that there is a basic semantic difference between each and every. He considers both each and every to be distributive as contrasted with the collective all, but each for him is somehow more distributive than every. He says

The other two orders are both distributive, yet with 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. (p. 78)

We shall explicate the distributive/collective contrast between each-every and all in chapter 5; it has a real basis in the difference in
number marking between all and the other two quantifiers. Vendler's distinction between each and every, however, is overdrawn. It may in part refer to the lexical difference we cited earlier concerning preference for co-occurrence with a narrow scope indefinite. But Vendler misstates this difference and misinterprets the real syntactic differences between these words in semantic terms. As Vendler says, the construction each of NP is grammatical in English while the construction every of NP is not. This difference, however, is due not, as Vendler claims, to any semantic difference but to the fact that every is a purely adjectival determiner while each may either be adjectival or serve as the pronominal head of a NP. This pronominal character of each is sufficient to explain Vendler's observation that:

(there is) an exclusive role for each in contexts like

(30) a. Each in turn contributed his share.
    b. They cost a penny each.
    c. They love each other.
    d. The sides of these triangles are equal each to each.

No semantic difference between each and every need be adduced here. In fact, it is dangerous to interpret every syntactic similarity and difference semantically. As the sentences of (31) and (32) below demonstrate, each and all pattern syntactically in a similar way.

(31) a. Each of the horses stumbled at the turn.
    b. The horses each stumbled at the turn.
    c. The horses will each stumble at the turn.
(32) a. All of the horses stumbled at the turn.
   b. The horses all stumble at the turn.
   c. The horses will all stumble at the turn.

If we follow Vendler's reasoning, this pattern, which is shared only by the quantifier word both, ought to be a sign of some semantic kinship between each and all as contrasted with every. But we would be hard pressed to find any such connection and Vendler does not mention this syntactic pattern.  

Regarding the difference between the sentences of (28) and (29) Vendler says:

The reason seems to be that no day is a second or a third day without a reference to other days. Now, then, while every considers the days as they are among other days, each takes them one by one, as it were without their environment. (p. 77)

The facts here are open to some dispute, however. While sentence (28b) does seem odd, sentence (28a) seems perfectly acceptable to a number of informants. If (28a) is acceptable even if stilted, as are many sentences containing each, then Vendler's semantic argument collapses. Perhaps the differential acceptability of (28b) and (29b) might best be handled by treating expressions like every three days as idioms. This makes particular sense given that these expressions violate an otherwise universal restriction of every to singular noun phrases.
Vendler's last arguments for the existence of a basic semantic difference between each and every turn out to hinge on examples in which each of Np is contrasted with the phrase every one of NP. Thus, the phrase each of the two NP is acceptable while every one of the two Np is odd. Further, the command like (33) seems more open to requiring a single act than (34), which seems to require a series of acts.

(33) Take every one of the apples.

(34) Take each of the apples.

These two facts indicate that every one behaves like all. Thus, all of the two NP is as odd as every one of the two NP⁶, and (35) like (33) requires a single act.

(35) Take all of the apples.

The reason for this similarity between all and every one is that the NP every one and the animate pronoun everyone have come to be used as pronominal forms for all and cannot be taken simply as pronominal forms of every. In those respects in which every one or everyone are like all, every is like each so that facts about every one cannot be used to argue for the existence of a semantic difference between every and each. Thus, (36) is distributive like (34), not collective like (35), and (37a) is unacceptable like (37b), not acceptable like (37c), (37d) or (37e):
(36) Take every apple.

(37) a. * Every worker in the plant surrounded the boss.
    b. * Each worker in the plant surrounded the boss.
    c. All of the men in the plant surrounded the boss.
    d. Every one of the men in the plant surrounded the boss.
    e. Everyone in the plant surrounded the boss.

In addition to the parallelism between all and every one/everyone mentioned above, there is some further evidence that every one and everyone are pro-forms for all. In colloquial speech the number assigned to every one/everyone, unlike every and each, is indeterminate. Although it selects a singular verb, it often shows plural number agreement in other ways. Thus, sentences of (38a) and (38b) are grammatical in colloquial English, but (38c) is definitely unacceptable:

(38) a. Every one of the women put on their hats.
    b. Everyone put on their hats.
    c. * Each of the women put on their hats.

Furthermore, this indeterminacy of number is associated with every one/everyone playing the role of all. The sentences of (39) are ungrammatical because every one and everyone are associated with singular pronouns and so cannot behave like all. In the sentences of (40), on the other hand, every one and everyone are associated with plural pronouns and they are perfectly acceptable to speakers who accept (38):
(39)  a. * Every one of the workers in the shop surrounded
     the managers during his break.

     b. * Everyone in the shop surrounded the managers
during his break.

(40)  a. Every one of the workers in the shop surrounded the
     boss during their break.

     b. Everyone in the shop surrounded the boss during their
     break.

In other words, the idiosyncratic semantic behavior of every one/
everyone co-occurs with idiosyncratic agreement behavior, and both
idosyncracies are explained if every one/everyone is being adapted as
a pronominal form of all.7

3.1.3 All and the indefinite NP

To the extent that the behavior of all depends on its plural
number we must postpone discussion of it to the next chapter. As a
result, we cannot at this point explain why all is acceptable in
contexts like (37) while each is not. What we can say is that sentences
containing all and an indefinite are generally ambiguous as to the
scope order of the two quantifiers. Thus, sentences of (43) and (44)
(as well as (3.0.1)), display the same ambiguity as do sentences with
each or every:

(43) All of those toys belong to one of the Jones boys.
(44) A Democrat won all of the important positions.

The ambiguity of these sentences suggest that we provisionally treat all as synonymous with each and every. This decision will be modified substantially in chapter five, however, in order to explain the facts of (37).

* * *

So far we have state the facts on the scope relations among the universal quantifier words and the indefinites. We have discovered that similar quantifier words can have peculiar lexical scope preferences in an environment in which scope order is ambiguous from a structural point of view. Aside from the influence of surface order on scope order preference, however, the investigation so far has told us little of the general principles underlying scope relationships in English. The discovery of these principles requires us to broaden our field of inquiry. We turn now, therefore, to the scope of negation.

3.2 The scope of negation

3.2.0 Describing semantics of negation in English is a complex task. Not only are there several different negative operators to contend
with, but also the primary negative _not_ appears in several distinct syntactic environments. In the following discussion we shall concentrate on illuminating the scope relationships between _not_ and the English quantifier words in the basic negative contexts of English; i.e., sentences with normal intonation where _not_ is found either in the auxiliary or sister adjoined to a quantifier. Such sentences might be called the "standard negative sentences" of English for while they do not exhaust the syntactic range either of the _not_ operator or negative operators in general, they have formed the basic material of all linguistic analyses of negation. A complete analysis of negation would, of course, require that we extend the analysis of scope presented here to include other negative sentence types, but this extension would be grounded on a firm analysis of the basic cases.

In devising our analysis of negation we shall be relying heavily on the previous work of other generative linguists, especially Ray Jackendoff, Edward Klima, and Howard Lasnik. We are indebted to these investigators not only for their systematic presentations of data and analytic problems but also for parts of our analysis and, not least importantly, for sparking our own analytic imagination.

3.2.1 Lasnik's analysis of the scope of negation

We shall begin our account of negation with the analysis proposed in Lasnik (1972). In order to accommodate certain additional data, however,
that analysis will have to be refined and extended in interesting ways. Lasnik argues persuasively that the basic facts of the scope of negation relative to quantifiers, certain quantificational adverbs, and motivational adverb-phrases can be handled by two end of cycle or surface structure\textsuperscript{9} scope rules which apply after the assignment of sentence stress and intonation contour. We give Lasnik's rules in (1) below:

(1) a. Quant→ [+negated] / \underline{not} + X + \\
    b. Quant→ [+negated] / not + ___

i) \underline{x y z} means that x y z is a single phrase intonationally

ii) The Quant in (1a) is marked [-some] so that the rule will not apply to a certain class of quantifiers including some, a number of, certain, several, etc. These quantifiers are labelled [+some]. This label, as Lasnik makes clear, is an arbitrary one. He gives no evidence for its having semantic significance.

iii) Quant includes:
   1. quantifiers like all, many, some, etc.
   2. Motivational adverbs like because and in order to phrases
   3. quantificational adverbs like often, always, until, etc.

By the feature [+negated] Lasnik means that the Quant phrase carrying it is within the scope of negation. The feature [-negated] means that the Quant phrase is outside the scope of negation. This feature notation is translatable into a first order formal language representation so that a [+neg] Quant would be to the right and a [-neg] Quant to the left of the negation operator in a logical formula. The translation of Lasnik's feature notation into formal language will be carried out
explicitly in chapter four to allow us to make certain useful additions to Lasnik's analysis. Even here at the beginning, however, such a translation would allow us the economy of eliminating Lasnik's redundancy rule: \([+\text{negated}] \rightarrow [-\text{referential}]\). The fact that negated quantifiers are non-referential follows directly from the way truth conditions are defined on formulae in any standard formal language that Lasnik's future marked English sentences might be translated into. The usefulness of formal languages for clearly portraying otherwise complicated or confused facts of reference has been demonstrated by a number of modern analytic philosophers, especially P.T. Geach (1962). Therefore, our definition of Lasnik's features in terms of a translation into the predicate calculus has obvious heuristic and theoretical advantages, especially in light of the vague theoretical status of such devices as semantic redundancy rules.

The operation of Lasnik's scope rule can be illustrated by the sentences in (2)-(4):

(2) a. Not many of the students supported the government's action against the Attica rebels.
   b. John couldn't solve many of the problems.
   c. John couldn't solve many of the problems.
   d. Many of the problems, John couldn't solve.

(3) a. Not often does John go drinking.
   b. John doesn't often go drinking.
   b'. John doesn't go drinking often. (no intonation break)
   c. John doesn't go drinking, often. (intonation break before often)
   d. Often, John doesn't go drinking.
(4)  
a. Not because he loves her does George beat his wife.
   b. George doesn't beat his wife because he loves her.
      (no intonation break)
   c. George doesn't beat his wife, because he loves her.
      (intonation break before because clause)
   d. Because he loves her, George doesn't beat his wife.

For the (a) sentences rule (1b) guarantees that the Quant phrase will be interpreted as negated. Sentence (2a), for example, could be represented in a first order formal language roughly as in (5), with many to the right of not (if the language was extended to include a quantifier M corresponding to many (cf. Altham, 1971)):

(5)  \neg(M \text{ students, s})(s \text{ supported the government...})
     [more correctly - \neg(Mx) \& (St(x), Sup(x, g))]  

The (b) sentences are interpreted with rule (1a) which guarantees that the Quant phrase will be negated since there is no intonation break in the sentence. In our notation (3b) and (3b') might be represented as in (6):

(6)  \neg(M \text{ occasions, o})(\text{John goes drinking on o})
     [more correctly - \neg(Mx) \& (Oc (x), GD (j, x))]  

The same representation would, of course, do for (3a). Finally, in the (c) and (d) sentences the Quant phrases are non-negated (i.e., outside
the scope of the not operator) because the rules of (1) cannot apply to them.11

Rule (1a) is restricted by Lasnik so as not to apply to a certain set of quantifiers: some, several, a number of and others. This restriction is necessary to account for the interpretation of sentences like (7).

(7) John didn't solve \{some\ several\} of the problems.

As Lasnik points out, the quantifier phrase in (7) is outside the scope of negation, although it appears to be in a negated position. By restricting the application of (1a), Lasnik avoids giving the wrong interpretation to (7). Lasnik also marks quantifiers like some as inherently [+referential]. He does so in order to explain the unacceptability of sentences like (8):

(8) * Not \{some\ several\} of the students stayed to hear the lecture.

By (1b) and the redundancy rule, the quantifier phrase in (8) should be [-referential]. This marking contradicts the lexical marking of [+referential] on the quantifier and makes the sentence unacceptable.

We can eliminate the need for the feature [+referential] here if we give some, several etc. the inherent marking [-neg]. Since rule (1b) operating by itself will mark the quantifier phrase in (8) as [+neg], the revised lexical marking will also account for the unacceptability
of (8). Of course, this use of the feature [-neg] as an inherent marker on quantifiers raises the question of what that feature would mean in sentences like (9), where there is no negative operator:

(9) \{\begin{array}{c} \text{Some} \\
\text{Certain} \end{array}\} \text{ of the students left the lecture early.}

This question receives a natural answer if we simply reinterpret the feature value [-neg] to mean "not inside the scope of not" instead of "outside the scope of not". Under this interpretation the lexical marking [-neg] we have proposed for some, etc. causes no problems for positive sentences.

Lasnik's analysis can be extended to a quantifier that he himself does not consider; the quantifier one. Consider the following sentence:

(10) John didn't solve one of the problems.

Under normal intonation sentence (10) is unambiguous and is interpreted with the quantifier phrase outside the scope of negation. Therefore, if we add one to the list of inherently [-neg] quantifiers, then (10) will be interpreted correctly.

Sentence (10), however, does have another interpretation. If there is heavy stress with rising pitch on the determiner one and secondary stress on the object of of, then (10) is synonymous with the preferred interpretation of (11):

(11) John didn't solve a single one of the problems.
The preferred interpretation for (11) is with the determiner phrase inside the scope of not, and with heavy rising stress on the determiner, it is the only one. A similar interpretation of one arises in sentences like (12):

(12) Not one of the men helped John out.

Sentence (12) is grammatical only with contrastive stress on one; and it is, of course, interpreted with one inside the scope of not; i.e., as synonymous with (13):

(13) a. Not a single one of the men helped John out.
    b. Not a single man helped John out.

Here, as in (12), contrastive stress on the determiner is obligatory.

The above facts lead us to conclude that the determiner one has at least two senses. Under normal stress it is simply a singular existential quantifier word that behaves with respect to scope of negation like the [-neg] existential quantifier words some, several, etc. Under contrastive stress, on the other hand, one is interpreted as a single (one) and falls inside the scope of not in the environments of rule (1).

Perhaps the most dubious aspect of Lasnik's analysis is his claim that sentences containing a not in the auxiliary with a many following, like (2b) above and (14) below, are unambiguous under normal intonation. (cf. note 3)
(14) The students didn't get the right answer in many of the discussion sections.

Lasnik's analysis generates only a reading in which many is negated but my informants generally find these sentences fully ambiguous as to the scope order of many and not, although the negated reading is the preferred one. Lasnik's assertion that the non-negated reading of many requires an intonation break after the verb seems false. Such an intonation break may force the non-negated reading (our intuitions, however, suggest that this intonation also allows the scope ambiguity of many and not); but the break is certainly not necessary for the reading to be possible.

Lasnik's judgment about sentences like (2b) and (14) is shared by Jackendoff (1969, 1972) who claims that the lack of a non-negated reading for many is demonstrated by the following sentences:

(15) a. *Not many of the arrows hit the target, but many of them did hit it. (36).

b. Many of the arrows didn't hit the target, but many of them did hit it. (37)

c. *The target wasn't hit by many of the arrows, but it was hit by many of them. (38)

Jackendoff argues that the common unacceptability of sentences (15a) and (15c) shows that the first clause of (15c) is unambiguous and has a negated quantifier reading. If the first clause of (15a) were ambiguous,
he says, then that sentence should be acceptable and synonymous with (15b). The data on which Jackendoff depends for this argument is, however, weak. In our judgment all of the sentences of (15) are awkward and (15c) is not much worse than (15b), if at all. In addition, even a sentence like (16b) is very odd, though one would not want to claim that its first clause lacks a non-negated Quant reading:

(16) a. Some of the arrows didn't hit the target, but some of them did hit it.

b. ? The target wasn't hit by some of the arrows but it was hit by some of them.

These facts suggest that the particular parallel construction in (15) and (16) blocks otherwise inherent non-negated Quant readings for the first clauses of (15c) and (16b). Evidence for this position comes from the following sentences:

(17) a. John couldn't solve some of the problems but some of them he could solve.

b. John couldn't solve many of the problems, but many of them he could solve.

Both of the above sentences are perfectly acceptable and in both of them the first clause has a non-negated Quant reading. We can, therefore, conclude that there is an inherent ambiguity in the scope order of many and not when the not is in the auxiliary and the many follows.
If we are correct about the ambiguity of (2b) and (14), then there is a serious weakness in Lasnik's analysis. That analysis is predicated on the assumption that there are no real scope ambiguities in the data covered by the rules of (1). Differences in scope order are always associated with differences in structure or intonation. Of course, we could make the ambiguity of (2b) and (14) compatible with Lasnik's analysis by hypothesizing the existence of two senses of many, one of which would carry the inherent feature [-neg] and give (2b)/(14) their non-negated readings while the other would carry no such marking and would account for the negated readings of the sentences. Unfortunately, this solution has little to recommend it for the two many's proposed show none of the differences in meaning that one associates with the different senses of a word. Thus, while the two senses of one are not equivalent in meaning, the two proposed senses of many would be identical in meaning and would differ only in permitted scope order with respect to not. Obviously, a unified treatment of many would be superior to the above solution; but such a treatment can be constructed only through a serious modification of Lasnik's analysis.

In the first instance we propose to modify Lasnik's analysis so as to permit rules that change the scope order of quantifiers with respect to negation after they are initially fixed by the rules of (1). Suppose that we introduce the following rule to be ordered after (1):

\[(18)\text{ existential Quant } \rightarrow \text{ [-neg]/\text{not}_\text{aux} X]Y\]

\[(18)\text{ is optional}\]
This rule is a feature changing rule that has the effect of changing the scope order of not and an existential quantifier after it has been established by rule (1a). By adding this optional rule we generate two readings for (2b) and (14) as desired without generating any undesired readings for sentences already considered.

Rule (18) can be immediately extended to one quantifier other than many; i.e., the mass noun quantifier much. We note that sentence (19) is ambiguous and rule (18) accounts naturally for that ambiguity:

(19) The firemen couldn't reach much of the burning house.

As in the case of many the negated Quant reading is preferred but not exclusive in (19) and (20) shows that much like many can be sister adjoined to not:

(20) Not much of the house was damaged.

The similarity between much and many is hardly surprising since the former is the mass noun variant of the latter and since the mass noun variants of some and all, the other standard plural quantifiers, are identical lexically and in scope behavior to their count noun variants.

The power we have added to Lasnik's grammar of not scope with our new mechanism of feature changing rules may seem greater than the case of two lexical items would warrant. The justification for this addition
to the power of the grammar will become clearer in the course of this chapter and the next as the number of phenomena that the new mechanism accounts for increases. Even now, however, we can point to a certain simplification in Lasnik's rules that the addition of rule (18) will permit.

In Lasnik's system the ungrammaticality of sentence (8) is due to the contradiction between the inherent [-neg] (originally [+referential]) feature marking on the [+some] quantifiers and the feature assigned by rule (1b). The acceptability of sentence (7), on the other hand, and its interpretation with the [+some] quantifier outside the scope of not is due to condition (ii) on rule (1a) which blocks the rule's application to (7). If we adapt Lasnik's inherent feature marking on the [+some] quantifiers to a system in which features can change, say as in (21) below, then we can use the existence of rule (18) to eliminate condition (ii) on rule (1a):

(21) Filter - If at the end of a given application of the scope component to a sentence $S$ there is an inherently [-neg] Quant in $S$ that has the feature marking [+neg], then $S$ lacks the reading produced by that application of the rules. (If no possible application of the rules produces a reading for $S$, then $S$ is, of course not an acceptable sentence of English.)

Condition (ii) on rule (1a) is now superfluous. The non-existent negated Quant reading for (7) that is generated by (1a) without condition (ii) is eliminated by output condition (21) while the actual non-negated Quant reading of (7) is produced by applying our new optional rule (18).
to the output of (1a). Notice too that our statement of filter (21),
along with the elimination of condition (ii) on rule (1a), eliminates
all reference to the *ad hoc* label [*some*] introduced by Lasnik. Thus,
our changes in Lasnik's analysis have resulted in the collapse of the
three features [↑ neg], [*referential*] and [*some*] into just one - [↑neg].

The elimination of condition (ii) on (1a) allows us to
collapse (1a) and (1b) into the following simple rule:

(22) Quant → [↑neg]/not X _____.

Notice that our statement of rule (22) eliminates reference to
intonation contour. This is due to our judgment, stated earlier,
that no intonation obligatorily removes a quantifier to the right of
not from its scope.

Lasnik proposes collapsing (1a) and (1b) into a single rule
because he claims that rule (1b) can be extended to account for certain
facts about non-quantified NP's. Thus, Lasnik argues that the
unacceptability of a sentence like (23) follows from assuming that
ordinary definite NPs are inherently [*referential*]:

(23) *Not the man in the dinner jacket got up and left.

This argument seems contrived, however, since definite NP's are
not referential in the same way that the [*some*] quantifiers supposedly
are. Thus, on one prominent reading the quantified NP headed by some
in sentence (24) has no reference, but the corresponding definite NP (25) must refer. Nevertheless, both sentences are perfectly grammatical.

(24) Not every soldier in the unit participated in some of the battles.

(25) Not every soldier in the unit participated in the battle of Dienbienphu.

Thus, not only is the feature [+referential] unnecessary, as we showed earlier, but it is even unclear what content that feature could have if it applied equally to definite NP's and to NP's headed by [+some] quantifiers. The unacceptability of sentences like (23) is more likely to be due to syntactic restrictions on the Not + NP construction than to any semantic unity among definite NP's and [+some] quantifiers. Thus, sentence (26a) below is acceptable while (26b) is not, but in both of the sentences the NP sister adjoined to not is definite. Sentence (27), where the definite NP of (26a) is replaced by a [+some] quantifier, is unacceptable, though Lasnik's analysis would lead us to expect it to be as acceptable as (26a).

(26) a. Not with John was Mary in love.
    b. * Not Mary was in love with John.

(27) * Not with someone was Mary in love.

Before we leave our current discussion of existential quantifier words let us give sentence (24) a second look. This sentence has
considerable importance for our analysis beyond its relevance to the existence of the feature [\textsuperscript{\textdagger}referential]. First, the acceptability of the sentence requires us to modify our rule (22). As the rule is now formulated, it would mark the quantifier some as [+neg] and filter (21) would throw the sentence out. To avoid this result we must revise rule (22) in the following way:

\[(28) \text{Quant} \rightarrow [+\text{neg}] / \text{not } X \quad \underline{x \text{ contains no Quant.}}\]

The condition added here will become superfluous in the next chapter when we extend our analysis to cover the general case of sentences with more than two operators.

The second consequence of sentence (24), which also will be fully explored only in chapter four, is due to the fact that it has a scope ambiguity. On one of its readings (24) could be represented by a formula like (29) but on the other reading its formal translation would have to be (30):

\[(29) \neg(A \text{soldiers, } s)(E \text{battles, } b) \text{Participate } (s, d)\]

\[(30) (E b)\neg(As) \text{Participate } (s, b)\]

The existence of this ambiguity makes more apparent the need for feature changing rules like (18) or their equivalent. It shows clearly that single syntactic structures can have more than one possible scope order of operators and some mechanism more powerful than Lasnik's
rules is needed for this. A more exact formulation of this mechanism will be our task in chapter four.

3.2.2 Extending the analysis to the universal quantifiers.

Consider the pattern of acceptability of negative sentences containing each, as in (31) and (32):

(31) a. *Mary didn't like each of the doctors.
     b. *Mary wasn't liked by each of the doctors.

(32) *Not each of them has a French roommate.

If each is assigned to the category of the [-neg] quantifiers so that the output filter (21) applies to it, then the ungrammaticality of the above sentences follows directly. Since rule (18) as written applies only to existential quantifier words while rule (22) applies to all Quant phrases, the scope marking on each in (31)/(32) will of necessity be [+neg]. Thus, the output filter will throw the sentences out.

