PLURALITIES

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Preface

In English, definite noun phrases come in two varieties, singular and plural. A phrase of the first type, such as *the diamond*, can be used to refer to a thing, while a phrase of the second type, such as *the coins*, can be used to refer to a set of things. In other words, the grammatical number distinction corresponds (in most cases) to an intuitive distinction between a thing and a set of things. This same intuitive distinction serves as the basis for the mathematical system which we call set theory. As is always the case in mathematics (and in other fields), in the course of generalizing from the basic intuition, unusual, sometimes unintuitive new concepts are included in the system. In the case of set theory, for example, the mathematician reasons that if a set can have three elements and a set can have two elements, then we may as well allow for a set with one element. Such sets are called singletons. The generalization goes even further. If a set can have three or two or one element, then why not a set with zero elements? This one is called the empty set. Anyone who has taught elementary set theory is aware that at this point we have stepped into the valley of the unintuitive. Returning to our initial linguistic observation connecting grammatical number with sethood, we might wonder whether the notion of a singleton set or of an empty set represents a kind or category of thing one refers to using natural language. At least as far as singleton sets go, my guess is that the answer is negative. I cannot think, for example, of a grammatical distinction that could be explained semantically in terms of the set theoretic distinction between John and the set containing just John. Going back again to mathematics, there is another, far more important way in which the set theorist generalizes the initial linguistic intuitions, and this has to do with iteration. Just as there appears to be no sortal restriction on pluralization in English (nouns can be pluralized regardless of the kind of thing they describe), likewise there is no restriction on the kind of things a set may contain. In that case, reasons the mathematician, sets themselves should be among the things sets can contain, so we should allow for sets of sets. Of course, it goes on from there to sets of sets of sets and so on, but we can stop here and again ask whether there is a kind of natural language expression that is used to refer to sets of sets. This last question, much-debated in the literature on plurals, is the central theme of this book.

There are two ways to form a plural noun phrase in English: by conjunction, as in *the diamond and the ruby* or via plural morphology as in *the gems*. The following reasoning would suggest that English does indeed allow for reference to sets of sets. If pluralization corresponds to the presence of a set, then a 'plural of a plural' should correspond to a set of sets. An example of this would be *the diamonds and the rubies*. Another example might be *the peoples* thought of as the plural of *the people* itself the plural of *the person*. This reasoning depends in the former case on how one spells out the semantics of conjunction and in the latter case on what one takes collective nouns to denote. Different choices will lead to different conclusions. In chapter 1, I will elaborate this point, and in subsequent chapters it will be my purpose to argue in favor of a semantics of plurals that does **not** include reference to sets of sets.

My discussion will be set in the framework of formal semantics often referred to as Montague Grammar. Within this framework, one provides rules that are meant to relate expressions of the language to elements outside the language. Such a set of rules, sometimes called a grammar, makes predictions about the truth of a sentence in a given situation, and about entailment relations between sentences. Such a system allows one to tie questions of reference, like the one we will be concerned with here, to claims about truth conditions of sentences and entailment relations, claims we can then test against intuition. To show how all this works with respect to the issue under discussion, I begin the first chapter with a pair of grammars for a small fragment of English. The grammars differ with respect to whether or not they allow for reference to things with the structure of sets of sets. My aim in choosing the particular grammars presented was to make them as simple as possible and as similar as possible and yet still differ in the required way. I found that the best way to do this was to allow the difference to turn on the meaning of the noun-phrase conjunction *and*. The reader should bear in mind that this is done for heuristic purposes. As will become clear in chapter 2, there are other possibilities to be found in the literature. Having presented the grammars, I then illustrate how they work by presenting various issues in the semantics of plurals in terms of these grammars.

In chapter 3, I present a general picture of the kinds of linguistic data that will be used and I talk in a general way about how it will be used. The remainder of the book is then devoted to making the case for the simpler ontology, in which there are just things and sets of things. In the course of the discussion, I develop an approach to distributivity and reciprocity which has a strong pragmatic element. This approach should be interesting in its own right regardless of how the ontological question turns out.

Chapters 1-5 and 8-9 are based on my 1991 University of Massachusetts dissertation entitled *On the Meaning of Definite Plural Noun Phrases*. The material in chapter 4 and in the first part of chapter 6 appeared in a 1992 paper in the journal *Linguistics and Philosophy*.