We should note that the above sentences do not help in choosing between Lasnik's original analysis and our modification of it. Under Lasnik's system the facts are accounted for if we mark each as inherently [-neg] (or [+referential]) but do not include it among the [+some] quantifiers. Then rule (1a) will mark each as [+neg] in (31) and rule (21) will do the same in (32). Since these markings contradict the inherent [-neg] feature marking of each, the sentences will be flagged as
unacceptable.

There is additional data on the scope of negation and universal quantifiers, however, which clearly is not accounted for by Lasnik's rules, modified or not, and this data requires us to extend our analysis. This circumstance should not be surprising since Lasnik (1973: note 4) explicitly declines to extend his analysis to sentences containing not and a universal quantifier word. Consider the following sentences:

(33) a. \{All the men\} in the room didn't sleep through the fight next door.

b. \{Everyone \ All of John's high school friends\} didn't come to the party.

(34) The children all didn't want to leave the party.\textsuperscript{15}

(35) John's problems, all of which he didn't solve, were interesting.\textsuperscript{16}

In order to capture the negated quantifier reading for sentences like (33)-(35), which none of the rules so far postulated will generate, we propose the addition of rule (36) to (18), (21) and (22).

(36) Universal Quant \rightarrow [+neg]/\underline{X[Y not \ aux} \ \ \ \ optional

Rule (36) appears at first to produce a non-existent negated quantifier reading for sentences like (37) below, that have an each NP subject:

(37) Each of my co-workers didn't hear \{the boss's instructions\} one of the numerous instructions.
But this reading is already ruled out by filter (21) so rule (36) does not have to mention any difference among the universal quantifier words. In fact, as the scope ambiguity of (38) shows, rule (36) applies very generally to universal quantifier words, even to ones that do not share the syntax of ordinary quantifiers:

(38) The \{whole \} class didn't know the answer.

Rule (36) as stated makes some wrong predictions. For example, it predicts wrongly that sentences of (39) should have a reading under which the universal quantifier is negated:

(39) a. During \{the whole \} performance, the audience didn't applaud.  
    \quad all of the  

b. All of the soldiers, when the captain mumbled, didn't hear the order.

This reading will be blocked if we add the following condition to rule (36):

(40) Condition: there is no intonation break between all and not.

A reference to intonation, like the one in (40) is also needed to handled sentences like (41):

(41) John couldn't solve all of the problems.

(42) The men didn't all leave when asked.

Under normal intonation (41) and (42) are unambiguous and rule (1a) or (28) as it stands gives the correct interpretation to them as well as to other negative sentences containing every and all in post-auxiliary position. If
we put an intonation break immediately before all in (41), however, the sentence becomes ambiguous as to the scope order of all and not. Sentence (42) is, of course, unambiguous because no intonation break is possible between didn't and all. To capture the intonation induced ambiguity in (41) we propose the following optional rule to apply after rule (28):

(43) Quant $\rightarrow$ [-neg]/not $X$ aux

Y contains an intonation break.

The intonation break referred to in (43) is, of course, the same one to which Lasnik wrongly attributed the scope ambiguity of many and not. We can see now that while Lasnik's analysis of that ambiguity was faulty, his intuitions about the semantic role of the intonation break pointed in the correct direction.

3.2.3 The indefinite article and the scope of not

The reader may have observed that in the preceding discussion there have been no example sentences illustrating the scope of negation with respect to the indefinite article. In discussing the scope of the universal quantifiers with respect to the existential ones, we treated a(n) as a simple existential quantifier, but the facts of not scope show this treatment to be oversimplified. Indeed, non-generic a(n) has at least three distinct senses. In all of these senses a(n) can be considered as a kind of existential quantifier but with distinct meaning and scope behavior.
Consider, first of all, the following sentences:

\[(44)\]
\[\begin{align*}
\text{a.} & \quad \text{John doesn't love a woman whom his father wants him to marry.} \\
\text{b.} & \quad \text{John didn't obey a red light (and was killed as a result.)}
\end{align*}\]

In these sentences the indefinite determiner \(a(n)\) is unambiguously outside the scope of not and these facts can be accounted for quite simply by including the indefinite article among the inherently \([-\text{neg}]\) existential quantifiers. In this way, the wide scope reading for \(a(n)\) will be generated by rule (18) and the narrow scope reading blocked by filter (21). On this interpretation the indefinite article is equivalent to the quantifier phrase \(\text{a certain}\) so that the sentences of (44) are synonymous with the corresponding sentences in (45):

\[(45)\]
\[\begin{align*}
\text{a.} & \quad \text{John doesn't love a certain woman whom his father wants him to marry.} \\
\text{b.} & \quad \text{John didn't obey a certain red light (and was killed as a result.)}
\end{align*}\]

As sentence (46) shows, the interpretation of \(a(n)\) as a \([-\text{neg}]\) existential quantifier is strengthened by the addition of descriptive material:

\[(46)\] John didn't obey a red light (that was) about to change to green (and was killed as a result.)

Sentence (46) seems more idiomatic than its counterpart (44b), and this
fact recalls the tendency for indefinite NP's with more descriptive content to take wide scope with respect to the universal quantifier more freely. Indeed, that principle should be extended to the scope relations between an and not. Thus, the sentences below grow progressively less acceptable as the descriptive content of the subject NP decreases:

\[(47) \begin{cases} \text{A diamond necklace worth }\$10,000 \text{ } \\
? \text{ A diamond necklace } \\
?? \text{ A necklace} \end{cases} \text{ wasn't in its usual place when John came into his store on Thursday.} \]

At the same time, all of the sentences of (48) are equally acceptable:

\[(48) \begin{cases} \text{A diamond necklace worth }\$10,000 \text{ } \\
\text{A diamond necklace } \\
\text{A necklace} \end{cases} \text{ was out of its usual place when John came in to the store on Thursday.} \]

Thus, a sentence like (49) below will be unacceptable because the inherent [-neg] marking on an will rule out a narrow scope reading while the lack of descriptive content in the NP a problem will mark the scope reading as marginal:

\[(49) ?? \text{ John didn't solve a problem (yesterday).}^{18} \]

Now let us move to consider another set of sentences involving an:

\[(50) \begin{cases} \text{Not a man in the village would approach the wild horse. } \\
\end{cases} \]

\[(51) \begin{cases} \text{John didn't solve a problem in the textbook. } \\
\end{cases} \]
In these sentences the a(n) NP phrase behaves exactly like a phrase headed by the determiner a single. This behavior is obviously induced by the stress pattern on the a(n) NP phrase; and we can conclude that a(n) displays the same ambiguity of sense as we earlier found in one.

The third sense of a(n) that concerns our analysis of not scope appears in sentences like the following:

(52) a. Mary doesn't own a car.
    b. John didn't see an oasis; (he only thought he did.)

(53) A .44 caliber pistol wasn't available in the gun shop.

In these sentences the indefinite NP, whether to the left or right of not, must be interpreted as inside the scope of not so the sentences clearly cannot be accommodated by the analysis we have given so far. A proper treatment of these sentences, however, requires an understanding of the semantics of English definite and indefinite determiners in both the singular and the plural. We propose, therefore, to postpone incorporating sentences like (52) and (53) into our analysis until chapter 5 where these matters will be discussed at length. For now we shall limit ourselves to pointing out that only a certain class of predicates allow a(n) to be inside the scope of negation. Thus while (52) is acceptable and has a negated reading of a(n), the syntactically similar sentence (49) is extremely odd. This difference is a major reason
why we have not treated a(n) as being like many (i.e., appearing freely both inside and outside the scope of not. Indeed, there are sentences like (54) below that allow both negated and non-negated readings for an a(n) NP phrase:

(54) John didn't see a cousin of his at the fair.

However, since only some predicates allow the narrow scope reading for a(n) and since such predicates allow it even when a(n) appears in surface subject position, it seems best, pending further analysis, to treat these cases as special.

3.3 Summary of chapter three.

The current chapter contains a great deal of descriptive material and as yet there is no single unifying system. It seems useful, therefore, to summarize the results we have established so far and to lay out the task ahead.

Our first result is that the surface structure order of two logical operator words in a simplex sentence gives, all other things being equal, the basic scope order. This principle is reflected directly in the not scope rule (3.2.28) and also in the general preference for surface order scope order among universal and existential quantifier words. The importance of surface order for determining scope order should be reflected formally in a grammar of scope; and in the next
chapter, where we shall develop a unified formalism for scope grammar, the principle will be formalized.

Our second result is that sentences with a single syntactic structure and intonation contour are often ambiguous as to the scope order of their logical operator words. This principle is reflected in sentences containing universal and existential quantifiers, existential quantifiers following not and universal quantifiers preceding not. In the case of not scope we have captured this ambiguity by means of feature changing rules and in the next chapter we shall further refine our formal account of scope ambiguity.

Our third result is that different lexical manifestations of the universal and existential quantifiers and even different senses of lexically unitary quantifiers require inherent markers referring to scope order. Sometimes these markings refer to scope order preferences (e.g., each with respect to indefinites) and sometimes to scope order incompatibilities (e.g., some immediately inside the scope of not). Furthermore, these lexical markings may be either idiosyncratic (each vs. every) or quite general (the [-neg] existential quantifiers). These inherent scope markings capture otherwise unaccountable differences in interpretation or acceptability among sentences containing similar, even equivalent, quantifier words. In the next two chapters some systematic basis for the scope order differences among similar lexical items will emerge. In particular, in chapter five we shall discover that the most obvious lexical marker on quantifiers, the number marker, has general implications for scope order.
FOOTNOTES TO CHAPTER THREE

1. The quantifiers in (3) and (4) are restricted in domain to the sets associated with them. Logically equivalent formulae using unrestricted quantification could be used, but they would be less readable and diverge more from the structure of English.

2. These sentences show that the scope order of two quantifiers is unaffected by the embedding of one inside an island (cf. Lasnik, n.d.).

3. The reason for sentence (5a) being unambiguous seems to be that the "there is" construction doesn't allow a non surface order interpretation. Sentence (5b) allows only one scope order because the two quantifiers are not in the same simplex sentence.

4. There is an extensive philosophical literature on the semantics of lexical items from both the intentionalist and extentialist points of view. Cf., for example, Katz (1972), and Putnam (n.d.) Since our view is that alternative acounts can all be integrated into our analysis of scope, it will not help in choosing among them,

5. These facts argue against the identification of syntax and semantics made by the generative semantics school of transformational linguists (Lakoff, McCawley, etc.) The facts about each and every show that words with identical semantic import can differ in syntactic co-occurrence and ordering restrictions. This is one of the few arguments in this work that bear on the generativist/ interpretivist controversy.

6. The unacceptability of these two phrases may be related to the existence of the plural quantifier both which semantically takes the place of *all of the two.

7. The presence of the plural pronoun "their" in (38a) and (38b) may not be due to plural agreement but rather to a tendency towards replacing singular gener marked pronouns with the genderless plural. Thus, sentence (i) is grammatical in colloquial English:

   (i) Someone put on their hat.

   The plural form "hats", however, cannot be explained in that way and is a true indication of plural agreement.

8. Here we are following a method of inquiry pioneered in Jackendoff (1969).
9. Lasnik (n.d.) argues on theoretical grounds that the scope rules should be cyclic but he admits that he has no empirical evidence that forces this alternative. We shall treat the scope rules as applying at surface structure because it is easier to do so but analysis can easily be translated into one in which the scope rules are cyclic.

10. The incorporation of a quantifier corresponding to many into a formal language can be accomplished in several ways. For two alternative formulations see chapter five, section 3.

11. The reader will note that according to Lasnik's rules the intonation pattern given to a string like (2b)/(2c) determines a unique scope order of quantifier and negation. There is no neutral intonation under which the string is ambiguous. This is contrary to my intuitions and those of others as well. Therefore, when we come to reformulate Lasnik's scope rules, we will assume that such strings are ambiguous under normal intonation. Of course, contrastive intonation contours may well serve to disambiguate these strings.

12. In fact, one has at least three senses. In addition to the two we discuss it has the sense of the numeral one.

13. The reader will have noticed that we are assuming that many is a kind of existential quantifier. This is the usual assumption and it is justified by the fact that the use of many asserts the existence of a set of objects that satisfy a predicate and then in addition that this set has a large number of members.

14. One might propose that (18) is not needed and that instead we should make (28) optional. The problem with this alternative is that it wrongly predicts that a sentence like (i) will be ambiguous in scope under normal intonation:

(i) John didn't see all of the cows.

To prevent (i) from being given two readings we would have to say that (28) is sometimes optional and sometimes obligatory depending on the quantifier involved. Such a marking on rule (28) is equivalent to having a rule like (18).

15. Contrast (34) with (i):

(i) The children didn't all want to leave the party.

16. Note that the following sentence is grammatical:

(i) John's problems, not all of which he solved, were interesting.

This suggests that the environment which allows all to be inside the scope of a not that is to right of it in surface structure is the same as the environment that allows the construction not + Q.
17. The first variant of (37) sounds odd because the sentence has no existential quantifier to fall inside the scope of each.

18. Sentence (49) is acceptable on a "direct denial" interpretation, i.e., where the speaker is using (49) to directly contradict the positive counterpart of (49). This interpretation, however, requires heavy contrastive stress on the auxiliary.
CHAPTER 4: BROADENING THE ANALYSIS OF SCOPE RELATIONS

4.0 Introduction

In the last chapter we devised a set of feature marking rules that produced the possible scope orders of a quantifier and not for certain basic sentences of English. These rules are equivalent to a mapping between English and a standard first order formal language. They constitute a fragment of that "scope component" for a grammar of English that we set out to construct at the end of chapter two.

In the current chapter we hope to justify and to broaden the formal analysis proposed in section 2 of chapter 3. In section 4.1 we shall revise the analysis presented in the last chapter by formalizing our analysis of the scope of universal and existential quantifier words, by replacing the feature notation adopted from Lasnik with a more suitable one, and by defending the analysis against one possible formal alternative. In the following sections we shall extend the analysis to a number of sentence types not so far discussed.
4.1 Reformulating the description of scope relations

4.1.1 Given the treatment of not scope in the preceding chapter, the most obvious way to integrate the facts about universal/existential quantifier scope into a formal system would be to extend our revised version of Lasnik's system. All of the facts so far presented, except those dependent on the plural number marking of all, could be handled by rules like (1) and (2):

\[
\begin{align*}
(1) & \text{ Quant } \rightarrow \left\{ \begin{array}{ll}
[+\text{universal}] & \text{universal} \\
& Q \ NP \\
[+\text{existential}] & \text{existential} \\
& Q \ NP \\
\end{array} \right. \\
& X ___(a) \\
& X ___(b) \\

(2) & \text{ Quant } \rightarrow \left\{ \begin{array}{ll}
[-\text{universal}] & \text{universal} \\
& Q \ NP \\
[-\text{existential}] & \text{existential} \\
& Q \ NP \\
\end{array} \right. \\
& X ___(a) \\
& X ___(b) \\
\end{align*}
\]

rule (2) is optional

Rule (1) fixes the scope order of quantifiers according to surface structure and then rule (2) optionally allows the order to change. The features [+universal] and [+existential] are to be interpreted by analogy with the feature [+negated]. In other words, a [+universal] marking on a quantifier means it should be interpreted as inside the scope of the universal quantifier. A [-universal] marking means that the quantifier should be interpreted as not inside the scope of a universal quantifier. The feature [+existential] should be interpreted similarly.
Rule (2) requires, if it is to be descriptively adequate, that a certain supplementary condition be added to it. Consider the following sentences:

(3) a. During \{all\} of the performances of the sonata, each \{one of the violinists\} missed his cue.
    \{some violinist\}

b. During each intermission, one of the kids went to the bathroom.

(4) a. During \{some\} intermission, \{each of the\} \{all of the\} \{every\} \{kid(s)\} went to the bathroom.

b. During \{some\} \{one\} intermission, John took each of the kids to the bathroom.

Rule (2) as it is now written predicts that all of the above sentences will be ambiguous as to the scope order of the universal and existential quantifier words. In fact, however, only the sentences of (3) are ambiguous. The sentences of (4) allow only the surface order reading. This difference does not appear if we compare the sentences of (5) with those of (6) below - all of these sentences are ambiguous:

(5) a. The boys played ball at each of the schools during one vacation.

b. During each rebellion in one of the major cities, the National Guard was sent in.

(6) a. The boys played ball at one of the schools during each vacation.
b. During one rebellion in each of the major cities, the National Guard was called in.

The sentences of (6) show that the reason why (4a) and (4b) block rule (2b) is not that they contain an existential quantifier inside a prepositional phrase or an existential quantifier in pre-subject position. Rather it seems that a pre-subject existential quantifier cannot wind up inside the scope of a universal quantifier when the former is separated from the latter by an intonation break. This constraint is stated in (7):

(7) Condition on rule (2b) - X contains no intonation break.

At the moment we can give no reason for the asymmetry between rules (2a) and (2b). At the end of this chapter, however, we shall attempt to give a general explanation of the role of intonation breaks in determining possible scope orders.

Let us now consider the scope order preferences of the various quantifiers discussed in (3.1). In order to capture these preferences we propose that the following output conditions be added to the scope component in addition to rules (1) and (2):

(8) If S is a sentence containing _each_ and R is a reading of S in which neither
i) _each_ is [-ex] nor
ii) S contains an existential quantifier marked [+uni]

then R is an unpreferred reading of S.
(9) If S is a sentence containing all and an existential quantifier word and R is a reading of S in which neither
  i) all is [+ex] nor
  ii) the existential quantifier is [-uni]
then R is an unpreferred reading of S.

(10) If S is a sentence containing a(n) NP and a universal quantifier and a(n) NP doesn't contain a substantial amount
of descriptive material (e.g., a relative clause) and R is a reading of S in which neither:
  i) a(n) is [+uni] nor
  ii) the universal Quant is [-ex]
then R is an unpreferred reading of S.

Output conditions (8)-(10) are rather complex because there is no unitary way to state the scope order preferences of the universal and existential quantifiers with respect to one another in a feature notation. Furthermore, as the reader may have noticed already, the scope rules as a whole are well-defined only for sentences which contain no more than two operators. These facts will shortly lead us to adopt a new notation for indicating scope order.

Integrating rules (1) and (2) into the system developed in section (3.2) requires working out some technical details. The first point is that rules (3.2.28) and (4.1.1) can be replaced by the following general scope principle:

(11) Within a simplex sentence, an operator receives an initial feature marking [+Op] for the operator which immediately precedes it in surface structure.

To illustrate this principle, consider sentence (12) below. Each
operator is marked with scope features in accord with the principle:

(12) a. Every worker in the plant did not get the bonus.
   [−] +uni

   b. One of the cops arrested each of the demonstrators.
   [−] +ex

   c. The students did not pass some of the exams.
   [−] +neg

Once sentences receive markings according to surface structure order as in (12), the remaining scope rules not subsumed under (11) apply to the representations which (11) produces. We list these rules, from now on called "scope readjustment rules", in a form rewritten to be compatible with our statement (11):

(13) = (3.2.18)
    existential Quant + [−neg] / not aux Y ______.

(14) = (3.2.36)
    not + [−uni] / universal Quant NP Y [X aux—].
    Y contains no intonation break.

(15) = (3.2.43)
    Quant + [− neg] / not aux Y ______
    Y contains an intonation break.

(16) = (4.1.2)
    [−uni] / X universal Y existential
    Quant + [−ex] / X existential Y universal
    (a) (b)

in (16b) Y contains no intonation break.

Conditions: i) rules (13)-(16) are optional
   ii) Y everywhere contains no operator.
4.1.2 The notation we have used in our analysis has been an adaptation of feature notation. Although it is descriptively adequate for the examples we have discussed so far, this notation seems an unnatural way to capture variations in the scope of operators. In fact, as we mentioned earlier, the notation is not well defined for sentences like (17a) below which contain more than two operators. The preferred reading for (17a) is given in (17b):

(17) a. Each of the people in the room didn't like one of the songs.

b. For everyone in the room there was one of the songs that he didn't like.

The initial scope ordering rule (11) would mark (17a) as in (18):

(18) Each of the people in the room did not like one of the songs.  
     [-]          [+uni]  [+neg]

The problem here is that when we apply rule (13) to (18) we get an ill-formed result, namely (19):

(19) Each of the people in the room did not like one of the songs.  
     [-]                      [+uni]  [-neg]

The representation (19) is ill-formed for two reasons. Firstly, the operator not retains its marking [+uni] even though it is no longer immediately inside the scope of not. Secondly, we defined the feature [-neg] in chapter three to mean "not inside the scope of not" so that
the inherent feature [-neg] on some, several, etc. would not block occurrence of these words in positive sentences. Under this interpretation of [-neg] representation (19) does not specify whether one is immediately outside the scope of not or also outside the scope of each. Thus, the feature system fails to maintain a one to one relationship between feature markings and scope order interpretations. This is surely an unacceptable result, if only because output condition (8) can now not be used to assign different levels of preference to the two orders of each and one in a sentence like (17a).

There are a number of ways one might try to modify the feature notation so as to avoid the problems sketched above, but none of them are very satisfactory. For example, we might redefine the features so that the feature [+op] meant "inside the scope of Op" instead of "immediately inside the scope of Op." We would then replace principle (11) by the following:

(20) Within a simplex sentence an operator receives an initial feature marking [+Op] for every operator that precedes it in surface structure.

Of course, such a definition of the features would greatly complicate output condition (3.2.21) on the [-neg] quantifiers. As was pointed out in chapter three those quantifiers are blocked only when immediately inside the scope of not. As sentence (3.2.24) showed, they may be inside the scope of not so long as they are not immediately inside its scope.
This complication granted, the newly defined features would eliminate
the two objections to the feature notation given above. Sentence (17a)
would receive the initial feature marking (21) and rule (13) would
produce the marking (22), a reasonable representation of reading (17b):

(21) Each of the people in the room did not like one of the songs.
[-] [+uni] [+uni] [+neg]

(22) Each of the people in the room did not like one of the songs.
[-] [+uni] [+uni] [-neg]

Unfortunately, this modified feature system raises new problems
of its own. Consider sentence (23) below along with its possible inter-
pretations (24):

(23) Every₁ child gave every₂ picture he drew to one of the teachers.

(24) i) every₁ - every₂ - one: For every child and every picture, there was a teacher to whom he
gave it.

ii) every₁ - one - every₂: For every child there was a teacher
to whom he gave every picture.

iii) one - every₁ - every₂: There was a teacher that every
child gave every picture to.

Principle (20) would assign the initial feature marking (25) to (23):

(25) Every₁ - every₂ - one
[-]  [+uni]  [+uni]  [+uni]
Now, although the details of scope order in sentences with more than two operators are yet to be discussed, we may safely assume that reading (24ii) should be produced by applying rule (16) to the initial scope order (24i) and that reading (24iii) should be produced by applying the same rule to the scope order of (24ii). The actual feature markings that are produced by applying rule (16) to the initial feature marking (25), first once and then again,¹ are given below:

(26) Every₁ - one - every₂
     [+]     [+]uniqueness
     [-]     [-]uniqueness

(27) one - every₁ - every₂
     [-]uniqueness
     [-] [+]uniqueness

Of course, no feature system can allow the markings that we have put on one in (25)-(27). If [+]uniqueness really were a feature, the markings in (25) and (27) would be redundant and the marking in (26) would be self-contradictory. The only solution to this problem within the revised feature notation would be to give the features an indexing that referred them to specific operators in the sentence. Of course if we did that, the features would lose their general character and become even more unnatural.

Since the above considerations indicate that the feature notation is at best a clumsy one and since scope feature markings are translatable into formal language formulae, we propose to change the notation
of our analysis. We will replace features attached to surface structure
lexical items by a scope order marker attached to the S node of each
sentence in surface structure. This marker would give the order of
quantifiers just as a logical formula does. Indeed, the notation
is simply a convenient short hand for fully specified logical formulae.
Here are the scope rules we have developed, as written in the new
notation:

General Scope Principle (obligatory):

(28) = (11) If within a simplex sentence there are operators
with the surface order W X Y Z . . . , then the operators
are indexed in order of appearance, giving W₁ X₂ Y₃ Z₄ . . . ,
and a scope marker is established as follows:

[W₁ X₂ Y₃ Z₄ . . . ]

where V is a quantifier of type V' (e.g., all is a
quantifier of type "universal" or "(A)").

Scope Readjustment Rules (Optional)

(29) = (13)
[α(ν)ₙ(E)ₙ₊₁β] + [α(E)ₙ₊₁(ν)ₙβ] / [Xₙ aux notₙ Y] Z existential Qₙ₊₁ NP

(30) = (14)
[α(ν)ₙ₋₁(A)ₙ₊₁β] + [α(ν)ₙ₊₁(A)ₙβ] / Qₙ NP X [Y aux notₙ₊₁

X contains no intonation break

(31) = (15)
[α(ν)ₙ₋₁(Q)ₙ₊₁β] + [α(Q)ₙ₊₁(ν)ₙβ] / notₙ aux X[Y Quantₙ₊₁

Y contains an intonation break.
(32) = (16)

a. \[ \alpha(A)_n(E)_{n+1} \beta ] \rightarrow [\alpha(A)_{n+1}(A)_{n+1} \beta ] / W^{\text{universal}} \times Q^n_{NP} \times \text{existenceal} \times Q^n_{NP} \times Q^n_{NP} \\

b. \[ \alpha(E)_n(A)_{n+1} \beta ] \rightarrow [\alpha(A)_{n+1}(E)_{n+1} \beta ] / Y^{\text{existenceal}} \times Z^{\text{universal}} \times Q^n_{NP} \times Q^n_{NP} \]

Z contains no intonation break.

Output Filters

(33) = (3.2.21) If the output R of the scope component when applied to a sentence S contains the following sequence, then R is not a possible scope order of operators for S:

\[ [\alpha(\omega) (Q)_n \beta ] / \{ \text{some, several, etc. } \} \times \text{each} \times Q^n_{NP} \]

The output R of the scope component applied to a sentence must contain the following sequences in the environments specified or R will be an unpreferred scope order for S:

(34) = (8) \[ [\alpha(A)_n(E)_{n+1} \beta ] / \text{each}_n \text{ is included in } S \]

(35) = (9) \[ [\alpha(E)_n(A)_{n+1} \beta ] / \text{all}_{Q+1} \text{ and an existential } Q \text{ are included in } S \]

(36) = (10) \[ [\alpha(A)_n(E)_{n+1} \beta ] / \text{all}_{Q+1} \text{ and a universal } Q \text{ are included in } S \text{ and } a(n)_{n+1} \text{ contains little descriptive material.} \]

The notation used in the above rules is more or less transparent. In a given rule the expression in front of the arrow specifies the scope marker as it must look in order for the rule to apply. The expression after the arrow gives the scope marker as it looks after the rule has applied. The expression to the right of the slash gives the surface structure condition under which the rule is allowed to apply. In other
words, the scope readjustment rules look at both the surface structure of a sentence and the scope marker associated with it before applying. Because in the scope marker to the left of the arrow, the two operators to which the rule applies are adjacent to one another, we can eliminate condition (ii) on rules (13)-(16). That condition was necessary to prevent the rules from applying if a third operator intervened between the two whose order was being switched. The index numbers 1, 2, ... introduced by the general scope principle are necessary to insure that when a rule applies the surface structure and scope marker conditions on it are met by members of a single semantic-syntactic pairing (as defined by the general scope principle (28)). By the way, one reason for preferring this notation to the feature notation is that the output conditions (34)-(36) are so much more simply stated than those of (8)-(10). The reason for this is, of course, that the notion of "immediately inside (or outside) the scope of" is not a natural one within the feature system while it is natural in linear systems like a logical formula and our scope marker system.

4.1.3 Thus far our scope component consists of three subcomponents, a general surface order scope assignment principle (28), scope readjustment rules (29)-(32), and a set of output filters on specific lexical items (33)-(36). Given the data as presented so far, however, one might argue that there is a formal alternative to this analysis. This alternative would be based on the assumption that scope order in English
is essentially free and that a scope component needs only output filters that block certain scope orders under certain conditions. Under this alternative, in other words, there would be no scope readjustment rules. In fact, however, the alternative is either not viable or not a real alternative, a claim which we shall now proceed to demonstrate.

Consider the following sentences:

(37) a. Not all of Mary's friends live on the East Coast.

b. Not many of the children went to school yesterday.

(38) a. All of Mary's friends do not live on the East Coast.

b. Many of the children did not go to school yesterday.

(39) a. John didn't visit all of the museums in Paris.

b. Mary didn't like many of the paintings in the Louvre.

As we pointed out in chapter three, sentences (37a) and (39a) are unambiguous under normal notation, and the scope order of all and not follows their surface order. Sentence (38a), on the other hand, is ambiguous as to the scope order of the two operators. Sentence (37b) is unambiguous and has the scope order not-many; sentence (38b) has the single scope order many-not; and sentence (39b) is ambiguous in the scope order of its two operators. These facts show clearly that operator scope order in English is neither free nor dependent solely on the lexical characteristics of operator words. Differences in surface order (compare (38) and (39)) and in constituent structure (compare
(37b) and (39b)) contribute to differences in the possible scope orders associated with a given sentence. A scope order that gives a prominent (or even the only), reading for one sentence containing two given operators is not even possible in another similar sentence containing the same operators (compare (37b)/(38b) or (38a)/(39a)). Thus output conditions constraining the scope orders allowed by given lexical items cannot by themselves capture the scope ambiguities of English. Of course, the differences in scope order between the (a) and (b) sentences of (37)-(39) are due to the different behavior of all and many. It is the differences within both the (a) set and the (b) set of sentences that output conditions along cannot handle.

In face of the above argument a proponent of the output condition approach might suggest that scope order be fixed by output conditions that refer to constituent structure and surface order as well as to the lexical characteristics of operator words. Such unusual output conditions, however, would merely be notational variants of the scope readjustment rules. For every scope rule in our current analysis, there would be instead an equivalent output condition. The output condition would simply list those surface syntactic environments in which the rule allowed ambiguity of operators and it would filter out that ambiguity in all other environments. Since these two analyses are so directly equivalent, such strong output filters are not an alternative of our original analysis.
4.2 Extending the analysis

The scope component developed in the previous section has so far been applied mainly to sentences containing two logical operator words. Now it is time to test our analysis on more complex sentences. Consider sentence (1) below:

(1) Every student didn't solve \{one \_ some\} of the problems.

Sentence (1) is, under normal intonation, four ways ambiguous as to the scope order of its operator words. The four scope orders are given in (2) below:

(2) i) [(A)(E)(\sim)]

ii) [([\sim](A)(E))]

iii) [(E)(A)(\sim)]

iv) [(E)(\sim)(A)]^2

The first two orders listed in (2) are generated straightforwardly by our scope component. First, the surface order principle (4.1.28) yields the scope marker (3) below:

(3) [(A)(\sim)(E)]

The either rule (4.1.29) applies and gives (2i) or rule (4.1.30) applies to produce (2ii). The second two readings of (1) can also be generated by the scope component, but only if more than one readjustment rule
applies. Scope order (2iii) is produced if first rule (4.1.29) and then rule (4.1.32a) is applied to (3). Scope order (2iv) will be produced if rule (4.1.29) applies to (3) followed by (4.1.32a) and then (4.1.30). The orders in (2) represent four of the six possible permutations of the order of three operators. The other two permutations are the surface order (3) and the order not-existential-universal, neither of which give readings for (1). Our scope component correctly blocks these orders with output condition (4.1.33).

One interesting aspect of our scope component is that the readjustment rules may apply in any order. We must allow this free ordering if the rules are to produce the correct readings for sentences like (4) and (5):

(4) All of the participating soldiers weren't killed in many of the battles.

(5) Every participating marcher wasn't arrested in many of the demonstrations.

The three readings of (4)/(5) are given in (7) along with the rules that will produce them from the surface scope marker (6):

(6) \[(A)(\omega)(E)\]

(7) i) \[(\omega)(E)(A)\] : (4.1.30) + (4.1.32a)

ii) \[(E)(A)(\omega)\] : (4.1.29) + (4.1.32a)

iii) \[(E)(\omega)(A)\] : (4.1.29) \rightarrow (4.1.30) or

(4.1.30) + (4.1.32a) + (4.1.29)

The other three possible scope orders, although generated by the rules,
are ruled out by the semantics of the word "participating", which seems to require that the quantifier on "soldiers" be inside the scope of the quantifier on "battles". 3 In any case, we can see by inspection of (7) that there is no consistent ordering of the scope readjustment rules that will produce all three readings for (7). The rule orderings in (7i) and (7ii) are naturally compatible; but one of the orderings that produces (7iii) contradicts the ordering for (7i) and the other ordering for (7iii) contradicts (7ii). Therefore we must allow the rules to apply in any order. Moreover, as we mentioned in (4.1) (cf. sentence (4.1.23)), we must allow a single rule to apply to a given simplex sentence more than once if its description is met more than once. In sum, there are no extrinsic restrictions on the order or frequency of application of the readjustment rules. A rule may apply to a scope marker wherever its structural description is met, irrespective of what rules have previously applied to the scope marker.

Let us now consider the following sentence:

(8) Not all of the students know \textit{many} of the answers, \textit{one}.

This sentence is ambiguous. It has one reading in which the scope order follows surface order and a second reading with the scope order exist Q - not - all. Unfortunately, our scope rules as they are now formulated will not produce this second order. To remedy this defect, we propose that rule (4.1.29) be rewritten as (9) below:
(9) \([\alpha(\tilde{\omega})]^n(E)^{n+1}\beta) \rightarrow [\alpha(E)^{n+1}(\tilde{\omega})\beta]/\text{not}_n X \text{ existential}_Q \text{ NP}_{n+1}\]

i) \(X\) is not null.

Now the desired reading will be produced by the consecutive application of rule (4.1.32a) and rule (9).

Unfortunately, we still have a problem with sentence (8). When rule (4.1.32a) by itself is applied to (8), the scope component produces the order \text{not-exist}_Q\text{-all} for the sentence; but no reading with that scope order exists. Furthermore, there is a condition built into the readjustment rules that only adjacent operators in a scope marker can have their order changed. Therefore, we cannot block the application of (4.1.32a) to the sentences if we wish to produce their exist. \text{Q-not-all} reading.\footnote{We propose, therefore, the following output condition to block the undesired reading:}

(10) If a sentence with the following surface structure is assigned the following scope marker under reading \(R\), then \(R\) is blocked:

\([\alpha(\tilde{\omega})]^1(Q)^n(Q)_2\beta)/\#\text{Not}_1 + Q_2 X\)

This output condition seems \text{ad hoc} but there is some evidence to support its existence. Consider the following sentence:

(11) Not all of the good assignments went to \(\begin{cases} \text{a single} \\ \text{just one} \\ \text{a handful of} \\ \text{one} \end{cases}\) reporter(s)

In this sentence the scope order \text{not-one-all} is possible, apparently
because of the lexical character of the existential quantifier words in the brackets. Although we cannot explain why those words allow a scope order that is otherwise blocked, the existence of that reading argues that rule (4.1.32a) should be allowed to apply to sentences with the structure of (8)/(11) and that a modified form of the output condition (10), say with the clause in (12) added, is a more natural way to handle the facts than would be a restriction on the applicability of (4.1.32a):

(12) unless \( Q_n \) is one of the following items: a single, just one, a handful, one, etc.

The modification in rule (4.1.29) represented by (9) is an extension of the syntactic environment in which the rule can apply. Rule (9) can apply in almost any environment containing an existential quantifier to the right of a not. The other readjustment rules also apply in a wide range of environments. This circumstance suggests that we could simplify our readjustment rules if we wrote the constraints on them in terms of negative rather than positive conditions; i.e., if we specified with each rule only the environments in which the rule could not apply. Here are the scope readjustment rules rewritten in this way with the blocking conditions to the right of the slash; they are indeed somewhat simpler in this form:

\[
(13) = (9) \quad [a(\sim)_n (E)_{n+1} \beta] \rightarrow [a(E)_{n+1} (\sim) \beta] / \text{not}_n + Q_{n+1}
\]
(14) = (4.1.30) \[ α(A)_{n}(\sim)_{n+1}β + [α(\sim)_{n+1}(A)_{n}β] / Q_n X | Y \not_ {n+1} \]

(15) = (4.1.31) \[ α(\sim)_{n}(Q)_{n+1}β + [α(Q)_{n+1}(\sim)_{n}β] / \not_ {n} X Q_{n+1} \]

(16) = (4.1.32) a. \[ α(A)_{n}(E)_{n+1}β + [α(E)_{n+1}(A)_{n}β] / φ \]
b. \[ α(E)_{n}(A)_{n+1}β + [α(A)_{n+1}(E)_{n}β] / Q_n X|Y Q_{n+1} VP \]

| means "intonation break"

X Y Z means "X Y Z are contained in a single intonation phrase."

With the changes we have made our scope component will produce the correct combinations of scope orders for a wide range of sentences. Below are some examples listed with their readings and the scope rules that generate them:

(17) The movie star didn't snub everyone of his co-stars during one picture.

i) \[ (\sim)(A)(E) \]: surface order

ii) \[ (\sim)(E)(A) \]: (16a) One must be stressed; i.e., interpreted as "a single". Otherwise filter (4.1.33) blocks.

iii) \[ (E)(\sim)(A) \]: (16a) - (13)

iv) \[ (A)(\sim)(E) \]: (15) This rule requires an intonation break at |. One must be stressed

v) \[ (A)(E)(\sim) \]: (15) - (13) Intonation break at | required.

vi) \[ (E)(A)(\sim) \]: (15) - (13) - (16a) Intonation break at | required.
(18) Many of the children didn't eat every meal, each of the meals.

i) [(E)(~)(A)]: surface order. Filter (4.1.33) blocks if (A) is each.

ii) [(E)(A)(~)]: (15) Requires intonation break at . If (A) is each, filter (4.1.34) marks this order unpreferred.

iii) [(A)(E)(~)]: (15) - (16b) Requires intonation break at .

The rules correctly fail to generate the other three permutations, in all of which (E) would be to the right of (~).

(19) The king didn't believe each of his ministers on many occasions.

i) * [(~)(A)(E)]: surface order. Blocked by filter (4.1.33)

ii) [(~)(E)(A)]: (16a) If (E) is some, this order is blocked by filter (4.1.33).

iii) [(A)(~)(E)]: (15) Requires intonation break at . If (E) is some, this order is blocked by filter (4.1.33).

iv) * [(E)(~)(A)]: (16a) - (13) Blocked by filter (4.1.33)

v) [(A)(E)(~)]: (15) - (13) Intonation break at required.

vi) [(E)(A)(~)]: (15) - (13) - (16a) Intonation break at required. This order is marked unpreferred by filter (4.1.34).

(20) Not many of John's brothers know all of the children.

i) [(~)(E)(A)]: surface order

ii) * [(~)(A)(E)]: (16b) Blocked by filter (10)

No other orders are generated by the readjustment rules.
4.3 Modal scope

4.3.0 An investigation of the modal operators reveals that their scope behavior can be treated by an extension of the principles we developed in 4.1 and 4.2. By observing the scope behavior of the universal quantifiers and the indefinite in modal contexts, therefore, we will strengthen the case for our surface structure scope ordering principle and its readjustment rules.

4.3.1 The first striking fact about the scope behavior of the modal operators is that they appear to have either verb phrase or sentence scope. Sentences (1) and (2) illustrate this variation, which is possible for all of the modals:

(1) Each of those candidates may win in the election.

(2) One of those sprinters must win in his event for us to win the meet.

The paraphrases of (3) give the two readings of (1) and those of (4) the two readings of (2):

(3) a. For each of those candidates, there is a chance that he will win in the election.

b. There is a chance that each (all) of those candidates will win in the election.
(4) a. There is one of those sprinters such that our winning the meet requires that he win his event.

b. Our winning the meet requires that one of those sprinters win his event.

That the truth conditions of the (a) and (b) paraphrases are different should be clear. For example, (3a) is compatible with all of the candidates running for the same single incumbent office at the same time while (3b) is not. 7

The existence of a scope ambiguity in the sentences of (1)/(2) is supported not only by the intuition of ambiguity but also by certain phenomena of coreference. The existence of the (a) readings for the modal sentences is not in doubt. The very acceptability of a sentence like (5), whose (b) reading would be self-contradictory, argues that something like the (a) reading must exist.

(5) All of these candidates may win the next presidential election.

It is the (b) reading whose existence we must demonstrate. To this end consider sentence (6):

(6) John will be surprised if it happens.

It can be added after (1) to produce an acceptable discourse with the it in (6) referring back to the previous sentence. In the present context it is acting as a sentence pronoun, and the subject of the simple predicate happen is a sentence. The question now is: To what
sentence does *it* refer? *It* cannot refer to (1) in its entirety. If *it* did so refer, then (6) would mean (7) and the actual paraphrase should read as in (8):

(7) *John will be surprised if each of these candidates may win in the election.*

(8) *John will be surprised if each of those candidates wins in the election.*

In other words, *it* refers to a sentence which does not appear as a syntactic constituent of (1). It is, however, a constituent of the semantic representation corresponding to the (b) reading of (1). Therefore, if we admit the existence of this (b) reading and say further that the coreference of *it* is based on semantic structure, then the acceptability and meaning of (1) + (6) and (2) + (6) is accounted for without an ad hoc complication on the description of sentence pronominalization by *it*. This solution also explains why a sentence like (5), whose (b) reading is self-contradictory, sounds odd when combined with (6).

(5) + (6) = *Each of these candidates may win the next presidential election. John will be surprised if it happens.*

4.3.2 In our analysis of the scope of negation we treated the surface position of *not* as reflecting its basic scope position and we devised rules to change its scope relations with the quantifiers under certain
conditions. The scope of the modals can be handled similarly by a rule like (10):

(9) A unicorn will appear on your doorstep tomorrow.

(10) \[ \alpha(Q)_n (\text{modal})_{n+1} \beta \rightarrow [\alpha(\text{modal})_{n+1} (Q)_n \beta] / \phi \]

The formalism of (10) is the same as that of (4.2.13-16).

Rule (10) will not only account for the ambiguity of sentences like (1)/(2) but it will also account for the similar ambiguity of sentences like (9) above. Notice also that (10) applies to sentences like (11)-(13) where there is an intonation break between the quantifier and the modal:

(11) All of John's children, while we are at the movies, may misbehave (or maybe only some of them will.)

(12) a. Someone here, while we're at the movies, \{should\} mind the baby. (Any of you can do it.)

b. One of you children, while we are away, may bring home a friend.

(13) During one of the intermissions, John may leave.

In passing we should note that if rule (10) applies to it twice, (14) below receives the scope order modal--\underline{one--all}:

(14) During one of the intermissions all of these children \{have\} to be taken to the bathroom.
The first application gives the order one-modal-all and the second gives modal-one-all. We discovered in analyzing sentence (4.1.23) that we had to allow rule (4.2.16a) to apply twice in order to generate all of the readings of that sentence. Here once again we find the same situation. It is important to reiterate, however, that allowing the rules to apply more than once does not complicate the scope readjustment rules at all. It simply means that, unlike the transformational component, this component of the grammar does not keep track of whether its rules have applied any more than it keeps track of their order of application. We must note as well that output condition (4.2.10), which in the environment not + Q₁, prevents a second quantifier from coming between not and Q₁ in scope order does not block the placement of a modal in that position. Thus, one reading of the sentences of (15) has the scope order not-modal-Quant:

(15) a. Not every candidate running can win a position in this election. (There are four candidates and only three positions open.)

    b. Not one of the candidates in a preliminary election has to win.

The optional inclusion of quantifiers to the left of a modal within its scope is not the only deviation from strict surface order scope relations to be found in modal sentences. Consider, for example the following sentences:
(16) a. John should solve one of these problems.
   b. John has to find a man in the audience.
   c. We may save someone in that burning building if we move quickly.

All of these sentences are ambiguous. On one interpretation the indefinite quantifier is outside the scope of the modal; on the other interpretation the scope relations are reversed. This ambiguity can be captured without adding any new rules to our scope readjustment component. If rule (4.2.13) is rewritten as in (17) to refer to modals as well as negation, then the ambiguity of (16) is automatically accounted for:

\[(17) = (4.2.13) \quad [\lambda^{(\text{modal})}_n (E)_{n+1} \beta] \rightarrow [\lambda (E)_{n+1}^{(\text{modal})} \beta] / \text{not}_{n+1} Q_{n+1}\]

Of course, the fact that all of the sentences of (16) are ambiguous shows that there are no modal scope filters associated with the indefinites corresponding to the negation filter (4.1.33).

An objection to including the modals in rule (4.2.13) would arise if the universal quantifier were subject to the same ambiguity in post-modal position as is the existential quantifier. Then we would have good reason to handle post-modal quantifiers by a separate rule. However, as the sentences of (18) demonstrate, the universal quantifier in post-modal position can only be interpreted as inside the scope of the modal.
(18) a. The presidential election may be won by each of those candidates. all of those candidates. every candidate in this room.  

b. The next race can be won by each of the sprinters. all of the sprinters. every entrant.

The active forms of these sentences have two readings, one self-contradictory like the above and the other not self-contradictory. The second reading, of course, has the quantifier outside the scope of the modal. This interpretation is produced by the rules but is self-contradictory. The fact that the sentences of (18) themselves have only the self-contradictory reading demonstrates that there is no rule that places post-modal universal quantifiers outside the scope of the modal. If such a rule existed, the sentences of (18) would have a non-self-contradictory reading and would be synonymous with their active counterparts.

The rules of section 4.2 along with rule (10) and rule (17) are sufficient to account for all of the scope relations between the modals and the quantifiers. To see how these rules account for the scope behavior of modals, we shall investigate the following sentences:

(19) Each of these soldiers may participate in one of the assaults.

(20) Each of the politicians may convince some witness to lie.

(21) Each of the rich freshmen may join a fraternity.
In all of these sentences the surface structure order of operators is *each*-may-existential; and as we would expect, each sentence has a reading in which the scope order parallels the surface order. This reading is given in the paraphrases and semantic representations of (22)-(24):

(22) a. Of each of these soldiers it may happen that there is an assault that he participates in.

   b. (Ax \( \in \{\text{these soldiers}\} \)) May (Ey \( \in \{\text{the assaults}\} \)) (x participates in y)

(23) a. Of each of the politicians it may happen that there is some witness that he convinces to lie.

   b. (Ax \( \in \{\text{the politicians}\} \)) May (E witness y) (x convinces y to lie.)

(24) a. Of each of the rich freshmen it may happen that there is a fraternity that he joins.

   b. (Ax \( \in \{\text{the rich freshmen}\} \)) May (E fraternity y) (x joins y.)

The sentences of (19)-(21) also share another interpretation, one in which the scope order of operators is *may*-each-existential. This reading corresponds to the (4b) reading for (2). The readings are paraphrased in (25)-(27):

(25) It may happen that for each of these soldiers there is an assault that he participates in.

(26) It may happen that for each politician there be some witness that he convinces to lie.
(27) It may happen that for each of the rich freshmen there is a fraternity that he joins.

These readings are, of course, produced by the operation of rule (10).

If we allow rule (17) to operate on (19)-(21) we produce an interpretation with the scope order each-existential-modal. This interpretation is perhaps brought out more clearly in the sentences of (28):

(28) a. Each of the secret service agents may guard one of the candidates.

b. Each of those women may marry someone that she hates.

If rule (17) is followed by rule (4.2.16), then a fourth reading is produced with the scope order existential-each-modal. This reading is paraphrased in (29)-(31):

(29) There is an assault such that for each of these soldiers it may happen that he participates in it.

(30) There is some witness such that for each of the politicians it may happen that he convinces him to lie.

(31) There is a fraternity such that for each of the rich freshmen it may happen that he joins it.