Readers who are familiar with the issues to be discussed and with the framework might want to skip directly to chapter 4. Before doing so, it is advisable to look at the two grammars beginning page 3, the definitions for the domain of individuals, page 8, and the Appendix.

Acknowledgments

Funds The research and writing that went into producing a book from a dissertation was conducted with the generous support of the Research Committee of the Hebrew University of Jerusalem. The dissertation itself was funded in part by NSF grant # BNS-8719999 and a Graduate School Fellowship at the University of Massachusetts.

People I am indebted to the members of my dissertation committee, Angelika Kratzer, Barbara Partee and Roger Higgins, for their generous contributions to my work, much of which I used for the first time in writing this book. I also wish to thank Fred Landman, Peter Lasersohn, Paul Portner, Karina Wilkinson and Ede Zimmermann for their comments and discussion of this material during my graduate studies and subsequently. Barry Schein read my dissertation and I especially thank him for all the stimulating bytes of email on the subject. Section 5.7 is largely a result of that interaction. Uli Sauerland deserves credit for my having written chapter 6 and for much of the content. Important ingredients in the making of this book were the detailed comments and expressions of support from the editor of this series, Gennaro Chierchia, and anonymous Kluwer reviewers. Finally, thanks to Bruce Hall for help with the index.

Places I was fortunate to begin this book as a student at the Department of Linguistics at UMass, Amherst. Later, I benefitted from the support, material and otherwise, at Bar-Ilan University, Hebrew University of Jerusalem, M.I.T. and Rutgers University. The following cafes deserve mention for inspiration etc.: Bagel Deli, Bonducci's (Northampton, MA); Cafe Tamar, Cafe Olga (Tel-Aviv); 1369 (Cambridge, MA).

Events I profited from the opportunity to present my work and from the discussion of it at the following venues: The Seventh and Eighth Amsterdam Colloquiums, The 1989 Annual Meeting of the Linguistic Society of America, the University of Rochester, UC Santa Cruz, the University of Stuttgart, McGill University and Brown University.

Chapter 1
Two Ways to Interpret Plural Noun Phrases

1.1 Introduction

In this chapter I offer two sets of rules, each a very elementary theory of the truth conditions for sentences containing definite plural noun phrases such as *John and Mary* or *the boys*. The goal here is to try to have as sparse a framework as possible that still allows us to represent competing approaches in this area. A limited overview of these approaches will be given in chapter 2 below. It is not my purpose in this chapter to argue for either theory. But I will analyze some sentences of English to give the reader a rough appreciation of the consequences of each theory and I will give a few examples of the type of data that my predecessors have been concerned with.

In sketching these two theories I will attempt to keep theoretical machinery to a bare minimum. To this end, I limit the vocabulary of the interpreted language, excluding, among other things, determiners other than *the* and I will be treating complex verb phrases and plural common nouns as basic expressions. I will also be ignoring number agreement and number marking on verbs in general. English will be directly interpreted without an intervening translation language. Finally let me caution the reader that these rules were written with a mildly non-standard set theory in mind. In particular, I assume a set theory in which individuals are identified with their singleton sets, for example $j = \{j\}$. W.V.O. Quine proposed a version of set theory having this property and so I will refer to it as "Quine's Innovation." This version of set-theory happens to be well suited for my purposes since in many cases I will want to apply set-theoretic operations such as 'union' to both sets and individuals. Quine's Innovation makes this possible. For example:

(1) $j \cup m = \{j\} \cup \{m\} = \{j, m\}$

I also find this innovation appealing in that it eradicates certain unintuitive distinctions introduced by other versions of set theory such as the difference between { {j}, {{j}} } and j. These distinctions do not appear to play a role in the analysis of natural language. As we progress, the relevance of this innovation will be made clear. Readers who are unfamiliar with this kind of set theory may want to consult the Appendix which is devoted to the source and some of the formal implications of this move.

1.2 Two Theories

Turning now to our two theories, we begin by choosing a common list of categories of basic expressions:

Category	Examples
name:	*John*, *Mary* (singular names)
singular common noun:	*man*, *woman*, *cow*, *pig*
plural common noun:	*men*, *women*, *cows*, *pigs*
verb phrase (VP):	*clapped*, *met in the morning*,
syncategorematic word:	*the*, *and*

Expressions of English will be interpreted with respect to a model M consisting of a function V which assigns semantic values to basic expressions of English as well as three sets D, D^* and a set of two truth values. D is meant to be a set of (singular) individuals such as John or Mary. D induces a larger domain D^* containing not only the elements of D but also sets formed from elements in D. This is all that can be said at present about D^* since the two theories differ on exactly how D and D^* are related.

In a moment I will give for each of the two theories a set of unordered rules for the syntax and the semantics of the fragment of English to be discussed in the remainder of this chapter. The syntactic portions of these rules will define the membership of the derived categories NP and "sentence" for the fragment of English to be discussed. The semantic portions will in effect be a definition of the function $\| \cdot \|^M$ which assigns semantic values with respect to the model M = $< \{1,0\}, D, D^*, V >$ to all expressions of English generated by the syntax. Finally, rules [2], [5], and [7] include constraints on V, the interpretation function of M. These constraints, as well as others to be considered later, have the effect of limiting the class of admissible models with respect to which the language is interpreted.

The following rules give the syntax and the semantics for the sentences to be discussed according to the first theory:

[1] If α is a member of category NP and β is a member of category VP, then $\alpha\ \beta$ is a sentence and $\|\alpha\ \beta\|^M = 1$ iff $\|\alpha\|^M \in \|\beta\|^M$.
[2] If α is a basic VP then $\|\alpha\|^M = V(\alpha)$ and $V(\alpha) \subseteq D^*$.
[3] If α and β are VPs, then α *and* β is a VP and $\|\alpha \text{ and } \beta\|^M = \|\alpha\|^M \cap \|\beta\|^M$.
[4] If α and β are NPs, then α *and* β is an NP and $\|\alpha \text{ and } \beta\|^M = \{\|\alpha\|^M, \|\beta\|^M\}$.
[5] If α is a name then α is an NP, $\|\alpha\|^M = V(\alpha)$ and $V(\alpha) \in D$.
[6] If α is a plural common noun or a singular common noun then *the* α is an NP and $\|\text{the } \alpha\|^M$ is the greatest element of $\|\alpha\|^M$. If $\|\alpha\|^M$ doesn't have a greatest element then *the* α fails to denote. [Note: For any sets m,S such that m $\in$ S, m is the greatest element of S if every element of S is a subset of m.]
[7] If α is a singular common noun, then $\|\alpha\|^M = V(\alpha)$ and $V(\alpha) \subseteq D$.
[8] If α is a singular common noun and β is the plural of α, then $\|\beta\|^M$ is the set of all non-empty subsets of $\|\alpha\|^M$.

The following rules give the syntax and the semantics for the sentences to be discussed according to the second theory. Except for the rule for noun phrase conjunction (rule [4']), these rules and constraints are exactly the same as in the first set.

[1] If α is a member of category NP and β is a member of category VP, then $\alpha\ \beta$ is a sentence and $\|\alpha\ \beta\|^M = 1$ iff $\|\alpha\|^M \in \|\beta\|^M$.
[2] If α is a basic VP then $\|\alpha\|^M = V(\alpha)$ and $V(\alpha) \subseteq D^*$.
[3] If α and β are VPs, then α *and* β is a VP and $\|\alpha \text{ and } \beta\|^M = \|\alpha\|^M \cap \|\beta\|^M$.
[4'] If α and β are NPs, then α *and* β is an NP and $\|\alpha \text{ and } \beta\|^M = \|\alpha\|^M \cup \|\beta\|^M$.
[5] If α is a name then α is an NP, $\|\alpha\|^M = V(\alpha)$ and $V(\alpha) \in D$.
[6] If α is a plural common noun or a singular common noun then *the* α is an NP and $\|\text{the } \alpha\|^M$ is the greatest element of $\|\alpha\|^M$. If $\|\alpha\|^M$ doesn't have a greatest element then *the* α fails to denote. [Note: For any sets m,S such that m $\in$ S, m is the greatest element of S if every element of S is a subset of m.]
[7] If α is a singular common noun, then $\|\alpha\|^M = V(\alpha)$ and $V(\alpha) \subseteq D$.
[8] If α is a singular common noun and β is the plural of α, then

$\| ß \|^M$ is the set of all non-empty subsets of $\| \alpha \|^M$.