A fifth reading is produced if we apply rule (10) and rule (4.2.16a). These operations produce the scope order modal-existential-each. This reading is most clearly brought out in a sentence like (32) below. On
one of its interpretations (32) is synonymous with the most prominent interpretation of its active variant (33):

(32) In this trick each of the candles may be extinguished by one \{\textit{a single}\} shot.

(33) In this trick \{\textit{one}\ \textit{a single}\} shot may extinguish each of the candles.

This shared reading of (32) and (33) is given in (34), which has the required scope order:

(34) In this trick it may happen that there is a shot that extinguishes each of the candles.

The sixth reading, with the scope order existential-modal-each is paraphrased in (35)-(37) below:

(35) There is an assault such that it may happen that each of these soldiers participates in it.

(36) There is some witness such that it may happen that each of the politicians convinces him to lie.

(37) There is a fraternity such that it may happen that each of the rich freshmen joins it.

This reading is produced by the application of rules (17), (4.2.16a) and (10). The rules may apply in the order (17)-(4.2.16a)-(10) or in the order (10)-(4.2.16a)-(17). Its existence is further evidence that the scope readjustment rules are unordered in their application. If they applied in a fixed order to interchange the scope of operators in adjacent
scope order, then we would have to choose one of the above orders to produce readings (35)-(37). If we choose the first order, then we couldn't produce the scope order modal-existential-each. It requires a rule ordering of (10)-(4.2.16a). If we chose the second ordering, on the other hand, we couldn't produce the scope order existential-each-modal. It requires a rule ordering of (17)-(4.2.16a). Therefore, there is no order which produces all of the six possible readings and our earlier choice of freely ordered rules is vindicated.

There are two possible objections to our analysis of sentences containing each-modal-existential that should be raised and answered. The first is that some of the readings we have admitted for such sentences are marginal or at best unpreferred, and should not be produced by a reasonable set of scope rules. The readings in question are the fourth, fifth, and sixth readings described above; but although it is true that these readings are secondary, they should be produced by the rules. Their lack of prominence is due to the fact that they involve the quantifier flip rule (4.2.16a) which even by itself produces only secondary readings for sentences with the surface order each-existential. Thus consider (38) below and compare it with (32):

(38) In this trick each of the candles was extinguished by one of the shots.

(39) In this trick there was a shot that extinguished each of the candles.
Reading (39) is no more or less marginal to sentence (38) than is reading (34) to sentence (32). Since we demonstrated earlier that we should allow quantifier flip in cases like (38), there is no reason to rule out its application in sentences containing modals. Furthermore, when each is replaced by all, these readings are no longer marginal because the order indefinite-universal is the preferred one when the universal quantifier is all rather than each.

(40) All of the kids have to be taken to the bathroom during one of the intermissions.

Thus, in sentence (40) the reading modal-existential-all is probably the most prominent.

The second and less forceful objection to our analysis of sentences containing each-modal-existential is that since all six logically possible permutations of scope order are possible readings of these sentences, why not just say that the scope order of modals and quantifiers is free. Of course, this solution would fail to predict that sentences like (18) are unambiguous (i.e., necessarily contradictory). Even if restricted to sentences with three operators, it would falsely predict that sentences like (41)-(43) below were six ways ambiguous.

(41) A soldier from this platoon can participate in each of the assaults.

(42) Someone will counsel each of those students.
(43) One of these targets may be hit by each of the arrows.

In fact, these sentences have three readings each, exactly those produced by our rules. To take (43) as an example, it has reading (44) if no rules apply, reading (45) if rule (10) applies, and reading (46) if both rules (10) and (4.2.16b) apply.⁹

(44) There is one among these targets such that it may happen that it is hit by each of the arrows.

(45) It may be there is one among these targets such that it is hit by each of the arrows.

(46) It may be that for each of the arrows there is one among these targets that is hit by it.

All other possible combinations of rules redundantly produce one of the above readings. Notice that reading (46) is not secondary even though rule (4.2.16a) is used to produce it. This is consistent with the fact that (4.2.16b) applies readily to sentences in which the surface order of quantifiers is indefinite-each.

4.3.3 Our last descriptive task in this chapter is to analyze the interaction of the modal and negation. Consider sentences like (47), (48) and (49) with the modal may interpretation in its root (i.e., permission) sense:

(47) One of those powerful explosives {mayn't} be stored in this warehouse.
(48) All of those children \( \{ \text{may} \text{t} \} \) leave the room.

may not

(49) a. John \( \{ \text{may} \text{t} \} \) take one of those books.

may not

b. John \( \{ \text{may} \text{t} \} \) take all of those books.

The most striking fact about these sentences is that a primary reading for (47) has the scope order not-modal-existential. The position of not to the left of the indefinite cannot be produced by the scope readjustment rules that we have written. In fact, the rules explicitly exclude such a result so as to avoid false making a sentence like (50) ambiguous.

(50) One of John's friends didn't come to his wedding.

Fortunately, the correct analysis of (47)-(49) does not require us to change our scope readjustment rules. Rather the way to a correct analysis of (47)-(49) lies in introducing a new kind of negative operator for these sentences, an operator we shall call "verbal negation" (cf. also Lasnik, 1972; Kiparsky, 1970). Verbal negation is distinguished from ordinary negation in that it applies directly to a verb and turns that verb into its "polar opposite" or "logical contrary". When a negative operator has been applied to a verb in this way, we will represent the result with the symbol \( (\forall V(a_1, a_2, \ldots, a_n)) \) where \( V(a_1, a_2, \ldots, a_n) \) is simply a verb with \( n \) predicate places. We cannot here give an adequate formal analysis of polar opposition but it is important to note that
"(\neg V(____))" is not logically equivalent to "\neg (V(____))". The latter formula is a representation of ordinary (sentence) negation, which is a weaker concept than polar opposition. Thus, the polar opposition of "like" is "dislike", of "agree" is "disagree"; and while the falsity of (51a) below is sufficient to guarantee the truth of (51b), it is only necessary and is not sufficient to guarantee the truth of (51c):

(51) a. John likes Mary.
   \text{(Like (John, Mary))}

b. It is not the case that John likes Mary.
   \neg (\text{Like (John, Mary)})

c. John dislikes Mary.
   (\neg \text{Like (John, Mary)})

Now to continue with our analysis of modals and negation, we list below all of the scope orders possible for sentences (47)-(49):

(47) \underline{not-may}-existential
     existential-\underline{not-may}

(48) \underline{universal}-not-may
     \underline{not-may}-universal

(49a) \underline{not-may}-existential
     existential-\underline{not-may}

(49b) \underline{not-may}-universal

This pattern looks very little like what we found in other negated sentences; but if we ignore the negative element for the moment, the
pattern looks like what we would expect for the modals. This observation
deep leads us to propose that *may not* and *maysn't* be treated as one operator
instead of two, and that this operator itself be considered as a modal.
Just as a verb like *disapprove* is a negated verb, decomposable into
another verb *approve* and the verbal negation element *dis-*, so the
modal *may not* should be seen as a combination of the modal *may* and a
verbal negation *not*. The assumption that negated modals are an
instance of verbal negation explains the pattern in (47)-(49) directly.
The modal maintains its scope ambiguities; but wherever the modal is
in the scope order of operators, the *not* is attached to it and so is
directly outside its scope.

Our analysis of modal negation applies very well as it stands
to modals like *can, will, have to*, root sense *may* and others;¹⁰ but
in order for it to apply equally to *must, should* and epistemic (i.e.,
possibility) sense *may*, it needs to be refined. Consider the sentences
below:

(52) a. One of those children \{shouldn't\} leave the dog.
    \{may not\} \{maysn't\}

b. One of the enemy commanders \{shouldn't\} find out about
    our plans.
    \{may not\} \{maysn't\}

readings: one - *should* - *not*, *may* - *should* - *not* - *one*,

*may*
*should* - one - *not*
*must*
(53) a. All of the children \{\textit{shouldn't}\} leave the house. \\
b. All of the enemy commanders \{\textit{shouldn't}\} find out about our plans.

readings: \underline{all} - \underline{should} - \underline{not} \\
\underline{should} - \underline{all} - \underline{not} \\
\underline{must} - \underline{not} - \underline{all}

(54) John \{\textit{shouldn't}\} give away one of the puppies.

readings: \underline{should} - \underline{not} - \underline{one} \\
\underline{one} - \underline{should} - \underline{not} \\
\underline{must} - \underline{one} - \underline{not}

(55) John \textit{mustn't} give away all of the puppies.

readings: \underline{must} - \underline{not} - \underline{all}

There are two ways in which the above sentences differ from (47)-(49). Firstly, the particle \underline{not} is inside the scope of the modal instead of outside, and secondly the sentences of (52)-(54) each have one reading in which \underline{not} and the modal aren't immediately adjacent. We shall consider each of these facts in turn.

The fact that \underline{not} is inside the scope of \underline{must}, etc. in (52)-(55) is perfectly consistent with the combination of modal and \underline{not} being considered verbal negation. Verbal negation in general has to allow for the \underline{not} attached to the verb being inside as well as outside its scope.
Where the not is attached seems to be a lexical peculiarity of the verb or modal concerned. The point becomes clear if we compare the verbs below:

(56) disapprove, be disinterested, be dissimilar, disagree, disenchant, disorder, disorganize, disobey, disunite, disentangle, disregard, disqualify, distrust, ...

(57) disprove, disincline, disserve, disbelieve, (dispute), ...

The verbs in (56) are inside the scope of the negation provided by dis-, but the verbs in (57) seem to be outside its scope. For example (58) has the reading (59) but (60) has the reading (61):

(58) John disobeyed his captain's command.

(59) It didn't happen that John obeyed his captain's command.

(60) Magellan disproved that the earth was flat.

(61) Magellan proved that it wasn't the case that the earth was flat.

These paraphrases aren't exact but they do show the different scope orders of the verbs with respect to the negative element. Now if the verbs of (56) and (57) differ with respect to the scope of an attached negative, there is no reason why the modals shouldn't.

Some evidence for the existence of two classes of negated modals can be found in the contrasting interpretations of the following sentences:
(62)  a. The teacher doesn't have to flunk some of his students.
     b. The teacher can't flunk some of his students.

(63) The teacher mustn't flunk some of his students.

Most informants who have been presented with these sentences will
give readings for (62) in which some is inside the scope of negation
but will not do so for (63). All the sentences have an interpretation
in which some has wide scope with respect to the negated modal. This
is explained if we look at scope markers for (62)-(63):

(64)  [(\text{^have to}(E))] (62a)
     [(\text{^can}(E))] (62b)
     [(\text{must \sim}(E))] (63)

The wide scope interpretation for some arises if rule (17) is applied
to (64) and the narrow scope interpretation for some in (63) is lacking
because the filter (4.1.33) rules it out.

Postulating two classes of negated verbs explains one way in which
must, etc. differ from other modals. The other way, the existence of
additional readings of (52)-(54), can also be explained by appealing to
the concept of verbal negation. Consider sentence (65) below:

(65) John can | not go if he wants to.

With an intonation break after can, this sentence is interpreted with
the not attached to the main verb go, and under this intonation the
modal participates in scope ambiguities while not remains attached to
the verb. This fact is clear if we examine the readings of a sentence
like (66).

(66) One of you children can | not go to Sunday school.
   i) (E child, x) CAN (\neg go (x, s. school))
   ii) CAN (E child, x)(\neg go (x, s. school))

Now if we say that modals whose negated form is (M \neg) allow the "\neg"
to be transferred to the main verb under normal as well as abnormal
intonation, then the added readings of (52)-(54) are immediately
accounted for. The existence of such transfers would not be surprising
since, as Lasnik (1972), has shown, ordinary negative sentences are
perferentially interpreted with verbal negation when there are no
operators separating not from the verb. Thus, compare sentences (67)
and (68) below:

(67) The mayor didn't approve all of those proposals.
   i) \neg (A proposals, x)(Approve (mayor, x)).

(68) The mayor disapproved the school proposal.
   i) (\neg Approve (mayor, school proposal))

(69) It's not the case that the mayor approved the school proposal.
   i) \neg (Approve (mayor, school proposal))
(70) The mayor didn't approve the school proposal.
   i) \( \sim (\text{Approve (mayor, school proposal)}) \)
   ii) \( (\sim \text{Approve (mayor, school proposal)}) \)

While (70) can be interpreted as synonymous with (69), it is by preference synonymous with (68). The process that interprets (70) with verbal negation on approve is the same as the one that generates the extra reading for (52)-(54). If we formalize this process as in (71), the lack of a third reading for (47)-(49) follows directly since only modals of the class of must, etc. fit the structural description of the rule:

(71) \[ (M \sim) (\text{Verb (K, L, . . . )}) \rightarrow (M)(\sim \text{Verb (K,L,. . . )}) \]

M is optional

Rule (71), the reader will notice, cannot be formulated in terms of the scope markers as devised in (4.1) and (4.2). Instead, it has been formulated directly in terms of the logical formulae for which the scope markers have been our shorthand. The scope formalism could easily be extended to allow the formulation of (71); but our purposes do not require that we work out this extension.
4.4 Summary and conclusions

4.4.0 In chapters one and two we decided to base our analysis of scope in English on the hypothesis that scope order in English is analogous to scope order in formal logic. In other words, we decided to define scope in English as a linear transitive relation that establishes the order in which operators are interpreted in determining the truth conditions of a sentence; i.e., just as it is defined in logic. We noted further that the major differences between scope in English and in formal logic are 1) that the English language sentences are quite generally ambiguous as to the scope order of their operators and 2) that English operator words often allow or prefer only certain other operators immediately inside or outside of their scope. In order to capture the scope ambiguities and the scope order preferences of English sentences, we determined to construct a mapping between English and a formal language that would fix the possible scope orders of operators for each English language sentence by representing its readings as unambiguous formulas of logic. The scope component we have developed in the course of this and the preceding chapter is such a mapping for an important fragment of English sentences containing quantifiers, modals and negation. As such it reconstructs, in part, the ability of a native speaker to determine the order of application of the operators contained in the sentences he hears and communicate an appropriate order of application for the operators in the sentences that he speaks. This ability is, of course, part of the speaker's general ability to interpret the truth
conditions of the sentences of his language, the ability at the heart of communication.

4.4.1 In order to construct our scope component we have had to disentangle and evaluate the various factors that together determine the possible operator scope orders for each English sentence. We discovered that the major factors involved are surface syntactic order, systematic principles of scope ambiguity, operator scope preferences and incompatibilities, and intonation. For the sake of clarity we shall here restate and make more explicit our evaluation of the role of each of these factors.

1. Surface syntactic order. In (4.2.28) we state directly a surface ordering principle for scope order. What it says is that the first determinant of scope order is the surface order of the operators in a sentence. Although output filters may block certain surface order readings and readjustment rules may add certain scope orders, the surface order is primary. This primacy is evidenced by two facts. First, unless scope order incompatibilities associated with certain lexical items block it, the surface order scope reading is always present, while other orders may or may not be. Second, when a sentence has a surface scope order reading along with readings based on other orders, the surface order reading is, all other things being equal, the preferred one. From a psychological or perceptual standpoint this prominence of surface order is, of course, entirely natural. It is hardly surprising
that the given order of operators in a sentence should be psychologically the most immediate in semantic interpretation.

2. Scope ambiguity. English sentences are quite generally ambiguous as to operator scope order; but as we discovered, this scope ambiguity cannot be captured by assuming that scope order is free. Rather there are scope readjustment rules (4.2.14-4.2.16; 4.3.10; 4.3.17) that optionally reverse the surface scope operator words under a favorable syntactic environment. These rules apply to the general categories universal quantifier, existential quantifier, modal, negation, rather than to specific lexical items. The rules apply only to operators that are adjacent in scope order. Thus, while they apply in sentences with any number of operators and apply consecutively in any order, they are basically binary flip rules.

The psychological significance of the great amount of scope order ambiguity in natural language is difficult to assess. It would seem to make sentences harder to interpret semantically; but if scope were generally easy to determine from context, then scope ambiguity would give flexibility to language syntax - allowing word order to carry information on other linguistic features in addition to scope; e.g., case marking, topic/comment relations, etc. In English word order carries such a large semantic load that large provisions for ambiguity may be necessary to prevent over determination of word order.
3. Lexical scope order preferences and requirements. In language it often happens that one tendency is balanced by another opposing tendency. So it is with scope ambiguity. The large amount of ambiguity produced by the scope readjustment rules is reduced somewhat by the scope order preferences and requirements of specific lexical items. Some of these constraints were formalized in (4.1.33–4.1.36). Their effect is to allow the speaker through a proper choice of lexical items to fix the order of operators in a sentence by ruling out a number of orders otherwise produced by the scope component (surface order principle and readjustment rules).

4. Intonation. Intonation affects scope order in different ways. Abnormal intonation breaks, for example, seem to allow scope orders that are otherwise impossible for the sentence in question. Thus, in sentence (4.2.18) only an abnormal intonation break allows a universal quantifier to escape from inside the scope of not; and in sentence (4.3.65) another such break is needed to mitigate the otherwise obligatory attachment of not to a modal as a verbal negative. Intonation breaks caused by moving post verb phrase NP's to the front of a sentence as in (4.1.4), have another effect. They seem to signal in rules (4.2.14) and (4.2.16) that a syntactic transformation has placed a quantifier into first position in a sentence and to block the scope readjustment rules from undoing the work of the transformation. Why this constraint does not apply to rule (4.2.16a)(i.e., where the surface order of operators is universal-existential) when it does apply to rule
(4.2.16b)(surface order existential-universal) we cannot say. Perhaps this asymmetry is related to the general asymmetry of behavior that exists between universal and existential quantifier words, which we now turn to discuss.

4.4.2 Although English sentences allow a great deal of scope ambiguity, there is a definite pattern in the permitted deviations from surface order that emerges from careful observation. Existential quantifiers tend to wind up outside the scope of other operators and universal quantifiers\(^{13}\) tend to wind up inside the scope of other operators. Thus, rule (4.3.17) moves the indefinites outside the scope of not and the modals but universal quantifiers that follow not or a modal in surface structure remain inside its scope (barring the application of rule (4.2.15) under abnormal intonation in the case of not). Further, rule (4.2.14) moves universal quantifiers inside the scope of not but there is no corresponding rule for indefinites. A final indication of the opposing behavior of universal and existential quantifier words is the asymmetry noted in the previous paragraph concerning the application of the quantifier flip rule (4.2.16) across and intonation break. If the quantifier on the left in surface structure is universal the rule applies; but if it is existential the rule does not apply.

We have no explanation for the opposed behavior of universal and existential quantifier words, but we can demonstrate that there are
other similar examples of opposed behavior among operators in English. Thus, it is interesting to note that in the case of quantifiers and not the readjustment rules favor the scope orders (E)(\sim) and (\sim)(A), orders that are logically equivalent. Given the tendency in language for one mechanism to be balanced by another opposing mechanism, we would expect English to have quantifiers that prefer the opposite order. Such quantifiers do exist; they are the no-words (no, no one, nothing, none, etc.) and the any-words (any, anyone, anything, etc.) These word sets are properly considered as corresponding to one another in the same way that all and some or every and one correspond to one another. The appropriateness of this pairing becomes clear when we remember that (as Klima (1964) showed) a no-word and a not followed by an any-word will generally substitute for one another with no change in meaning. In any case, the no-words compensate for existential quantifiers like one and the some-words by building the scope order (\sim)/(E) into single lexical items. The any-words compensate for universal quantifiers like all and every because they are, as was pointed out in chapter two, universal quantifiers with lexical markings that require them to be immediately outside the scope of not, a modal or some similar operator. Finally, as a last piece of evidence that these scope order preferences are an important semantic phenomenon, let us mention that in section 2 of the next chapter we shall find that in terms of scope order with respect to negation the definite and indefinite determiners constitute a third opposed pair like all etc./some etc. and no-/any-.
FOOTNOTES TO CHAPTER FOUR

1. Allowing scope readjustment rule (16) to apply twice to the same existential quantifier causes no problems for our analysis. We shall later explicitly decide to allow the rules to apply whenever their environment is met in any order and any number of times.

2. We have eliminated the indexing on the operators in (2) so as to simplify the notation, but a full specification of the scope markers would include it.

3. This restriction can be explained if we assume that "participating" is semantically to be represented as "participating in x" with the variable x bound by a quantifier over battles.

4. One might propose blocking the application of rule (4.1.32a) to (8) and giving up the condition on the scope readjustment rules that restricts their application to operators that are adjacent to one another in scope order. This alternative fails, however, because it makes several wrong predictions, including that a sentence like (i) will be ambiguous under normal intonation.

   (i) One of the students didn't solve all of the problems.

5. Sometimes surface order scope order is acceptable in sentences similar to (19); for example in (i) below:

   (i) John didn't send each of his relatives a postcard.

   The analysis of this sentence is beyond the scope of this thesis, but it appears that it is an example of verb phrase negation, a form of negation to which filter (4.1.33) does not apply. Thus, consider sentence (ii):

   (ii) The painter didn't paint some of the walls bright red
   (even though the architect asked him to.)

   This sentence is much more acceptable with a not-some scope order when the "even though" clause is appended. This clause seems to force the not to be interpreted as negating the verb phrase as a unit and thereby to remove the sentence from the domain of filter (4.1.33).

6. We should point out that for the modals must and should the scope orders modal-universal and universal-modal are logically equivalent. Thus, sentences (i) and (ii) are equivalent:

   (i) It must be that each of those runners won his event.
   (ii) For each of those runners it must be that he won his event.
7. An ambiguity similar to the one we are discussing is pointed out in Jackendoff (1971), where the following sentence is said to be ambiguous:
   (i) A unicorn will appear on your doorstep tomorrow. As Jackendoff points out, "a unicorn" can be either specific or non-specific in sentence (i). The ambiguity of (i) is handled automatically by our analysis (cf. infra) without the difficulties caused by Jackendoff's approach. (cf. chapter two).

8. Jackendoff (1971, 1972) has an alternative analysis of modal sentences like these within the general framework we discussed in chapter two. His analysis of modal sentences produces the same readings for such sentences as ours does, but we avoid the problems discussed in our consideration of Jackendoff's system.

9. The logically possible but non-existent readings for (43) are:
   (i) For each of the arrows it may happen that there is one among these targets that it hits.
   (ii) For each of the arrows there is one among these targets such that the target may be hit by it.
   (iii) There is one among these targets such that for each of the arrows the target may be hit by the arrow.

10. The modal have to, unlike the others, allows both verbal negation and ordinary negation. We do not know why this should be.

11. This order is, as was pointed out in note 6, logically equivalent to the order all-should- not.

12. Notice that sentences with epistemic may and not require a different intonation pattern than sentences with other modals. This intonation pattern, illustrated below, is probably there to force the not to be attached to the following verb instead of to the modal, since epistemic may does not allow modal negation:
   (i) Nixon may not be impeached.

13. Because each is subject to output filters (4.1.33) and (4.1.34), it is somewhat of an exception to this generalization.

14. The actual constraints on any are actually more complex than this but our point here is not affected by these complexities.
CHAPTER 5: PLURALITY AND QUANTIFIER SCOPE

5.0 Introduction

In the last chapter we treated the singular and plural quantifiers identically, arguing that the semantics of number marking were independent of quantifier semantics. In the current chapter we shall have to revise that estimate as we try to account for the differences among the singular and plural quantifiers. The formal apparatus of the last chapter is adequate for the description of the singular quantifiers but it must be supplemented if we are to account for many of the semantic characteristics of plural quantifiers.

Up to now we have treated the universal and indefinite quantifier words of English as simple reflexes of the universal and existential quantifiers of formal logic. Sentences like (1) and (2) below were assigned readings equivalent to (3) and (4):

(1) \( \left\{ \text{Each} \right\} \) of the men in Horseshoe, Wyoming loved Sally.