Armed with either of the above sets of rules, the entailment relation is defined as follows: if G is a set of sentences generated by these rules and s is a sentence generated by the rules then, G **entails** s if and only if s is true in every admissible model M in which all the sentences of G are true. Throughout the remainder of our discussion, I will write simply $\| \cdot \|$ instead of $\| \cdot \|^M$ omitting the superscripted M. In general, object language expressions appear italicized except when enclosed by '$\| \cdot \|$', for example: $\|$ John $\|$ is the denotation of *John*.

We turn now to examples whose interpretation is the same on the two theories, beginning with the example in (2):

(2) The boys clapped.

The common noun *boy*, by rule [7], denotes a set of individuals in D. By rule [8], *boys* denotes the set of all non-empty sets of boys. By rule [6], *the boys* denotes the greatest element in this set of sets which is just the set of all the boys in D. According to rule [1], if this set of boys is in the extension of *clapped* then sentence (2) is true. Note, by rule [2], *clapped* is a subset of D^*. This means that, on both theories, D^* will have to include sets of the individuals in D. So we impose the following constraint on the model, $M = < \{1,0\}, D, D^*, V >$:

(3) Any non-empty subset of D is a member of D^*.

(3) will also require D^* to contain singleton sets but that amount of overkill is probably harmless.

This analysis of plural definite noun phrases is roughly the set-theoretic counterpart of the analysis given in Link (1983, see also Landman 1989a). The appeal to maximality in the interpretation of the definite article (i.e. "greatest element" in [6]) derives as well from Sharvy (1980). He argues that what is common to the meaning of the definite article in plural, singular and mass noun phrases is this notion of maximality. The analysis of *boys* as denoting a set of sets is partially motivated by its predicative use. Intuitively, the predicate *are boys* should apply truthfully to a term denoting any set of boys (e.g. *the older boys are boys*). Bearing rule [1] in mind, this would suggest that in the extension of *are boys* we find every set of boys.[1] Interpreting *boys* as a set of sets allows then for a simpler analysis of the copula (*are*), which might be desirable. This interpretation of plural common nouns in turn allows for a unified analysis of the (plural and singular) definite article as given in rule [6]. In order to see how this works we need to consider an example in which *the* combines with a singular common noun as in (4):

(4) The girl clapped.

The common noun *girl*, by rule [7], denotes a set of individuals in D. By rule [6], *the girl* denotes the greatest element in this set, if there is one. There are three possibilities. If there are no girls in D then *girl* will denote the empty set and so *the girl* will fail to denote. If there is one girl in D, then $\|$ girl $\|$ will contain that girl. Given my assumption of Quine's Innovation (e.g $j=\{j\}$, see page 1) $\|$ girl $\|$ contains a singleton set in this case. Since every element in $\|$ girl $\|$ is a subset of that singleton, *the girl* denotes that singleton set, or equivalently, *the girl* refers to the single girl in D. If there is more than one girl in D, then $\|$ girl $\|$ will contain many individuals, hence many singletons. Since the subset relation does not hold between various distinct elements of $\|$ girl $\|$, *the girl* fails to denote. So

[1] The reader may be bothered by the inclusion of singleton sets of boys in the extension of *boys*. We can argue for their inclusion as follows. Consider the sentence:

(i) No individuals are boys.

Construing the English word *individual* broadly, the noun phrase *no individuals* could plausibly be assumed to combine with any and only predicates whose extension is empty to yield a sentence which is true. If there are no boys in our domain of discourse, D, then (i) is true. If however there is just one boy in D then, intuitively, (i) is false. Now assume for the moment that *are boys* denotes the set of all sets of two or more boys. It follows that *are boys* has the same denotation if D has just one boy as it does if D is devoid of boys. For in the case where D has no boys, *are boys* will denote the empty set, since if there are no boys then any set of sets of boys is empty. In the case where D has just one boy, there are no sets of two or more boys and hence $\|$ are boys $\|$ is again empty. If we allow singletons in the denotations of plural predicates then $\|$ are boys $\|$ will have different denotations in the two cases. On this argument see van Eijck (1983:105), Hoeksema (1983:66-67) and Lasersohn (1988:203-4).

if *the girl* denotes, it denotes the one girl in D and according to rule [1], if she is in the extension of *clapped* then (4) is true. So if (4) is true, *clapped* will have individuals in its extension. Now, recall rule [2] repeated here:

[2] If α is a member of category VP then $\| \alpha \| \subseteq D^*$.