(2) a. Some man in Horseshoe, Wyoming loved Sally.
    b. Some men in Horseshoe, Wyoming loved Sally.
(3) \((\forall x \in \{x : \text{x is a man and x lives in H., Wyo.}\})(\text{Love}\ (x, \text{Sally}))\).

(4) a. \((\exists x : \text{x is a man and x lives in H., Wyo.})(\text{Love}\ (x, \text{Sally}))\).

b. \((\exists x_1, x_2, \ldots, x_n : n > 1 : x_i \text{ is a man and x_i lives in H., Wyo.})(\text{Love}\ (x, \text{Sally}))\).

These simple representations are adequate to capture the truth conditions and scope behavior of the singular quantifiers, but they are not adequate for the plurals. Consider, for instance, the following sentence pairs:

(5) a. All of the soldiers in the battalion surrounded the town.

b. Each of the soldiers in the battalion surrounded the town.

(6) a. All of the donuts have holes.

b. Each of the donuts has holes.

(7) a. Some of the soldiers in the battalion surrounded the town.

b. Some soldier in the battalion surrounded the town.

(8) a. Some of the donuts have holes.

b. One of the donuts has holes.

In none of these pairs are the singular and plural variants equivalent. In (5) and (7) only the plural is natural; the singular seems physically impossible. In (6) the singular and plural share one reading but the plural has another reading which the singular lacks. In (8) the plural
has two readings, neither of which is shared by the singular, which has a third reading. If we represent the quantifiers in (5)-(8) as we did in (1) and (2), we get the following readings:

(9) \((Ax \in \{x:x \text{ is a soldier and } x \text{ is in the battalion}\})(\text{Surround, (x, town)})\).

(10) \((Ax \in \{x:x \text{ is one of the donuts}\})(\text{Have (x, holes)})\).

(11) \((\text{Ex}_1, x_2, \ldots , x_n : x_i \text{ is a soldier and } x_i \text{ is in the battalion}) \text{(Surrounded (x}_i, \text{ town)})\).

\[ n > 1 \text{ if "some N" is plural} \]
\[ n = 1 \text{ if "some N" is singular.} \]

(12) \((\text{Ex}_1, x_2, \ldots , x_n : x_i \text{ is one of the donuts})(\text{Have (x}_i, \text{ holes)})\)

\[ n > 1 \text{ for (8a)} \]
\[ n = 1 \text{ for (8b)} \]

These readings are, as we said, correct for the singular variants in (5)-(8) and not for the plural. Readings (9) and (11) express the physically impossible situation (one soldier surrounding a town) that seems implied by (5b) and (7b). Readings (10) and (12) express the attribution of numerous holes to single donuts found in (6) and (8). In none of the cases where the plural has an interpretation different from the singular do the representations (9)-(12) express that interpretation. In order to capture these interpretations we must extend our analysis in ways that turn out to have consequences for the whole theory of scope.
In considering the contrasts of (5)-(8) we must ask how the semantics of plural quantified NP's compares to the semantics of simple definite and indefinite plurals. For instance, sentences (5) and (6) seem to have the same range of interpretation as (13) and (14) below:

(13) The soldiers in the battalion surrounded the town.

(14) The donuts have holes.

This circumstance suggests that we investigate closely the relationship between the quantified and the unquantified plural. We hope that an examination of the semantic relationship between quantified and unquantified plurals, when added to an account of the relationship between singular and plural quantifiers, will lead us to understand number marking and quantificational semantics as a single integrated system. We shall, therefore, investigate these relationships step by step. We ask the reader to bear with us in this complicated analysis with the promise that the questions posed by sentences like (5)-(8) and (13)-(14) will be answered in the end.

5.1 The universal quantifier and the unquantified plural

5.1.1 Consider the following sentence pairs:

(1) a. The men in this room are angry.
   b. All of the men in this room are angry.
(2) a. The prisoners in cell block D escaped from Walpole today.

   b. All of the prisoners in cell block D escaped from Walpole today.

(3) a. The Jones's horses died in the barn fire.

   b. All of the Jones's horses died in the barn fire.

In each of these pairs the quantified and unquantified variants are synonymous.\(^2\) Though one might suspect that the (a) sentences are really weaker or less committal than the (b) sentences, that is not so.

Suppose we assume that the (a) sentences were actually equivalent to the sentences of (4):

(4) a. More or less all of the men in this room are angry.

   b. More or less all the prisoners in cell block D escaped from Walpole today.

   c. More or less all of the Jones's horses died in the barn fire.

Then the fact that the unquantified sentences are generally used in situations where the quantified ones are appropriate could be accounted for by invoking a Gricean implicature to the effect that the predicate is assumed to apply to all referents of the plural NP unless exceptions are noted explicitly. The problem with this description is that the (a) sentences, like the (b) sentences, are incompatible with the contexts in which exceptions are noted. Thus all of the following
sentences are anomalous:

(5) a. *Although the men in this room are angry, there are some who aren't.

b. *Although all of the men in this room are angry, there are some who aren't.

(6) a. *Although the prisoners in cell block D escaped from Walpole today, there were some who didn't.

b. *Although all of the prisoners in cell block D escaped from Walpole today, there were some who didn't.

(7) a. *Although the Jones's horses died in the barn fire, there were some who didn't.

b. *Although all of the Jones's horses died in the barn fire, there were some who didn't.

Of course, the sentences of (4), supposedly equivalent to (1a)-(3a), are perfectly acceptable in this context:

(8) Although more or less all of the men in this room are angry, there are some who aren't.

(9) Although more or less all of the prisoners in cell block D escaped from Walpole today, there are some who didn't.

(10) Although more or less all of the Jones's horses died in the barn fire, there are some who didn't.

Given that the unquantified sentences of (1)-(3) are synonymous with the quantified ones, the sentences can all be represented semantically with
the universal quantifier. Reasonable representations for (1)-(3) are given in (11)-(13) below:

(11) \((\forall x \in \{\text{the men in this room}\})(\text{Angry}(x))\)

(12) \((\forall x \in \{\text{the prisoners in cell block D}\})(\text{Escape}(x, \text{Walpole, today}))\)

(13) \((\forall x \in \{\text{the Jones's horses}\})(\text{Die}(x, \text{that fire}))\)

Note: "def pl NP" is the set of all the objects denoted by a definite plural NP.

What these representations show is that a first approximation to describing the relationship between quantified and unquantified plurals, far from requiring that the plural quantifier all be handled differently from the corresponding singular quantifiers each and every, actually leads to treating the simple definite plural as quantified in the standard way.

The sentences (1)-(3) suggest that all is a redundant lexical marker of a quantifier already implicit in the definite NP itself. This suggestion, however, turns out on further investigation to be inadequate. Consider for instance the sentences of (14) and (15) below:

(14) a. The ants in the colony were numerous.
    b. The men who run the country are politically homogenous.
    c. The people on this boat are a motley crew.
(15) a. * All of the ants in the colony were numerous.
    b. * All of the men who run the country are politically homogeneous.
    c. * All of the people on this boat are a motley crew.

Since the sentences of (14) are acceptable while those of (15) are not, we must conclude that the universal quantifier all is more than a purely redundant element. The fact is that the definite NP subjects of (14) cannot be interpreted as they were in (1a)-(3a). If they were, the semantic representation produced would be the anomalous ones of (16):

(16) a. * (Ax ∈ {the ants in the colony})(Numerous (x)).
    b. * (Ax ∈ {the men who run the country})(Politically homogeneous (x)).
    c. * (Ax ∈ {the people on this boat})(Motley crew (x)).

These representations are anomalous because in them predicates which semantically require collective subjects have as subjects variable standing for individuals. Of course, the formulas in (16) will do nicely as representations of (15) because these sentences are anomalous for precisely the reason that (16a-c) are. Notice that when the universally quantified variable ranges over sets instead of individuals it is perfectly compatible with collective argument predicates. For example, (17) is perfectly acceptable and has the reading (18):
(17) All of the enemy armies are numerous.

(18) \((\forall x \in \{\text{the enemy armies}\}) (\text{Numerous}(x))\)

The sentences of (14) should be represented as in (19):

(19) a. Numerous \(\{\text{the ants in the colony}\}\).

b. Politically homogeneous \(\{\text{the men who run the country}\}\),

c. Motley crew \(\{\text{the people on this boat}\}\).

The variable "x" ranges over sets in these representations, reflecting the fact that predicates like "be numerous" semantically take only sets or collectives as arguments. If the representations of (19) are correct, however, we must say that the simple definite plural NP is semantically ambiguous. With some predicates it acts like a set and with others like a set governed by the universal quantifier.

This ambiguity can easily be formalized. Suppose we say that the basic semantic form of a simple definite plural NP is a set and that a quantifier is added later by an interpretive rule. Suppose further that we define two semantic features on predicates [+distributive] and [+collective], as follows:

(20) a. A predicate \(P\) is [+distributive] if and only if it can take as its argument a single individual.

b. A predicate is [+collective] if and only if it can take as its argument a set or collective.
The notion of 'collective' is introduced here because there are many [+collective] predicates that do not take sets as arguments. Thus, sentence (a) in its collective interpretation does not mean (b); it means (c):

a. The soldiers attacked the fort.

b. *The set consisting of the soldiers attacked the fort.

c. The group consisting of the soldiers attacked the fort.

A collective in semantic representation is the equivalent of a collective NP and can be given a truth definition as follows:

(d) Let C =\{C\} be a collective and P a [+collective] predicate that cannot take a set as an argument. Then "P(C)" is true⇔ all members of the collective denoted by "C" are part of a group that performed or underwent the action or state that "P" denotes.

We should note that a group can perform an action, etc. even if not all of its members do. Therefore, the boundary conditions of a predicate holding rue of a group are not entirely well-defined. The exact definition of these conditions would require a careful study of the collective NP, which is beyond our purposes. All we wish to assert in (d) is that a plural NP under a collective interpretation can be equivalent semantically to a singular collective NP as well as to a set.

Given (20), the following interpretive principle will account for the ambiguity of the simple definite plural:
(21) $P(S) \rightarrow (Ax \in S) P(x)$  
    $P$ is a predicate; $S$ is a set or collective

If we allow rule (21) to apply freely and optionally, then we will get readings both for sentences like (1)-(3) and (14). In order to avoid generating wrong interpretations for these sentences, however, we must use the features defined in (22) to filter out some representations. This filter might be stated as in (22):

(22) If an output semantic representation for a sentence $S$ is an expression of the form $E = \ldots P(\alpha)$ and either 
    a. $P$ is $[-\text{collective}]$ and $\alpha$ is a variable or constant standing for a set 
    or b. $P$ is $[-\text{distributive}]$ and $\alpha$ is a variable or constant standing for a set 
    then the interpretation $E$ of $S$ is anomalous.

It might seem that filter (22) is not really necessary and that its effect could be duplicated by restricting the application of rule (21) to $[+\text{dis}]$ predicates. Such a restriction, however, would prevent (21) from applying to a sentence like (23a), which has (23b) as one of its readings:

(23) a. The enemy battalions outnumber our battalion.  
    b. $(Ax \in \{\text{the enemy battalions}\})\text{Outnumber}(x, \text{our battalion}).$

If we say that the basic reading of (23a) is (24) and allow rule (21) to apply to it, then the reading (23b) is produced automatically:

(24) Outnumber(\{the enemy battalions\}, our battalion).
Thus, the formulation of the interpretive process in two parts is justified. Also, the way (22) is now formulated it rules our sentences which contain no plural NP's but contain arguments of the wrong logical type for a given predicate. For example (22b) would correctly mark a sentence like (25) as anomalous:

(25) * The soldier is numerous.

If we rewrote (22) as a restriction on rule (21) it would not apply to a sentence like (25) at all.

The rule (21) and filter (22) belong to a different component of the grammar than do the rules discussed in the last chapter. Those rules took as given the relationship between a predicate and its argument and tried to account for the semantics of the interactions among the operators that govern predicates and arguments. Rules (21)/(22), on the other hand, are an attempt to formalize the effect of an operator, the plural marker, on the relationship between a predicate and its argument. We labelled the rules in chapter four the scope component of the grammar. Let us call the component to which (21) and (22) belong the number component. In the course of this chapter we shall fill out this component at least partly in order to discuss its interactions with the scope component. What should be understood at this point is simply that this component of the grammar functions to map a morphological marker, the plural, onto a semantic representation in terms of sets and
qualifiers over sets. In other words, our study of the plural marker, like our study of scope, is based on the construction of mapping from English to formal logic.

5.1.2 The clearest difference between actual universal quantifier
words and the universal quantifier introduced by rule (21) is that the
latter is not subject to the scope readjustment rules. Consider the
following sentence pairs:

(26)  a. All of the students know one of the answers.
     b. The students know one of the answers.

(27)  a. All of the students didn't pass the exam.
     b. The students didn't pass the exam.

The scope component gives sentence (26a) the readings in (28) and (27a)
the readings in (29):

(28)  a. \((E \text{ answer}, x)(Ay \in \{\text{the students}\})(\text{Know } (y, x)).\)
     b. \((Ay \in \{\text{the students}\})(E \text{ answer}, x)(\text{Know } (y,x))\)

(29)  a. \((Ax \in \{\text{the students}\}) \neg (\text{Pass } (x, \text{ exam}))\).
     b. \(\neg (Ax \in \{\text{the students}\})(\text{Pass } (x, \text{ exam}))\)

Sentence (26b), however, has only reading (28a) and sentence (27b) has
only reading (29a). The contrast between (26a)/(27a) and (26b)/(27b)
can be accounted for if we say that rule (21) applies after the scope
component. Then the semantic representations of (26b) and (27b) will look like (30) and (31) at the time when the scope readjustment rules could have applied:

(30) \( (E \text{ answer, } x)(\text{Know } \{ \{ \text{the students} \}, x \}) \)

(31) \( \text{Pass } \{ \{ \text{the students} \}, \text{exam} \}. \)

Since the readjustment rules do not apply to such representations, there is no way to generate two readings for (26b) and (27b). If we reformulate rule (21) as below, then it will produce the correct unique readings for these sentences:

(21') a. \( \begin{cases} X \ Y \ P \ (S) \\ X \ P \ (S) \end{cases} \begin{cases} X(Ax \in S) \land Y \ P \ (x) \\ X(Ax \in S) \land P \ (x) \end{cases} \)

b. \( \begin{cases} X \ Y \ P \ (S) \\ X \ P \ (S) \end{cases} \begin{cases} X(Ax \in S) \land Y \ P \ (x) \\ X(Ax \in S) \land P \ (x) \end{cases} \)

Rule (21a) gives the reading for (27b) and (21b') gives the reading for (26b). The parts of rule (21') must be conjunctively ordered so that (31') below is assigned its correct reading (i) by the first line of the rule and not the incorrect reading (ii) by the second line:

(31') The students don't know all of the answers.

(i) \( (Ax \in \{ \text{the men} \}) \land (Ay \in \{ \text{the answers} \})(\text{Know } (x, y)). \)

(ii) \( (Ay)(Ax)(\text{Know } (x, y)). \)

The difference between the quantified and unquantified definite plurals also comes out sharply in sentences containing more than one
plural noun phrase. Consider the following sentences:

(32) a. These men know the safe combinations.
    b. All of these men know all of the safe combinations.

Sentence (32a) appears to have two readings, given in (33) and (34):

(33) \((Ax \in M = \{\text{these men}\})(Ay \in C = \{\text{the safe combinations}\})\)
    \((\text{Know } (x, y))\).

(34) \((Ay \in C)(\text{Know } (M, y))\).

Reading (33) is produced when rule (21') applies to both subject and
object NP's and reading (34) is produced when (21') applies only to
the object NP. Reading (33) is shared by (32b) but (34) is not.
Because (32b) contains two overt quantifiers it must also have two in
its semantic representation. Sentence (32a), on the other hand, is
under different restrictions. It corresponds to a situation in which
a group of men have collective knowledge of a number of safe combinations.
This is possible even if no individual knows more than a part of a
combination. The fact that (32a) would be true in this situation
but (32b) would not is reflected in the restriction of (34) to (32a).

Sentence (32a) raises the semantic problem of why its object NP
is obligatorily governed by the universal quantifier and cannot be
interpreted simply as a collective. Just as the intransitive predicates
of sentences (1)-(3) require a distributive interpretation of the subject
NP, so the transitive predicate "NP knows ___" requires that interpretation
of its object NP. Other transitive predicates, for example emotional love(s) attitude predicates like "_____ like(s) NP" require that their subject hate(s) NP's be interpreted distributively. To handle these facts we can simply mark verbs as to which of their predicate places cannot take collective arguments. This marking, along with a marking of those predicate places that cannot take individual arguments, is an extension of the features defined in (20), which are redefined for this purpose below:

\[(35) \begin{align*}
\text{a. A predicate } P(\alpha_1, \ldots, \alpha_n) \text{ is } [+\text{distributive}] \text{ in the } i\text{th place if and only if } \alpha_i \text{ can be a single individual.} \\
\text{b. A predicate } P(\alpha_1, \ldots, \alpha_n) \text{ is } [+\text{collective}] \text{ in the } i\text{th place if and only if } \alpha_i \text{ can be a set (or collective)}
\end{align*}\]

Filter (22) must be reformulated as in (36) to function under the altered formalism:

\[(36) \text{If an output semantic representation for a sentence } S \text{ is an expression of the form } E = \ldots P(\alpha_1, \ldots, \alpha_n) \text{ and either} \\
\text{a. } P \text{ is } [-\text{collective}] \text{ in the } i\text{th place and } \alpha_i \text{ is a variable or constant standing for a set or collective.} \\
\text{or b. } P \text{ is } [-\text{distributive}] \text{ in the } i\text{th place and } \alpha_i \text{ is a variable or constant standing for an individual, then the interpretation } E \text{ of } S \text{ is anomalous.}
\]

To illustrate how our analysis to this point accounts for the interpretations of sentences with quantified and unquantified definite plurals, let us apply it to the following sentence pair:
(37) a. The boxes in the cellar contain the new toasters.

   b. *All of the boxes in the cellar contain the new toasters.\textsuperscript{5}

First, the unacceptability of (37b) follows directly from the treatment of the universal quantifier words so far in this chapter. The two readings that our analysis assigns to (37b) are:

(38) a. $(Ax \in B)(\text{Contain} \ (x, \ T))$

   b. $(Ax \in B)(Ay \in T)(\text{Contain} \ (x, \ y))$.

| $B$ = {the boxes in the cellar} |
| $T$ = {the new toasters}      |

Reading (38a) is produced when the plural object NP is interpreted collectively (rule (36) not applied) and reading (38b) when that NP is interpreted distributively (rule (36) applied). Both of these readings require the impossible situation in which each box contains the whole set of toasters, which is why (37b) sounds odd.

Second, our analysis produces the following readings for (37a):

(39) a. $\text{Contain} \ (B, \ T)$

   b. $(Ay \in T)(\text{Contain} \ (B, \ y))$

   c. $(Ax \in B)(\text{Contain} \ (x, \ T))$

   d. $(Ay \in T)(Ax \in B)(\text{Contain} \ (x, \ y))$

Reading (39a) is produced when rule (36) does not apply; reading (39b) when it applies only to the object NP; reading (39c) when the rule applies
only to the subject NP; and reading (39d) when it applies to both NP's. Readings (39c) and (39d) are identical to (38a) and (38b) respectively and are ruled out for the same reason as the latter. Readings (39a) and (39b), on the other hand, require no impossible situation and so give the interpretation of (37a). Notice that these readings correctly say nothing about how the toasters are contained in the boxes. In particular, not every box need contain a toaster in order for either the formulas or the sentence they represent to be true.

It seems at first that our rules are wrongly predicting that (37a) is ambiguous because they generate two acceptable readings for the sentence. The fact is, however, that for the verb contain the distributive and collective interpretations of the object NP are logically equivalent: To contain a set of objects is to contain every object in the set and vice versa. This equivalence means that formulas (39a) and (39b) are equivalent and so no false ambiguity is generated. In a sentence like (40) below, the predicate does not allow for such a logical equivalence of the collective and distributive interpretations of the object NP:

(40) The bomb scattered the soldiers.

Therefore, the two readings in (41), though they correspond to (39a) and (39b), define very different situations:
(41) a. Scatter (bomb, {the soldiers}).
   b. (Ax ∈ {the soldiers})(Scatter (the bomb, x))

We should notice that our analysis correctly predicts that sentence (42), with a quantified object NP will be acceptable:

(42) The boxes in the cellar contain all of the new toasters.

By our rules it receives readings (39b) and (39d) and so is correctly predicted to be logically equivalent to (37a).

5.1.3 So far we have needed only one interpretive rule and a filter to account for the semantics of the definite plural. However, there are sentences that cannot be handled by this machinery. Consider (43) and (44) below:

(43) The men in the room are married to the girls across the hall.

(44) a. * All of the men in the room are married to the girls across the hall.
   b. * The men in the room are married to all of the girls across the hall.

Now if we take marriage as defined in our society, then we must interpret (43) as implying a one to one pairing of the subject and object NP sets. This pairing, however, is not expressed by any of the readings produced by our rules. These readings are given in (45):
(45) Let \( M = \{ \text{the men in the room} \} \) and \( G = \{ \text{the girls across the hall} \} \).

a. Married \((M, G)\)

b. \((Ax \in M)(\text{Married } (x, G))\).

c. \((Ay \in G)(\text{Married } (M, y))\).

d. \((Ax \in M)(Ay \in G)(\text{Married } (x, y))\)

Readings (45b–d) are obviously incompatible with such a pairing while (45a) seems to imply a kind of group marriage.

The correct reading for (43) is obviously something like (46):

\[(46) \; \phi((Ax \in M)(Ey \in G)(\text{Married } (x, y)), (Ax \in G)(Ew \in M)(\text{Married } (w, z)))^6\]

Let us call this sort of reading a serially distributive interpretation. Although it is the only interpretation possible for (43) it exists also with other sentences where it is not the only interpretation. The unacceptability of the sentences of (44) shows that the universal quantifier word is incompatible with a serially distributive reading. This is not surprising since such a reading requires that the NP's of a sentence be governed in turn by the universal and the existential quantifier.

The serially distributive reading can be incorporated into our analysis by a rule like (47):

\[(47) \; P (X, Y) \rightarrow ((Ax \in X)(Ey \in Y) P (x, y) \text{ and } (Ay)(Ex) P (x, y))\]
This rule can apply freely to predicates that allow a distributive interpretation of two NP arguments. Predicates which allow only this interpretation of plural NP's will have to be marked and filter (22) extended so as to block the other readings produced by our rules. The semantic significance of this marking is at this point unclear.

5.1.4 Thus far we have found a number of contexts in which the simple definite plural behaves differently from the universally quantified plural. These differences have been accounted for by the postulation of two interpretive rules (21') and (47) which generate distributive interpretations for plural NP's that are represented initially as sets. A filter (36) blocks various of these interpretations according to the semantic character of the predicate. This process does not apply to NP's that have overt universal quantifier words. They must be interpreted from the beginning as being governed by the universal quantifier. Only lexically present universal quantifiers are subject to the scope readjustment rules of chapter four.

The synonymy of the paired sentences of (1)-(3) and the contrasts in the pairs of (14)/(15), (26)/(27), (32)/(33) and (43)/(44) are the evidence we have adduced to justify our analysis. Before we go on to extend our analysis of plurality to indefinite NP's, there is one more argument for our analysis that is worth presenting. It demonstrates again that the unquantified definite plural should be represented basically as a set and then be made subject to interpretive rules. Consider the
following sentence pair:

(48) My friends are \{\text{generally} \atop \text{mostly} \atop \text{by and large}\} honest.

(49) All of my friends are \{\text{generally} \atop \text{mostly} \atop \text{by and large}\} honest.

Sentence (48), lacking the universal quantifier, is ambiguous while (49) has only one reading. The readings of (48) can be paraphrased as (50) and (51), where the former reading is shared with (49):

(50) All my friends are honest on most occasions.

(51) Most of my friends are honest.

In other words, the surface adverb in (48) can be interpreted either as quantifying over 'instances' or 'occasions' of the predicate or as quantifying over the members of the set referred to by the subject noun phrase. In (49) only the former interpretation is allowed. The second reading is missing in (49) because there is a natural semantic restriction which allows only one quantifier per set of quantifiable elements. The second reading of (49) would be something like (52a) which is itself semantically anomalous because of the one quantifier per set restriction, as are the other sentences of (52):

(52) a. *Most of all of my friends are honest.

b. *Some of all of my friends are honest.
c. * All of most of my friends are honest.

d. * Many of all of my friends are honest.

and so forth.

The semantic restriction which rules out the sentences of (52) and makes (49) unambiguous does not affect (48). This fact reinforces our claim that the universal quantifier in the representation of the simple definite plural has a different origin from the universal quantifier in all NP's. The fact that the restriction does apply to (49) confirms what is obvious from surface structure, that the subject noun phrase is governed by the universal quantifier.

The ambiguity of (48) can be captured formally by an interpretive rule of the same type as (21') and (47). The rule is given here in rough form as (53):

\[
(53) \begin{cases} 
\text{mostly, generally, } \\
\text{by and large, etc.} \\
\text{GEN}
\end{cases} (F(X)) \rightarrow (\text{Most } x \in X)(P(x)).
\]

The marker GEN mentioned in (53) is the syntactically zero marker of generic or usitative aspect needed to explain why a sentence like (54) may be interpreted as synonymous with (55) rather than (56) (Cf. note 2).

(54) The men in the army are rebellious.

(55) The men in the army are generally rebellious.

(56) All of the men in the army are rebellious.
Since (54) like (55) can mean (58) as well as (57), we need a way of getting rule (53) to apply to it. Mentioning the marker GEN in the rule serves this purpose.

(57) The men in the army are rebellious on most occasions.

(58) Most of the men in the army are rebellious.

The important point about (53) is that, like (21') and (47), it introduces quantification on NP's which have no overt quantifier words. The rule and the facts it is based on demonstrate again that there must be a semantic component that determines the quantificational status of lexically unquantified plural NP's. This component, which we have called the number component, is further investigated in the next section of this chapter.

5.2 The indefinite plural

5.2.1 So far in this chapter we have analyzed the semantic behavior of the simple definite plural and compared it to the definite plural governed by all. We have discovered that these types of NP differ because the latter is obligatorily governed by a universal quantifier while the former is only optionally so. Now we shall extend our analysis of plural NP's to the indefinite plural and in the process begin to make clear the difference between the singular and plural quantifier words.
Consider first the following sentences:

(1) a. The men in the platoon died in the attack.
   b. The pupils in Mrs. Jones's class solved the problem.

(2) a. Men in the platoon died in the attack.
   b. Pupils in Mrs. Jones's class solved the problem.

As these examples show, one difference between the definite and indefinite plural is in the boundaries of the set or collective of which the predicate is asserted to be true. The sentences of (1) assert their predicates to be true of the collectives defined in (3):

(3) a. let M be a collective such that \((Ax)(x \in M \leftrightarrow x \text{ is a man and } x \text{ is in the platoon})\).
   b. Let P be a collective such that \((Ax)(x \in P \leftrightarrow x \text{ is a pupil and } x \text{ is in Mrs. Jones's class})\).

The semantic representations of (1), therefore, look like (4):

(4) a. \((Ax \in M)\text{Die (x, attack))}\).
   b. i) \((Ax \in P)\text{Solve (x, problem))}\) - distributive interpretation
      ii) Solve (P, problem) - collective interpretation

In (2), on the other hand, the sentences assert only that there is some subcollective of M or C of which the predicate is true. Therefore, we should represent the sentences of (2) as in (5):
(5) a. \((EM' \subseteq M)(Ax \in M')(Die (x, attack))\).

b. i) \((EP' \subseteq P)(Ax \in P)(Solve (x, problem)).\) - distributive

ii) \((EP' \subseteq P)(Solve (p, problem)).\) - collective

\(M'\) and \(P'\) are defined as sub-collectives having a cardinality of at least 2.\(^{10}\)

The representations in (5) can be integrated into our analysis if we assume that there is an existential quantifier over a set or collective associated with the non-generic indefinite plural.\(^{11}\) This quantifier is parallel to the existential quantifier over individuals associated with the indefinite singular. Then the representations in (5) will be produced out of these basic formulas by the operation of rule (5.1.21'):

(6) a. \((EM' \subseteq M)(Die (M', attack))\).

b. \((EP' \subseteq P)(Solve (P', problem)). = (5bii)\)

The behavior of the indefinite plural confirms our claim that rule (5.1.21') must apply after the scope readjustment rules. Consider sentence (7):

(7) Men from the ranch saw a steer on the ridge.

As with definite plural NP sentences (5.1.32b) this sentence is unambiguous. It has the reading of (8).

(8) Let \(M\) be the collective such that \((Ax)(x \in M \leftrightarrow x is a man and \(x is from the ranch)\)

\((EM' \subseteq M)(Ey = a steer)(Ax \in M')(See (x, y, ridge))\).
The scope readjustment rule that might have optionally reversed the order of operators in this reading does not apply, because at the time when they might apply the semantic representation of (7) is (9):

(9) \((EM'_2 \subseteq M)(Ey)(See (M'_2, y, ridge))\).

When we add the indefinite quantifier some to the sentence we get (12):

(10) Some men from the ranch saw a steer on the ridge.

Sentence (10) turns out to be ambiguous. As we shall see in section 5.3, sentences like (10) are subject to the scope readjustment rules. (10) itself has in addition to reading (8), reading (11) below:

(11) \((EM'_2 \subseteq M)(Ax \in M'_2)(Ey = a \text{ steer})(See (x, y, ridge))\).

The scope order of quantifiers in (11) is, of course, the reverse of that in (8).

The above analysis of the indefinite plural can be extended to cover predicates over sets as well as the above ones, which are either distributive or take a collective rather than a set as an argument. Consider sentence (12):

(12) Women were numerous in the audience.

At first glance this sentence appears to be a counter-example to our analysis because it is synonymous with sentence (13), which contains a
definite plural NP in place of the indefinite:

(13) The women in the audience were numerous.

The synonymy of (12) and (13) suggests that indefinite plurals and
definites be treated as synonymous in the context of set argument
predicates. We can, however, maintain a unified treatment of the
indefinite plural if we represent sentences like (12) as in (13').
Sentences with definite plurals, like (13), would, of course, still
be represented as in (13''):

(13') Let \( W \) be the set of all women
\[ (EW_2 \subseteq W) \land (\text{Numerous}(W'_2) \land (Ax \in \{x : x \text{ was in the audience} \land x \in W\})(x \in W'_2)). \]

(13'') Let \( W_A \) be the set of all women in the audience
\[ \text{Numerous}(W_A). \]

Now the second conjunct in the predicate of (13') is an attempt to show
how the locative phrase "in the audience" might contribute to defining
the size of a set associated with an indefinite NP. We have no strong
evidence for this representation but it does allow us to give a unified
treatment to the indefinite plural. Also, it is interesting to note
that sentence (13'') is ungrammatical:

(13'') * Women in the audience were numerous.

The fact that this sentence is ungrammatical suggests that treating the
phrase "in the audience" as making a formally different contribution to
the readings of (12) and (13) is reasonable.
5.2.2 Once we go beyond the simplest cases the facts on the indefinite plural become even more interesting. Consider first of all the following sentence:

\[(14)\] Firemen from Connecticut didn't show up at the Chelsea fire.

The proper semantic representation for (14) is (15):

\[(15)\] Let F be such that \((Ax)(x \in F \leftrightarrow x \text{ is a fireman from Ct.})\) 
\[(EF'_2 \diamond F)(Ax \in F'_2)(\text{Show up } (x, \text{ Chelsea fire})).\]

This representation entails that no group of firemen from Connecticut went to the Chelsea fire but it is compatible with one single fireman from Ct. going. In other words, by saying that (15) is the correct representation for (15), we are claiming that (15) is not logically equivalent to (16), which clearly entails that not one fireman from Ct. went:

\[(16)\] No firemen from Connecticut showed up at the Chelsea fire.

\[(17)\] Representation of (16) = \(\sim (Ex \in F)(\text{Show up } (x, \text{ Chelsea fire})).\)

Of course, under normal circumstances, the speaker of (15) is assumed to mean (16) by some sort of conversational implicature, but this implicature is not an entailment to be captured in semantic representation. It is more likely to be handled by something like Grice's conversational maxims (Grice, n.d.).
In order to integrate sentence (14) into our analysis we must explain how the existential quantifier over the collective winds up inside rather than outside the scope of \underline{not}. This same scope order is found in sentence (18), represented in (19):

(18) John didn't see nails in the barrel.

(19) Let N be the set of nails in the barrel.

\[(EN'_2 \subseteq N)(Ax \in N'_2)(\text{See } (\text{John, } x)).\]

To account for semantics of sentences like (14) and (18) we propose that the following rule of interpretation be added to the surface order scope principle (4.1.28):

(20) In forming the initial semantic representation for a sentence all existential quantifiers that correspond to simple indefinite plural NP's should be placed to the right of all auxiliary operators in the sentence (i.e., \underline{not}, \underline{modals}) (The scope readjustment rules must, of course, be marked so as not to apply to the simple indefinite plural.)

Then, in order to allow for distributive readings of indefinite plurals in negative sentences, we propose that rule (5.1.21') be reformulated as (21):

(21) a. \[\left\{ X \sim Y P \left( S_{\text{def}} \right) \right\} \rightarrow \left\{ X (Ax \in S) \sim Y P(x) \right\}\]

b. \[\left\{ X P \left( S \right) \right\} \rightarrow \left\{ X (Ax \in S) P(x) \right\} \]

By restricting part (a) of the rule to definite plurals as we have, we guarantee that no anomalous ill-formed strings will be produced in which the existential quantifier of an indefinite plural is to the
right of not while the universal quantifier is to the left. Principle (20) is formulated to place the indefinite plural quantifier inside the scope of all operators rather than just inside the scope of not because in sentences like (22) and (23) the indefinite plural always has narrow scope:

(22) All of John's friends have to have jobs.

(23) Candidates from western Mass. may win in the election.

One of the advantages of principle (20) is that it allows us to explain the semantics of a class of sentences we were unable to handle previously (cf. chapter three, section 2.3)
Consider a sentence like (24):

(24) = (3.2.53) A .44 caliber pistol wasn't available in the gun shop.

As we pointed out in (3.2.3), this sentence is perfectly grammatical but in the preferred reading the indefinite singular NP subject is inside the scope of not. Our scope readjustment rules do not produce this interpretation for the sentence because they do not allow an existential quantifier to move inside the scope of a not to the right of it in surface structure. On the other hand, if we extend principle (20) so that it applies optionally to singular as well as plural simple indefinite NP's, then the needed interpretation of (24) is produced. This extension gives substance to our claim in (3.2.3) that the simple indefinite article a(n) can be interpreted either as an overt quantifier
like one, some, etc. or as a marker of indefiniteness. Under the first interpretation it obeys the scope readjustment rules and under the second it does not.

Hard evidence that a(n) has a sense in which it is not a quantifier word is not easy to come by, although the notion itself is not implausible. One argument we can find for the position is that the indefinite singular, like the indefinite plural, has a generic interpretation and can appear in definitional sentences with the copula while the overt singular existential quantifiers generally cannot do either. The sentences below illustrate that point:

(25) a. A bear hibernates in the winter.
    b. Bears hibernate in the winter.
    c. Some bear hibernates in the winter.\(^\text{12}\)
    d. One bear hibernates in the winter.

(26) a. Snoopy is a dog.
    b. Snoopy and Rover are dogs.
    c. * Snoopy is some do\(\text{\textsubscript{3}}\).\(^\text{13}\)
    d. * Snoopy is one dog.\(^\text{14}\)

Additional evidence to support our treatment of a(n) as being sometimes an overt quantifier words and sometimes a marker of indefiniteness comes from the fact that this ambiguity of sense can be extended to other indefinite NP's. Thus, consider sentence (A) below:
(27) John didn't solve many problems for the teacher.

This sentence is unambiguous and has the scope order not-existential, a fact which can only be explained if the quantifier many is here not subject to the scope readjustment rules. Now let us consider the following sentence:

(28) John didn't solve many problems that the teacher had assigned.

Sentence (28) unlike (27) is fully ambiguous as to scope order. These facts lead us to conclude that all quantificational determiners on indefinite NP's are ambiguous as to sense. They often act as markers of indefiniteness not subject to scope readjustment; but when they contain a relatively large amount of descriptive material (cf. 3.23), they are likely to act as overt quantifier words and be subject to the readjustment rules. The one exception to this ambiguity of sense is the simple indefinite plural, which cannot be interpreted in terms of overt quantification, probably because it contains no overt determiner word.

One important flaw in our analysis of the indefinite article is that we have not explained the fact, noted in (3.2.3), that only some predicates allow simple indefinite NP's to fall inside the scope of a not in the auxiliary. Thus, sentences like (29) cannot be interpreted with the indefinite article inside the scope of negation:
(29) A room in the hotel wasn't locked.

Similarly, the plural variant of (29) is ungrammatical.

(30) *Rooms in the hotel weren't locked.

The difference between sentences like (29)/(30) and sentences like (15)/(24) seems to be due to the character of their respective predicates. Consider the sentences of (31) and (32):

(31) a. A door in the room was stuck.
    b. Weapons in the armory were stolen.

(32) a. A messiah appeared to the Jews.
    b. Unicorns exist.

The sentences of (31) appear to presuppose the existence of their subjects while the sentences of (32) do not presuppose, but only assert, the existence of their subjects. Let us assume that two conditions obtain: first, that when an indefinite NP is inside the scope of a not in auxiliary position, any presupposition of existence associated with it is cancelled and second, that predicates like those in (31) require a presupposition of the existence of their subjects. Then sentences like (29)/(30) won't have the scope order not-existential because under that scope ordering both conditions cannot be satisfied simultaneously. Sentences like (15)/(24) will have that scope order
because the second condition doesn't refer to them. This analysis of
the behavior of (29)/(30) is just a sketch of a possible solution. To
take it further would require us to formulate an entire theory of
presupposition, which is beyond the aims of our work. We present it
only to show that the non-existence of the *not*-existential scope order
for (29)/(30) is probably not a serious problem for our analysis of the
scope of indefinites.

5.2.3 The above discussion allows us to restate an important
generalization outlined in chapter four. We said there that the
scope readjustment rules seemed to favor the scope orders $\sim A$ and $E \sim$.
Principle (20), combined with rule (21) allows us to state another
generalization of the same type as the above. As we shall see in section
(5.3), the distributive indefinite plural is semantically very close to
universal *all*. Therefore, the effect of principle (20) and rule (21)
is to make the scope order of indefinite plural and distributive definite
plural non-quantified NP's with respect to *not* opposite to the preferred
scope order of overtly quantified NP's with respect to *not*. In
chapter four, we noted that the scope order $\sim A$ and $E \sim$ were logically
equivalent and that the *no*-words and *any*-words seemed to balance the
scope readjustment rules by requiring the scope orders $A \sim$ and $E \sim$.
Similarly, the definite and indefinite determiners also produce opposite
scope orders to those preferred by the readjustment rules. The tendency
towards logically equivalent scope orders in complementary NP determiners
and towards opposite scope orders among different types of determiner is very striking. We cannot at this point explain it; but an explanation must be sought somewhere in the communicative flexibility which these complex parallelisms and oppositions must give to natural language.

5.2.4 Thus far we have considered the indefinite plural NP in contexts where it is the only plural NP in a sentence. The analysis we have given can now be extended to sentences containing two plural NP's. Consider, for example, these sentences:

(33) a. The boxes in the cellar contain new toasters.

b. The donuts on the tray have holes.

(34) a. All of the boxes in the cellar contain new toasters.

b. All of the donuts on the tray have holes.

The sentences of (33) and (34) are ambiguous and the corresponding sentences are largely synonymous. The readings of (33) are given in (35) and the readings of (33) in (36):

(35) Let B be the collective of boxes in the cellar; let T be the collective of new toasters.

a. \((\text{ET}^{'2} \subseteq T)(\text{Contain}(B, T^{'2})).\)

b. \((\forall x \in B)(\text{ET}^{'2} \subseteq T)(\text{Contain}(x, T^{'2})).\)

c. \((\forall x \in B)(\text{ET}^{'2} \subseteq T)(\forall y \in T^{'2})(\text{Contain}(x, y)).\)

d. \((\text{ET}^{'2} \subseteq \exists z(\forall x \in B)(\forall y \in T^{'2})(\text{Contain}(x, y))).\)
(36) Let D be the collective of donuts on the tray; let H be the collective of all holes.

a. \((EH')_2 \subseteq H(\text{Have } (D, H'))\)

b. \((Ax \in D)(EH')_2 \subseteq H(\text{Have } (x, H'))\).

c. \((Ax \in D)(EH')_2 \subseteq H(Ay \in H')(\text{Have } (x, y))\).

d. \((EH')_2 \subseteq H(Ax \in D)(Ey \in H')(\text{Have } (x, y))\).

Let us begin our explanation of the semantics of (33)/(34) by considering how the above readings could be formally associated with the sentences of (33).

Readings (35a) and (36a) are the initial semantic representations of the sentences. The second readings (35b) and (36b) require another reformulation of rule (5.2.21). As the rule now stands, the universal quantifier must be inserted immediately to the left of the predicate. It should be reformulated as in (37) so as to produce the (b) readings:

\[
\begin{align*}
(37) & \quad \begin{cases}
  a. & X \sim Y P(S_{\text{def}}) \\
  b. & X(E'_{T}) \sim P(s, T')_2 \\
  c. & X P(S) \\
\end{cases} \rightarrow \begin{cases}
  x(Ax \in S) \sim Y P(x) \\
  x(Ax \in S)(E'_{T}) \sim P(x, T')_2 \\
  x(Ax \in S) P(x) \\
\end{cases}
\end{align*}
\]

If we start with initial representations (35a) and (36a) then (37b) applied to the subject NP's produces (35b) and (36b). If (37c) is then applied to the object NP's, then we get the readings (35c) and (36c). This fact suggests that we order the application of rule (37) so that it applies first to definite NP's and then to the indefinites. These readings are, for reasons discussed in section (5.1.2), logically equivalent to (35b).
and (36b) respectively.

The formulation (37) is not yet entirely accurate. Consider the sentence (38) with the interpretations in (39):

(38) The cowboys saw riders in the distance.

(39) a. \((ER'_2 \bowtie R)(See \,(x, \, R'_2))\)
   
b. \((ER'_2 \bowtie R)(Ax \varepsilon C)(See \,(x, \, R'_2))\)
   
c. \((Ax \varepsilon C)(ER'_2 \bowtie R)(See \,(x, \, R'_2))\).
   
d. \((ER'_2 \bowtie C)(Ax \varepsilon C)(Ey \varepsilon R'_2)(See \,(x, \, y)),\)

Note: each reading a-c has a logically equivalent alternate with \(R'_2\) governed by a universal quantifier.

Reading (39c) is produced by rule (37) but (39b), which certainly is a reading for (38), is not. The reading (39b) will be produced by part c of (37) if part b is blocked from apply first. If we define angle brackets so that material inside them is optional and reformulate (37) as (40), then reading (39b) will be generated:

(40) a. \(X \sim Y \; P(S_{def}) \rightarrow X \; (Ax \varepsilon S) \bowtie Y \; P(x)\)
   
b. \(X \; \langle (ET'_2 \bowtie T) \rangle \; P(S, \, T'_2) \rightarrow X(Ax \varepsilon S) \langle (ET'_2 \bowtie T) \rangle \; P(x, \, T'_2)\)
   
   Or
   
   \(X \; (ET'_2 \bowtie T) \; (Ax \varepsilon S) P(x, \, T'_2)\)

The formula corresponding to (39b) for sentence (33a) is (41):

(41) \((ET'_2 \bowtie T)(Ax \varepsilon B)(Contain \,(x, \, T'_2))\)
This formula is generated by rule (40) but it is anomalous because a single collection of objects cannot be contained simultaneously in two separate boxes. As usual our scope rules admit of readings that are then blocked by semantic characteristics of the predicate.

In order to account for readings (35d) and (36d) (and (39d) as well), we must add a new rule. This rule must replace existential quantification over an individual. The rule can be formulated as in (42):

\[(42) \ (ET'_2 \subset T) (Ax \in S) P(x, T'_2) \rightarrow (ET'_2 \subset T) (Ay \in S) (Ey \in T'_2) P(x, y)\]

Rule (42) will convert into (39d) and (41) into (35d).

One important point about the distributive interpretations of unquantified plural NP's is that neither surface nor deep structure order has any effect on scope ordering. For example, a sentence like (43) below has all of the readings in (44) even though deep and surface orders of its NP's are opposite to those in the sentences of (33) and (34):

(43) Crates in the warehouse contain the new missiles.

(44) Let \(M = \{\text{the new missiles}\}\), \(C = \{\text{the crates in the warehouse}\}\):

a. \((EC'_2 \subset C) (\text{Contain}(C', M))\).

b. \((Ax \in M)(EC'_2 \subset C) (\text{Contain}(C', x))\)

c. \((EC'_2 \subset C) (Ax \in M)(Ey \in C'_2) (\text{Contain}(x, y))\)
The reading corresponding to (35c) is missing not because of the reversed order of NP's but because as mentioned in 5.1 the object position of "contain" is more freely distributive than the subject position. If we change the predicate appropriately, then all four readings are once again present, as in (45) with readings in (46):

(45) Students in the introductory syntax class found the answers.

(46) Let A = {the answers}; let S = {the students in the class}.
   a. (ES'2 ⊑ S)(Found (S'2, A)).
   b. (Ax ε A)(ES'2 ⊑ S)(Found (S'2, x)).
   c. (Ax ε A)(ES'2 ⊑ S)(Ay ε S'2)(Found (y, x)).
   d. (ES'2 ⊑ S)(Ax ε A)(Ey ε S'2)(Found (y, x)).

As we remarked earlier, the sentences of (34) are largely synonymous with the sentences of (33). In fact, the readings of (34a) are (35b-d) and of (34b) are (36b-d). Readings (35a) and (36a) are missing because they lack a universal quantifier over the subject NP set. Our problem is to explain why the overt quantifier all winds up in the same positions as the quantifier introduced by the interpretive rule (41). The sentence (47) below shows that the order of quantifiers cannot be determined by either the deep or the surface order of the plural NP's:

(47) Students in the introductory syntax class found all the answers.
The readings of (47) are (46b-d). Reading (46a) is missing because it contains no universal quantifier over the object NP set.

In order to generate the proper readings for (34) and (47) we must propose the following rule for placing the indefinite plural in an initial semantic representation. This rule should be added to rule (20) in (5.2.1):

(48) If a sentence contains an indefinite NP and a quantified plural, then in the initial semantic representation the quantifier over the indefinite NP may be placed either to the left or to the right of the quantifier associated with the other NP.

The result of rule (48) when applied to the sentences containing all is to give them the same distributive readings as are given to the sentences with the simple definite plural. For example, sentence (47) is given reading (46b) if the indefinite quantifier is placed to the right of the quantifiers associated with all NP and reading (46c) comes from applying (41b) to (46b). If the initial order of quantifiers is reversed, the (46d) results.

4.2.5 Principle (48) and the facts on which it is based provide us with a motivated way of distinguishing the plural universal quantifier all from the singular each. Consider the following sentences:

(49) a. *Each of these men is married to girls from NYC.

b. Girls from NYC are married to each of these men.
(50)  a. All of these men are married to girls from NYC.
    b. Girls from NYC are married to all of these men.

The sentences of (50) receive their readings from rule (48), followed
by (42). Rule (48) ignores the order of NP's in the sentence and so
 treats (50)a and (50)b in the same way. Our rules give (50) the
readings in (51) but, of course, all but (51a) are legally impossible
since they express polygynous relationships:

(51)  Let \( M = \{ \text{these men} \} \); let \( G = \{ \text{the girls in NYC} \} \)
    a. \( (EG' \subseteq G)(Ax \in M)(Ey \in G'_{2})(\text{Married } (x, y)) \)
    b. \( (EG' \subseteq G)(Ax \in M)(\text{Married } (x, G'_{2})) \).
    c. \( (Ax \in M)(EG' \subseteq G)(\text{Married } (x, G'_{2})) \)
    d. \( (Ax \in M)(EG' \subseteq G)(Ay \in G'_{2})(\text{Married } (x, y)) \).

The sentences of (49) are obviously not interpreted in accordance
with (48). Sentence (49a) sounds odd because its only readings are
those of (52), both of which express polygynous relationships:

(52)  a. \( (Ax \in M)(EG' \subseteq G)(\text{Married } (x, G'_{2})) \)
    b. \( (Ax \in M)(EG' \subseteq G)(Ay \in G'_{2})(\text{Married } (x, y)) \).

Sentence (49b), on the other hand, has as its readings (51a) and (51b).
Since (51a) does not express a polygynous relationship, the sentence does
not sound odd.
The readings of (49) are easily accounted for. If we say that in semantic representation a singular quantifier is ordered with respect to the indefinite plural according to the surface order of the two NP's, then our interpretive principles will generate the correct readings. The initial semantic representation of (49a) will be (52a) from which (52b) derives by rule (40b). The initial representation of (49b) will be (51b) from which (51a) derives by rule (42). This same analysis will, of course, account for the difference between the sentences "all of these donuts have holes." and "each of these donuts has holes." that was pointed out in the introduction to this chapter.

This formulation makes the difference between each and all very clear. The scope behavior of all with respect to the indefinite plural is governed by the scope principles of plural NP's in general while the scope behavior of each with respect to the indefinite plural is governed by surface order, that is by the scope principles derived in chapter four and still adequate for singular quantifiers.

4.2.6 The main results of our investigations to this point can be summarized as follows:

A. 1. The overt plural and singular quantifiers, not and the modals in S are placed with respect to each other in their surface structure order.

   a. a. The indefinite singular and plural quantifiers are placed either to the left or right of the quantifier representing all NP.

   b. At the same time the indefinites must be placed with respect to the singular quantifiers in their relative surface structure position. With respect to not and the modals the indefinites are placed to the right of those operators.
B. The scope readjustment rules apply to the representation resulting from 1-2. They apply to the singular and plural quantifier words, but not to the indefinite markers.

C. 1. Rules (5.1.47, (40) and (42) apply. They are the rule for inserting universal and existential quantifiers over individuals into the representations of sentences containing unquantified plural NP's.
   2. Filter (5.1.36) applies to rule out those results of these rules that are incompatible with the verb of the sentence being represented.

5.3 Indefinite plural quantifiers

5.3.0 So far we have discussed mainly the overt quantifier all in our account of the interaction of plurality and quantification. We can conclude from our observations that all behaves generally as a simple reflex of the universal quantifier of logic. Its semantics are governed by the principles of chapter four just as the semantics of the singular universal quantifier words each and every. In particular, it is represented in a scope marker so that its order with respect to other quantifiers reflects its surface structure ordering position, and it is subject to the scope readjustment rules. With respect to the indefinite plural, however, all NP is treated as a variant of the definite plural. In order to pursue the relationship between quantified and unquantified plurals we must now extend our analysis to the plural existential quantifiers.

5.3.1 Consider the following sentence:

(1) \{\text{Some} \}_\text{Many} \text{ of John's friends are bald.}
The plural existential quantifiers in (1) cannot be represented by either the simple universal or existential quantifiers of formal logic. In order to capture the truth conditions of (1) in a formal way we must use devices not so far employed. Basically, there are two ways of representing the plural existential quantifiers (Altham, 1971). The first would be to invent new quantifiers for each of the indefinites and incorporate them in a standard first order language. The plural some might be represented as "S" in (2) and many as "M" in (3):

(2) $(Sa)P(a)$ is true if and only if $P(a)$ is true for at least two distinct values of $a$, where $P$ is an English language predicate.

(3) $(Ma)P(a)$ is true if and only if $P(a)$ is true for at least $n$ distinct values of $a$. The size of $n$ is not fixed but depends on the context of the sentence and in that context $n$ must be large.

On the basis of these definitions the sentences of (1) can be represented as in (4):

(4) a. $(Sx)(x$ is a friend of John's and $x$ is bald).
    
    b. $(Mx)(x$ is a friend of John's and $x$ is bald).

As Altham points out, however, there is another way of formalizing the plural existential quantifiers, what he calls the double quantifier form. In this form the plural quantifier words becomes a predicate defining a set or group and the universal quantifier does the job of quantification per se. In this formalization some and many would be
defined as in (5) and (6) below:

(5) \((ES_{NP})(A_\alpha \in S)P(\alpha)\) is true if and only if there is a set \(S\) consisting of two or more elements of the type NP, and such that \(\alpha\) is any member of \(SP(\alpha)\) is true. An element is of type NP if the NP governed by the quantifier is a true description of that element.

(6) \((EM_{NP})(A_\alpha \in M)(P(\alpha))\) is true if and only if there is a set \(M\) consisting of at least \(n\) elements of type NP such that if \(\alpha\) is any member of \(MP(\alpha)\) is true.

In the double quantifier formalism the sentences of (1) would be represented as in (7):

(7) a. \((ES_{fJ})(Ax \in S)(x \text{ is a friend of John's and } x \text{ is bald.})\)

b. \((EM_{fJ})(Ax \in M)(x \text{ is a friend of John's and } x \text{ is bald.})\)

With a slight change in the formalism we can make clearer the relationship between NP's like "{some\} of John's friends" and "John's friends."

The quantifiers serve semantically to select a subset/collection from the set/collection defined by the definite NP, just as does the indefinite plural. Therefore, we will represent (1) as in (8); with the same basic device we used for the latter:

(8) Let \(F = \{\text{the friends of John's}\}\)

a. \((ES \subset F)(Ax \in S)(x \text{ is bald}).\)

b. \((EM \subset F)(Ax \in M)(x \text{ is bald}).\)

Now Altham claims that these two formalisms are logically equivalent and that the choice of which one to use if a matter of
convenience. There is evidence, however, that the two forms are not equivalent and that only the double quantifier form is adequate to describe English plural quantifier semantics. Consider sentences (9) and (10) below:

(9) I told many of the men \{\text{three} \}_{\text{some}} \text{ of the stories.}

(10) I told \{\text{three} \}_{\text{some}} \text{ of the stories to many of the men.}

Sentence (9) is two ways ambiguous as to the scope of the object quantifiers and so is sentence (10). The readings of (9) are given in (11), those of (10) in (12):

(11) a. There was a group of many men and I told each of them a set of \{\text{three} \}_{\text{some}} \text{ of the stories.}

b. There was a group of many men and a set of \{\text{three} \}_{\text{some}} \text{ stories and I told each of them those stories.}

(12) a. There was a set of \{\text{some} \}_{\text{three}} \text{ stories and I told each of them to many men.}

b. There was a group of many men and I told each of them a set of \{\text{three} \}_{\text{some}} \text{ stories and I told each of them those stories.}

As Jackendoff (1972) points out, readings (11b) and (12b) are equivalent but (11a) and (12a) are not. This fact makes the single quantifier description untenable because it produces only two possible readings for (9) and (10) instead of the three that exist. Jackendoff, however,
(14) = (4.2.13)
\[ [\alpha(\text{modal}_n \backslash_n (E \backslash_n (A \in \chi \backslash_n )_{n+1} ) \beta] + \]
\[ [\alpha \left\{ \begin{array}{c}
\left( E \backslash_n (A \in \chi \backslash_n )_{n+1} \right) \\
\left( E \backslash_n \right)
\end{array} \right\} _n \beta] / \text{not}_n \land Q_{n+1} \]

(15) = (4.2.15)
\[ [\alpha(\backslash_n \backslash_n (E \backslash_n (A \in \chi \backslash_n )_{n+1} ) \beta] + \]
\[ [\alpha \left\{ \begin{array}{c}
\left( E \backslash_n (A \in \chi \backslash_n )_{n+1} \right) \\
(Q \backslash_n \right)
\end{array} \right\} _n \beta] / \text{not}_n \land Q_{n+1} \]

(16a) = (4.2.16a)
\[ [\alpha(A \backslash_n \backslash_n (E \backslash_n (A \in \chi \backslash_n )_{n+1} ) \beta] + \]
\[ [\alpha \left\{ \begin{array}{c}
\left( E \backslash_n (A \in \chi \backslash_n )_{n+1} \right) \\
(E \backslash_n \right)
\end{array} \right\} _n \beta \land (A \in \chi \backslash_n )_{n+1} \beta] / \emptyset \]

(16b) = (4.2.16b)
\[ [\alpha \left\{ \begin{array}{c}
\left( E \backslash_n \backslash_n (A \in \chi \backslash_n ) \right)
\end{array} \right\} _n \beta] + \]
\[ [\alpha(A \backslash_n \backslash_n (E \backslash_n (A \in \chi \backslash_n )_{n+1} ) \beta] / Q_n \land Y Q_{n+1} \land VP \]

The expression in the angle brackets is optional. 16
(17) = (4.3.10)

\[ (E \chi)_{n} \left( \alpha \left( \chi \in \chi \right)_{n} \right)_{[\text{modal}]_{n+1} \beta} + \\
\left( Q_{n} \right)_{[\alpha(\text{modal})_{n+1} \left( (E \chi)_{n} \left( \chi \in \chi \right)_{n} \right)_{\beta}] / \phi} \]

Notice that rule (16a) correctly predicts that the second reading of (9) will be (13c) not (13b) and that the second reading of (10) will be (13c) not (13a). The reader can check for himself that the rewritten rules do not produce any wrong readings for the sentences discussed in the previous chapter.

Aside from the correct handling of the scope ambiguities of (9)/(10), there is considerable additional evidence to support the double quantifier treatment of the plural existential quantifiers. Firstly, consider the following sentences:

(18) Only John loves Mary.

(19) Only the men in the office know the secret.

(20) Only some of John's friends are honest.

A widely discussed analysis of only argues that a sentence like (18) has the semantic structure of (21) under normal intonation:

(21) Assertion: (Ax)(x ≠ John+ ∼ (x loves Mary))

Presupposition: John loves Mary.
If this analysis or anything close to it is correct, then the easiest way to represent a sentence like (19) would be as follows:

(22) Assertion: Let \( G = \{ \text{the men in the office} \} \)
    \( (Ax)(x \notin G \rightarrow \neg(x \text{ knows the secret}) \) \)

Presupposition: The men in the office know the secret.

If we place contrastive stress on the head of the NP governed by only, however, the semantics becomes a bit more complex. Consider (23):

(23) Only the men in the office know the secret.

The effect of the contrastive stress is to change the assertoric force of the sentence slightly. Sentence (19) makes a statement about all things in the universe that are not included in the set of NP defined by the NP "the men in the office." Sentence (23) makes a statement limited to things in the office and states that all of them other than those covered by the NP do not know the secret. The meaning of (23) can be represented as in (24):

(24) Assertion: Let \( G = \{ x : x \text{ is in the office} \} \), let \( G' = \{ \text{the men in the office} \} \).
    \( (Ax \in G)(x \notin G' \rightarrow \neg(x \text{ knows the secret}) \) \)

Presupposition: The men in the office know the secret.

It should be clear that the semantics of a sentence like (20), containing the plural existential quantifier some, can be handled with the double quantifier form. Sentence (20) would be represented as in (25):
(25) Assertion: Let $F = \{\text{John's friends}\}$
\[(Ax)(x \notin F \rightarrow \neg(x \text{ is honest})).\]

Presupposition: $(Es \subset F)(Ax \in S)(x \text{ is honest})$

The double quantifier form can also handle sentences like (26), in which there is contrastive stress on the plural quantifier word. Sentence (26) would be represented as in (27):

(26) Only some of John's friends are honest.

(27) Assertion: $(Ex \subset F)(Ax \in F)(x \notin S \rightarrow \neg(x \text{ is honest}))$

Presupposition: $(Ax \in S)(x \text{ is honest})$

The single quantifier representation cannot handle the semantics of (26). Because there is no set corresponding to the NP "SOME of John's friends" in that notation, there is no way to express the implication that non-membership in some subset of John's friends entails dishonesty.

It is interesting to note that the universal quantifier over the elements of $S$ does not appear in the assertion part of (26). When inside the scope of only the plural quantifiers have only the set predicate quantifier. We cannot explain this fact but it must be included in any description of the semantics of only.

Aside from the arguments based on the scope of many and some or on the behavior of only, there are still other arguments for the double quantifier form. Consider, for instance, a sentence like (28):
(28) Some of the children in the room have a sick mother.

This sentence is ambiguous. It may be interpreted either as in (29) or as in (30):

(29) Let \( G = \{ \text{the children in the room} \} \)
\( (\exists x \in G)(Ax \in S)(E \text{ sick mother, } y)(x \text{ has } y) \)

(30) \( (\exists x \in G)(E \text{ sick mother, } y)(Ax \in S)(x \text{ has } y) \)

The ambiguity of (28) is predicted by our new scope readjustment rule (15) which will derive (30) from (29). This prediction is good evidence in favor of our formalism. Of course, we could capture this ambiguity with the single quantifier formalism as in (31) and (32) below:

(31) \( (Sx)(E \text{ sick mother, } y)(x \text{ is a child in the room and } x \text{ has } y) \).

(32) \( (E \text{ sick mother, } y)(Sx)(x \text{ is a child in the room and } x \text{ has } y) \).

To make (31) equivalent to (29), we would simply write a definition of the quantifier \((Sx)\) in the appropriate way. The only problem with this solution is that single quantifier formalism, though it is descriptively adequate in this case, is semantically unrevealing. What explanation can we give for the fact that although \((Sx)\) is an existential quantifier, it is crucially ordered with respect to another
indefinite quantifier (Ey)? In formal logic the ordering of two adjacent existential quantifiers is semantically irrelevant while the ordering of existential and universal quantifiers is crucial. The double quantifier formalism makes the ambiguity of (28) follow from this basic characteristic of formal logic. In the single quantifier formalism it must be captured by the ad hoc assignment of some universal and some existential quantifier characteristics to the new plural existential quantifiers. We should also note that the double quantifier form related the quantified plural to the unquantified plural in an explicit way while the single quantifier form does not.

One welcome piece of evidence in favor of our reformulation of the scope readjustment rules comes from a comparison of the following sentences:

(33)  a. Each member of the audience was related to one of the actors.

     b. One member of the audience was related to each of the actors.

(34)  a. Some members of the audience were related to one of the actors.

     b. One member of the audience was related to some of the actors.

As was discussed in chapter three, the sentences of (33) are both ambiguous as to the scope order of the two quantifiers.

Our rules (15) and (16) preserve that ambiguity. As has been discussed
in the preceding paragraphs sentences like (34a) are also correctly predicted to be ambiguous by our new rules. When we arrive at sentence (34b), however, we discover that it is not ambiguous and that its only reading is (35), in which the semantic order of quantifiers follows the surface order:

\[(35) \text{Let } G = \{\text{the actors}\} \]
\[(E \text{ member of the audience}, x)(ES \subset G)(Ay \in S)(x \text{ was related to } y)\]

A glance at rules (16a) and (16b) shows that (35) cannot be the input to either rule. Our formalism thus predicts correctly that (34b) will be unambiguous.

A final argument for the double quantifier form depends on sentences like (36):

\[(36) \{\text{Many} \atop \text{Some}\} \text{ of the boxes contain refrigerators.}\]

Now sentence (36) also (5.0.8a) follows semantically just like sentences (5.2.33) and (5.2.34) discussed earlier. The latter sentences have either universally quantified plural or simple plural NP subjects. The ambiguity of (36) is captured in the double quantifier form by giving it readings (37) and (38):

\[(37) \text{Let } G = \{\text{the boxes}\}; \text{let } H = \{\text{all refrigerators}\} \]
\[(EH'_2 \subset H)(ES \subset G)(Ax \in S)(Ey \in H'_2)(x \text{ contains } y)\]

\[(38) (ES \subset G)(Ax \in S)(EH'_2 \subset H)(x \text{ contains } H'_2)\]
In other words, the indefinite NP is governed by the same rule of distributivity and scope when it is associated with the plural \textit{some} or \textit{many} as it is when associated with \textit{all} or the definite plural. With the single quantifier form this fact can only be described and not explained, but with the double quantifier form it can be explained. If the distributivity rule for the indefinite refers to the second (i.e., the universal) quantifier in the representation of \textit{some} and \textit{many}, then the facts follow automatically.

4.3.2 \textbf{All} and the double quantifier form

As matters now stand we have not treated the plural quantifiers in a unified way. While the existential quantifiers are represented in the double quantifier form, the plural universal quantifier \textit{all} is treated as having only a single quantifier representing it. Thus, two sentences like (39) and (40) below will not receive parallel representations.

(39) All of the boys on the ship got seasick.

(40) Many of the boys on the ship got seasick.

Sentence (39) will be represented as in (41) and (40) as in (42):

(41) Let $G = \{\text{the boys on the ship}\}$
    $(Ax \in G)(x \text{ got seasick}).$

(42) $(EM \forall G)(Ax \in M)(x \text{ got seasick}).$
We can achieve a unified treatment of the plural quantifiers easily, if we reinterpret *all* in line with the double quantifier form. We can define the new formalism for *all* as follows:

\[(43) \ (EV = \chi)(Ax \in V)P(\alpha) \text{ is true if and only if there is a set } V \text{ identical in membership to the set } \chi \text{ defined by the NP determined by } \text{all} \text{ such that if } \alpha \text{ is any member of } V, P(\alpha) \text{ is true.}\]

With this formalism sentence (39) would have the semantic representation (44), parallel to (42):

\[(44) \ (EG = \{\text{the boys on the ship}\})(EV = G)(Ax \in V)(x \text{ got seasick})\]

Now it is clear that the expression "\((EV = X)\)" in (43) and (44) is semantically redundant and its use requires some justification. That justification lies in the formal simplication resulting from treating all plural quantifiers in the same way. It is a fact, discussed earlier, that a sentence like (1) is identical in meaning to the unquantified (45):

\[(45) \text{ The boys on the ship got seasick.}\]

In a certain sense, therefore, the word *all* is itself redundant in contexts like (44). In section (4.1) we explained the semantic contribution of *all* by saying that it caused the universal quantifier to be present from the beginning in the representation of a NP while for a sentence like (7) it is introduced by the rule of distributive predicates. Now, however, it appears that there is also a universal quantifier in the
semantic representation of the plural existential quantifiers. Under these circumstances it would seem odd to claim that the universal quantifier in the representation (41) of a sentence like (39) is a reflex specifically of the universal quantifier all. A better solution would seem to be to say that all plural quantifiers insert a universal quantifier in the initial level of semantic representation. But then all can no longer be identified with that universal quantifier so that its treatment with the double quantifier formalism becomes even more natural.

Aside from the above arguments there are still further reasons for handling all with the double quantifier formalism. Consider sentences (46)-(47) below:

(46) * All of the soldiers sufficed to defeat the enemy.

(47) Only all of the soldiers will suffice to defeat the enemy.

Sentence (46) is ungrammatical for the same reason that the sentences of (5.1.15) are. The verb suffice requires a collective (group or set) subject and the quantifier all forces a distributive interpretation. Sentence (47) on the other hand, is grammatical in the same way that (26) is. The grammaticality of (47) can be accounted for by having the same marking that allows only to delete the universal quantifier associated with some and many work on all. This marking will be more natural if all has the double quantifier form. More importantly, sentence (47) is not synonymous with the unquantified variant (48):
(48) Only the soldiers will suffice to defeat the enemy.

Sentence (48) has the semantic representation (49):

(49) Assertion: Let \( G = \{ \text{the soldiers} \} \)

\((\forall y)(y \notin G \supset (y \text{ will suffice}))\)

Presupposition: The soldiers will suffice to defeat the enemy.

Now if all is represented with a single quantifier the representation assigned to (47) will be identical to (49) because the marking on only which deletes the universal quantifier will eliminate the only source for a semantic difference between (47) and (48). In fact, of course, (47) means something like (50):

(50) Only the whole contingent of soldiers and not just part of it will suffice to defeat the enemy.

If all is represented in the double quantifier formalism, then (47) will be represented by (51), which gives the meaning in (50):

(51) Assertion: Let \( G = \{ \text{the soldiers} \} \)

\((\forall y = G)(\exists s \forall v \supset (s \neq v \supset \neg (s \text{ will suffice}))\)

Presupposition: The soldiers will suffice to defeat the enemy.

The representation in (51) is constructed by analogy to those in (23)–(27) where there is contrastive stress on the NP determined by only. This is reasonable since sentence (47) seems acceptable only with contrastive
stress on all. Once again the introduction of the set is redundant from a truth functional point of view but its presence is useful linguistically because it allows us to treat (47) and (26) in a parallel way as well as to explain why (48) cannot be interpreted as (50).

The decision to use the double quantifier formalism for all has certain consequences for the scope readjustment rules that should be mentioned. Firstly, it requires that rule (4.2.14) be reformulated as follows:

\[(52) = (4.2.14)\]
\[
[a \left\{ (EV)_n (Ax \in V)_n \right\} (\forall) \beta] + [a (EV)_n (\forall) \left\{ (Ax \in V)_n \right\} \beta]
\]

Condition: \(a \neq a' (Ex_{exist})\)

Secondly, it makes the prediction that while sentences like (53) are ambiguous, sentences like (54) have only the surface order reading:

(53) All of the members of the audience are related to one of the actors.

(54) One of the members of the audience is related to all of the actors.

These sentences, in other words, behave like the sentences of (34). In chapter three section 3.1.3 we claimed that sentences like (54) were ambiguous although the reading which gave wide scope to all was definitely not the preferred one. A re-examination of this judgment in
light of the facts of (34), however, suggests that since this reading is extremely marginal we might do well to accept the prediction of non-ambiguity made by our revised rules.

5.4 The NP quantifiers and adverbial quantification

So far in this chapter we have provided an analysis of plurality and quantification that accounts for most of the similarities and differences among unquantified plural NP's, quantified plural NP's and quantified singular NP's. In fact, all of the sentences in the introductory section of the chapter have been accounted for except those involving the predicate "surround". In this section we shall deal with such predicates and related phenomena.

4.4.1 Consider the following sentence pairs:

(1) a. The men left the room \{simultaneously at one (certain) time\}.
   b. The men left the room \{together in a group\}.

(2) a. All of the men left the room \{simultaneously at one (certain) time\}.
   b. All of the men left the room \{together in a group\}.

(3) a. \{Every man\} left the room \{simultaneously at one (certain) time\}.
   b. \{Every man\} left the room \{together in a group\}.

(4) a. \{Simultaneously at one (certain) time\} the men left the room.
   b. \{Together in a group\}, the men left the room.
(5) a. Simultaneously
    At one (certain) time, all of the men left the room.
    Together

b. In a group, all of the men left the room.

(6) a. Simultaneously
    At one (certain) time, every man left the room.
    Together

b. In a group, every man left the room.

(7) a. Simultaneously
    At one (certain) time, ?? each of the men left the room.
    Together

b. In a group, ?? each of the men left the room.

The pattern of acceptability in (1)-(7) can be accounted for within the
general framework of our analysis if the adverbs together, simultaneously,
etc. are represented semantically as quantifiers. The only other
analysis of such sentences that we know of is (Dougherty, 1971).
Dougherty tries to handle the pattern by assigning features to the
adverbs and the plural or quantified NP's. If the features on the
adverb and the NP in a given sentence are of opposite sign, then the
sentence is ungrammatical. As we pointed out in chapter two, there are
numerous problems with Dougherty's feature analysis. We hope to produce
less problematic results with our quantificational account, but we will
also use feature marking in part of our analysis.

Let us suppose that the sentences of (1) can be represented as
in (8) and (9) below:

(8) Let \( G = \{ \text{the men} \} \)
    \( (\exists y : y \text{ is a time})(\forall x \in G)(x \text{ left the room at } y). \)
(9) \((Ey : \text{group } (y))(Ax \in G)(x \text{ left the room in } y)\).

These readings are, of course, generated for the variants with explicit quantifiers by our analysis in 5.1. What we want to claim here is that the adverbs \textit{simultaneously} and \textit{together} should be represented in the same way as their synonymous quantified variants.

If the sentences of (1) are represented by (8) and (9), then the sentences of (2) should be given both those readings and these below:

(10) Let \(G = \{\text{the men}\}\)  
\((Ax \in G)(Ey : \text{time } (y))(x \text{ left the room at } y)\).

(11) \((Ax \in G)(Ey : \text{group } (y))(x \text{ left the room in } y)\).

Readings (10) and (11), however, only apply to the variants of (2) that contain the overt quantifiers. This ambiguity is also predicted by our previous analysis. The fact that it does not exist for the sentences in which the quantifiers are implicit suggests that the latter should be introduced by the same component that introduces the quantifiers on unquantified plurals so that the scope readjustment component won't apply to them.

Suppose this component were renamed the "implicit quantification component" instead of the "number component" and that rule (12) were added to handle adverbs like \textit{simultaneously} and \textit{together}. 
(12) \[ \langle (Ax \in \chi) \rangle \left( (P(\langle \chi \rangle)) \text{ adverb} \right) \rightarrow (Ey : \chi \text{ adv. Obj. (y)}) \langle (Ax \in \chi) \rangle \langle (P(\langle \chi \rangle)) \text{ adv. prep. y} \rangle \]

Condition - "(Ax \in \chi)" represents a plural overt quantifier word. "Adv. obj." and "adv. prep." refer to the semantic parts of the adverb. We assume that the adverbs can be divided up semantically into a preposition and its object in the same way that "at one time" and "in a group" are in (8)-(11). Of course, to produce readings (8) and (9) for the sentences of (1) rule (5.3.52) must apply after rule (12).

Rule (12) is of the same sort as rule (5.2.48) which was given only in prose in section (5.2.4). If expressed formally it would look like this:

(5.2.48') \[ \langle (Ax \in \chi) \rangle \left( P(\langle \chi \rangle, \text{NP}\{p^1}, \text{sing}\{\text{indef}\}) \right) \rightarrow \]

\[ \left\{ (E(\langle \chi \rangle)) \langle (Ax \in \chi) \rangle, (E(\langle y \rangle)) \right\}(P(\langle x \rangle, \{y\})) \]

"\(\chi^2\)" is the set referred to by "NP\{p^1},\{\text{indef}\}",

"y" is the individual variable for the singular case.

"(Ax \in \chi)" represents a plural overt quantifier word.

The sentences of (3) are grammatical only in the variants containing overt quantifiers in the adverb. Our analysis in chapter four gives these variants the readings of (10)/(11) as their initial semantic representations since those readings reflect the surface order of quantifiers. The scope readjustment rules, however, predict that these variants will be ambiguous since they will take (10)/(11) as input and give (8)/(9) as an output. This prediction seems correct for the variants of (3) containing every. The facts about each will be discussed shortly.
The problem we must now discuss is why the variants of (3) with simultaneously and together are ungrammatical. If we assume that the quantifiers associated with these adverbs behave with respect to each and every like other singular and plural existential quantifiers (i.e., according to the surface structure ordering principle), then the only readings for these variants of (3) are those of (10)/(11). For some reason these readings are not acceptable for the implicitly quantified adverbs though they are for their overtly quantified synonyms.

There does not seem to be any necessary reason for adverbs in general to fall outside the scope of the universal quantifier. In fact, some adverbs, like separately, individually, etc. seem to have to fall inside the scope of the universal quantifier. Sentences like those of (13) have to be represented as (14a) and never as (14b):

(13) a. The men left the room separately.
   b. All of the men left the room separately.
   c. Each of the men left the room separately.

(14) a. Let \( G = \{ \text{the men} \} \)
   \[ (Ax \in G)(Ex_i)(\text{left}_i(x, \text{the room}) \land \neg(Ex')(\text{left}_i(x'))) \] 
   b. \( (Ex)(Ax \in G)(\text{left}_i(x, \text{the room}) \land \neg(Ex')(\text{left}_i(x'))) \).

Note: the variable \( i \) ranges over instances or occurrences of the predicate. It will be discussed further in 4.4.2.
The facts of (3) and (13) suggest that adverbs like *simultaneously*, *separately* etc. should be marked with a semantic feature \([\pm \text{universal}]\) in the manner Dougherty suggests. This feature marking, however, will be interpreted as blocking, through output conditions, certain quantifier scope orders. An adverb marked \([-\text{universal}]\) must have its existential quantifier placed outside the scope of the universal quantifier on an argument NP. An adverb marked \([+\text{universal}]\) cannot have its quantifier in that position. Thus, if we mark *simultaneously*, *together*, etc. as \([-\text{uni}]\), then readings (10) and (11) will be ruled out leaving no interpretation for the variants of (3) containing *simultaneously* and *together*. If we mark *separately* as \([+\text{uni}]\), then reading (14b) will be ruled out for the sentences of (13).

One of the effects of introducing the above feature marking is that it allows us to collapse rules (5.2.48) and (12) into (15):

\[
(15) \quad \langle (\text{Ax} \in \chi) \rangle P \left( \langle x \rangle \right., \left. \begin{cases} \text{NP} & \text{if } \text{sing} \\ \text{Indef} & \text{indef} \\ \text{Adv.} & \text{adv} \end{cases} \right) \rightarrow \\
\quad \quad \begin{cases} \quad a. \quad \langle (E \langle x' \rangle \rangle P \langle x' \rangle \rangle \\
\quad b. \quad \langle (\text{Ax} \in \chi) \rangle (E \langle x' \rangle \rangle P \langle x' \rangle \rangle \end{cases}
\]

This simplification is made possible because the additional readings for (1) and (2) that (15) would wrongly give are blocked by the feature mechanism. An additional advantage of (15) is that it generates an
interpretation for (13a) and (13b). Again (15) produces two scope orders, (14a) and (14b), but the feature mechanism blocks one. If (12) were not restated as (15), then only the (c) sentence of (13) would receive an interpretation. It would be given reading (14a) by the surface structure ordering principle, but since (13a) and (13b) are not subject to that principle, they would receive (by (12)), only reading (14b), the reading blocked by the feature mechanism.

Rule (15) and the feature mechanism will handle not only all the variants of (1)-(3) but (4)-(6) as well. The sentences of (4) and (5) have, of course, the exact same interpretations as the corresponding sentences of (1) and (2). Because principle (15), which determines the scope ordering in these sentences, does not refer to the order of elements in the sentence, there is no way to generate differences of interpretation between (1)/(2) and (4)/(5).

With the sentences of (6), on the other hand, the change of surface position does cause changes of interpretation. In the overtly quantified variants the surface order change means that readings (8)/(9) become the initial interpretations. The readings (10)/(11), which might be derived by the scope readjustment rules, however, are not present because of the conditions on rule (4.2.16b).

In the implicitly quantified variants of (6) the change produced by the altered surface order is striking. The adverbs simultaneously and together, which were incompatible with every in the sentences of (3),
are perfectly acceptable in (6). The reason for this is clear. Since these adverbs are to the left of every on the surface, they appear to its left in semantic representation as well. Thus the initial representations of the implicitly quantified variants of (6) will be the acceptable (8)/(9). Since the scope readjustment rules cannot apply to these variants of (3) or (6), the only way to wind up with the implicit quantifiers to the left of the singular universal quantifier is to have them start out that way do to surface structure position.

The sentences of (7) pose a problem for us. By our analysis they ought to be acceptable and to be entirely equivalent to (6). In fact, however, they all sound very odd. It seems that there must be some restriction placed on the freedom with which an existential quantifier can occur to the left of a quantifier associated with each. This possibility is strengthened by the fact, noted earlier, that the overtly quantified variants of (3) that contain each are not ambiguous even though the scope readjustment rules predict them to be. More evidence is apparent in the fact that (16) below is also unambiguous, contrary to scope readjustment rules.

(16) Each of the reporters hates some members of the White House staff.

If, as in (17), each is replaced by every, the predicted ambiguity reappears:
Every reporter in Washington hates some members of the White House staff.

We do not know exactly how to solve this problem regarding the scope behavior of each. The sentences of (3.1.1) demonstrate that each generally has ambiguous scope with respect to singular existential quantifiers and it appears that only an ad hoc marking of some sort will capture the irregularities of (3), (7) and [. . .]. I. e., however, suggestive of a need for further analysis as was pointed out in chapter three, the wide scope interpretation for each is the preferred one even where the narrow scope reading is possible.

4.4.2 So far we have considered in our analysis of the plural two kinds of predicates, those (like outnumber) which take sets as arguments and those (like be angry, escape) which take individuals as arguments. There is another sort of predicate which we must consider, the sort which includes surround, collide, meet and mix. Such predicates, which we shall call "joint predicates", appear as intermediate between the set-taking and the individual-taking predicates we have already discussed. On the one hand, they occur freely with plural quantifier words as in (18) below, so they are unlike predicates over sets.

(18) a. \{Some\} all the cars in the intersection collided.
   b. \{Some\} of the team captains met in the center of the field.
   c. John mixed \{some\} all the ingredients.
   d. \{Some\} all of the soldiers surrounded the town.
On the other hand, they seem to require plural or at least collective noun phrase subjects and cannot be predicated of single individuals, witness the ungrammaticality of (19):

(19)  
   a. * The car collided on turning the corner.
   b. * The team captain met in the center of the field.
   c. * John mixed the ingredient.
   d. * The soldier surrounded the town.

We will show that consideration of these predicates causes no new problems for our analysis.

The first important fact about joint predicates is that a simple definite plural noun phrase and its universally quantified plural variant often produce synonymous sentences when combined with one. Thus sentences (18a-c) in their variants with all are synonymous with those of (20) below:

(20)  
   a. The cars in the intersection collided.
   b. The team captains met in the center of the field.
   c. John mixed the ingredients.

The synonymy of (18) and (20) is supported by the equal unacceptability of sentences of (21) and (22), sentences containing our test environment for the presence of semantic universal quantification.
(21) a. *Although all the cars in the intersection collided, some of them didn't.

b. *Although all the team captains met in the center of the field, some of them didn't.

c. *Although John mixed all the ingredients, some of them he didn't.

(22) a. *Although the cars in the intersection collided, some of them didn't.

b. *Although the team captains met in the center of the field, some of them didn't.

c. *Although John mixed the ingredients, some of them he didn't.

A second important fact is that these predicates cannot take NP arguments that are governed by singular quantifiers. This is shown by the ungrammaticality of (23):

(23) a. *Each of the cars in the intersection collided.

b. *Each of the team captains met in the center of the field.

c. *John mixed each of the ingredients for the punch (together).

Thus, in order to account for the semantics of joint predicates we must explain why they will accept plural, but not singular quantifiers on their NP's.

The sentences of (18) appear to mean something like (24):

(24) a. \( \text{Some} \) of the cars in the intersection participated in a collision.
b. \{\text{All}\} of the team captains participated in a meeting in the center of the field.

c. \{\text{Some}\} \{\text{All}\} of the ingredients participated in a mixing by John.

d. \{\text{Some}\} \{\text{All}\} of the soldiers participated in a surrounding of the town.

The paraphrases in (24) suggest that we adopt the quantifier over events used in (14) and originally suggested in Davidson (1967) for the interpretation of the joint predicates. Suppose that we represent sentence (18a) as in (25):

\[(25) \text{Let } G = \{\text{the cars in the intersection}\} \]

\[(Ei)(E x \subseteq G)(Ax \in \overline{x})(p(\text{collide } (x, i))) \]

"p(\text{collide } (x, i))" means "x participates in the collision event i"

Except for the introduction of the operator p, the representation (25) can be produced by a rule like (26):

\[(26) (Ex' \subseteq x)(Ax \in x') (V(x)) \quad \begin{cases} (Ei)(Ex' x)(Ax \in x') \quad (V(q, i)) \\ (Ex' x)(Ax \in x')(Ei) \end{cases} \]

Rule (26) can, of course, be incorporated into rule (15) since like the latter it creates an indefinite existential quantifier which it places on either side of a quantifier over a set. If the verb is joint, then only (26a) will produce an acceptable reading.
We must now answer the question of how the predicate p (= participate) is introduced into the semantic representation of joint predicates. We propose that this predicate be considered an optional part of the internal semantic structure of all verbs. It is present in (25) because if it were lacking the semantic representation would be anomalous and so blocked. Without p, representation (25) would entail the impossible situation of a series of individuals each independently having the same collision. The evidence for saying that verbs generally contain the predicate comes from sentences like (27):

(27) John carried the box but he didn't carry it alone.

The first conjunct of (27), if taken by itself, would certainly imply that John carried the box by himself. As a part of (27), however, it seems to mean that John participated in an act/event of box carrying. In other words, when the context favors it, any verb of action can be interpreted as being modified by the predicate p.

One advantage of our analysis is that it explains why sentence (28) below is acceptable but (29) is not;

(28) The soldiers attacked the two towns simultaneously.

(29) * All of the soldiers attacked the two towns simultaneously.

Sentence (29), according to our analysis, receives the representation (30):
(30) Let \( G = \{ \text{the soldiers} \} \) let \( H = \{ \text{the two towns} \) 
\((E_i)(A V = G)(E_t:\text{time } (t))(A x \epsilon V)(A y \epsilon H)(p \text{ attack } (x, y, i, t)).\)

This representation entails that every soldier participate in attacking both cities at once. Since that is physically impossible, the sentence is out. If change the physical character of the subject NP, so that this simultaneous action is no longer physically impossible, then the sentence becomes acceptable. Thus, (31) is perfectly alright:

(31) All of the allied air forces attacked the two towns simultaneously.

The reason why sentence (28) is acceptable is that if the subject NP is interpreted collectively, the sentence receives the reading (32):

(32) Let \( G = \{ \text{the soldiers} \} \); \( H = \{ \text{the two towns} \) 
\((E_i)(E_t)(A x \epsilon H)(\text{attack } (G, x, i, t))\)

Now since a group of soldiers (e.g. an army) can attack in two different places simultaneously, reading (32) is acceptable.

Another advantage of our analysis of joint predicates is that it explains why they are incompatible with the singular universal quantifiers each and every. The reason is simply that rule (12)/(15), into which (26) is incorporated, applies only to plural quantifier words. That restriction was necessary to handle the facts about the adverbs simultaneously, together, etc. and the joint predicate facts force the same restriction. We should note that our parallel analysis of the joint
predicate and adverbial facts predicts that if the singular quantifier occurs to the right of a joint predicate verb (carrier of the quantifier over instances), then they should be compatible. This situation exists in (33):

(33) John mixed together \{both\} spice on the shelf.

The grammaticality of (33) in the variant with every confirms our analysis. The unacceptability of the sentence with each reveals the same sort of difficulty as was caused by the unacceptability of the sentences of (7), in which each appears to the right of the adverbs simultaneously and together. Thus, even the idiosyncratic behavior of each (i.e., its strong tendency to require wide scope with respect to indefinites) points up the parallelism between the adverbial and joint predicate cases and strengthens our quantificational analysis of the letter.

As a final point to our analysis we should not that it explains why the universally quantified variant of (18d) is not necessarily synonymous with the simple definite plural variant (34). The explanation is simply that (20) has a collective reading (35) which lacks the universal quantifier on the subject NP as well as the reading (36), shared with (18d), containing the quantifier. The two readings are given below:

(34) The soldiers surrounded the town.
(35) Let $G =$ the soldiers
    $(Ei)(\text{Surround } (G, \text{ the town, } i))$.

(36) $(Ei)(Ax \in G)(p \ (\text{surround } (x, \text{ the town, } i)))^{19}$

Under reading (35) not all the soldiers in the group need have
participated in the surrounding so long as the group itself did the
act. It is this reading for (34) which allows (37) to be acceptable:

(37) Although the soldiers surrounded the town, not all of
    them participated.
FOOTNOTES TO CHAPTER FIVE

1. The reader will not that the entailments of (3) and (4) differ in an interesting way. The formula (3) does not entail that there are any men in Horseshoe while the formulas of (4) do have that entailment. In fact, (4b) entails that there are at least two men in the town. As far as we can see, these formulae correctly represent the semantics of (1) and (2). The sentences of (1) would appear to be true if there are no men in Horseshoe, Wyo. while the sentences of (2) would appear to be false. A comparison of questions (i) and (ii) below gives further evidence that plural some entails "two or more"

(i) Are there any men in Horseshoe?
(ii) Are there some men in Horseshoe?

The answer to (i) is "yes" if there is at least one man in the town, but the answer to (ii) is "yes" only if there are two or more.

2. There are sentence pairs similar to those of (1)-(3) that are not synonymous. Consider, for example the following pairs.

(i) a. The people of Boston are brave.
    b. All of the people of Boston are brave.

These sentences differ from (1)-(3) because they are generic. Thus, (ia) is more or less synonymous with (ii) below:

(ii) The people of Boston are generally brave.

We would propose that generics like (ia) be interpreted as containing an implicit generic marker in the auxiliary that functions semantically like generally does in (ii). Since (ii) is not synonymous with (ib), the presence of the marker in (ia) will account for the fact that it is not synonymous with (ib) either. (Cf. section 5.1.4 for further discussion).

3. The one problem with the representations (11)-(13) is that they like (5.0.3), do not entail that there are any objects in the set "{NP}". Unlike sentence (5.0.1), however, the sentences of (1)-(3) do entail that their subject NP's have reference. Therefore, (11)-(13) are not adequate to represent (1)-(3). A possible solution to this problem is to say that certain predicates, say the non-generic ones, presuppose that their plural NP arguments have reference. Then this presupposition will make up for the inadequacy of representations like (11)-(13). Without being able to prove that this solution is correct we shall assume that it or something similar is correct in order to be able to represent sentences like (1)-(3) in a way parallel to sentences like (5.0.1).
4. Sentences like (14) and (15) were discussed in detail in Dougherty (1970), (1971). Dougherty tried to handle the semantics and syntax of such sentences by the feature mechanism we discussed and criticized in chapter two.

5. Sentence (37b) is acceptable with contrastive stress on new as below:

(i) All of the boxes contain the new toasters, (not the old ones.)

The variant seems to be acceptable because it means something like (ii):

(ii) All of the boxes contain the new type of toaster (not the old type.)

We cannot explain why contrastive stress should produce this reading for the sentence but the fact that it does is not particularly damaging to our analysis since contrastive stress generally allows interpretations which are otherwise impossible (e.g., direct denial negation).

6. The reader will note that both formula (46) and the sentence that that it represents are consistent with a polygamous marriage between the men and the girls. In other words, it does not require either that every man be paired with a unique girl or that every girl be paired with a unique man.

7. The serially distributive interpretation is analyzed in Fiengo (1972). He calls it the cross-product mapping and gives it essentially the same analysis as we do here. Fiengo points out that ordinary active sentences generally have the serially distributive interpretation as one of the readings. Thus, (i), below, can be represented on one of its readings as (ii):

(i) The men talked to the boys.

(ii) \( ((Ax \in \{\text{the men}\})(Ey \in \{\text{the boys}\})(x \text{ talked to } y) \) and \( (Ay)(Ex)(x \text{ talked to } y) \)

8. The restriction of one quantifier per noun phrase might either by syntactic or semantic. In fact, it must at least have a semantic component, as we can demonstrate from the sentences already introduced. If the restriction were simply syntactic, then the adverbiai quantifier movement rule (53), the interpretive rule which generates reading (51) for sentence (48), would also apply to sentence (49). Since it does not, the simplest hypothesis is that there is a semantic constraint on the number of quantifiers on a single noun phrase.
9. Later on in this chapter we will propose that plural quantifier words must be represented semantically by two quantifiers. Therefore, the restriction that blocks (5a) is actually somewhat more complex than "one quantifier per set". Two quantifiers on a given set are acceptable if and only if they come from a single lexical quantifier.

10. The reader will note that the representations in (5), entail that the plural NP collective is non-empty and of cardinality greater than 1 while those of (4) do not. This difference reflects our intuition that sentences like (i) are true in the null case while those like (ii) are false.

   (i) The men in Horseshoe loved Sally.
   (ii) Men in Horseshoe loved Sally (in the sense of "some men" rather than "men in general")

This difference parallels the difference between the universal and existential quantifiers illustrated in (5.0.1) and (5.0.2) and discussed in the footnote number one. The entailment of existence in (1) is due to the non-generic character of the predicates. (Cf. note 3).

11. As the sentences below show the indefinite plural behaves quite differently in generic contexts than it does in non-generic ones:

   (i) Little boys play baseball.
   (ii) Spring is a time for lovers.

We shall assume in this work that the generic uses of the indefinite represent a different sense of it and shall not attempt to integrate such sentences into our analysis.

12. The plural of (25c) has a generic interpretation but there the quantifier some does not lose its role as an existential quantifier as does the indefinite article in (25a).

13. Sentence (26c) is acceptable with contrastive stress on some but that is clearly a special usage in which some means something like "terrific".

14. Sentence (26d) is acceptable with contrastive stress one but in that case it is being interpreted as the numeral, not as an existential quantifier. For some reason the sentence "Snoopy is one of the dogs" is acceptable.

15. If contrastive stress is put on the auxiliary in (29)/(30) the scope order not-existential becomes possible because contrastive stress signals direct denial negation, which can cancel all the presuppositions of any sentence.
16. The angle brackets are necessary to account for the ambiguity of of (i) below, which has both of the readings in (ii):
   (i) Pencils are contained in each of those boxes.
   (ii) a. Let B = {those boxes}; let P = {all pencils}
        (EP' \subseteq P)(Ax \in B)(Ey \in P')(y is contained in x).
        b. (Ax \in B)(EP' \subseteq P)(P' is contained in x).

   The initial semantic representation for (i) is (iii) below:
   (iii) (EP' \subseteq P)(Ax \in B)(P' \subseteq x).

   If (16b) applies to (iii) we get (iib). Otherwise we get (iia).
   There are no similar brackets on (16a) because the corresponding sentences to (i) with the reversed surface order of NP's is unambiguous. The only reading of (iv) is (iib).

   (iv) Each of those boxes contains pencils.

17. There are many predicates (e.g., surround, encircle, etc.)
   which sometimes take single individuals as subjects and sometimes require the plural. The choice here depends entirely on the physical situation being described. Thus in (i) **surround** can take a single individual as the subject while in the situation of (ii) it can not:
   (i) The ring surrounds the bath tub.
   (ii) The men surrounded the cops.

18. Sentence (19c) is acceptable if **mixed** is taken to mean "stirred" or something similar. This is, of course, not the meaning we are interested in.

19. The careful reader will have noted that representation (36) does not quite capture the truth conditions of (34) or (18d). In particular, (36) does not entail that the act of surrounding was completed by the group of soldiers without need for any outside help. The fact that a group of people participate in an act obviously does not mean that they accomplish it without help. The sentences (34) and (18d), on the other hand, do have this entailment. This problem does not arise with the verbs **collide**, **mix**, and **meet** so we propose that there is a meaning postulate, say (i) below, on the verbs **like** surround:

   (i) The explicitly specified agent of a given action of **Ving** is the exhaustive agent if **V** is a verb of the "surround" category.

   This meaning postulate appears somewhat **ad hoc** but it has been suggested (Lauri Karttunen, personal communication) that it is a general property of "accomplishment" verbs in the sense of Vendler (1967).
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