This requires that *clapped* be a subset of D^*. This means that, on both theories, D^* will have to include individuals. This has in fact already been provided for in our constraint on the model, $M = <\{1,0\}, D, D^*, V>$ repeated in (5):

(5) Any non-empty subset of D is a member of D^*.

D^* contains the singleton set of each element of D. Given Quine's Innovation, these singletons are themselves elements of D. Hence, D is a subset of D^*.

Now we come to the analysis of term conjunction. Here is where the two theories differ. According to the first theory, term conjunction is interpreted according to rule [4] as set formation.

[4] If α and ß are NPs, then α *and ß* is an NP and $\| \alpha \text{ and } ß \| = \{ \| \alpha \| , \| ß \| \}$.

Henceforth I will refer to this theory as the "sets theory." According to the second theory, term conjunction is interpreted according to rule [4'] as union.

[4'] If α and ß are NPs, then α *and ß* is an NP and $\| \alpha \text{ and } ß \| = \| \alpha \| \cup \| ß \|$.

Henceforth, this theory is referred to as the "union theory."

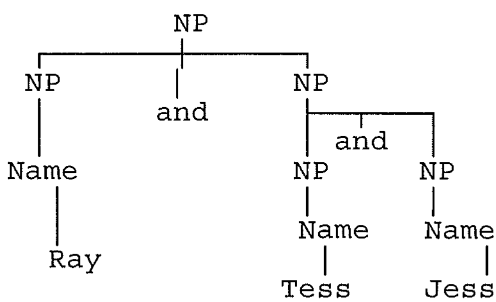
Let us consider first (6), a type of example involving NP conjunction where the two theories assign the same interpretation.

(6) Ray and Tess wrote poems.

On the sets theory, $\|$ Ray and Tess $\|$ is the set containing Ray and Tess or equivalently the set containing the singleton containing Ray and the singleton containing Tess. On the union theory, $\|$ Ray and Tess $\|$ is the union of Ray and Tess, which is just the set containing Ray and Tess, given Quine's Innovation (cf. (1) above). So the two theories assign the same interpretation to the subject of (6) hence they do not differ on the truth conditions for the whole sentence. Next, we consider a slightly more complicated example:

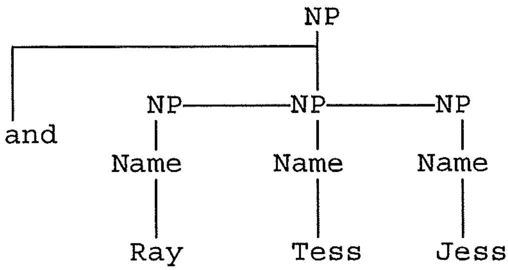
(7) Ray and the boys wrote poems.

Let's assume that D contains more than two boys and that Ray is not a boy. According to both theories, || the boys || is the set of all the boys. On the sets theory || Ray and the boys || is a set containing two elements: Ray (an individual, which is equivalent to a singleton of an individual) and || the boys || (which is a non-singleton set given our assumption that D contains two or more boys). On the union theory, || Ray and the boys || is the union of Ray and || the boys || which is a set of individuals containing Ray and the boys and nothing else. So the two theories assign different interpretations to the subject of (7) and hence assign (7) different truth conditions (assuming D contains two or more boys). Next consider the NP *the boys and the girls*. On the sets theory, this NP, if it denotes anything, will be interpreted as a set containing two sets, one of boys, the other of girls. On the union theory, this NP denotes the union of two sets, a boy-set and a girl-set, which is just a set containing boys and girls. Again the two theories differ. Finally, we take up the case of an NP with multiple conjunction, for example: *Ray and Tess and Jess*. The following is a possible structure for this NP given rule [4] or [4']:



On the union theory, this NP will denote the set containing Ray, Tess and Jess. On the sets theory, this NP will denote a set with two members: Ray and the set containing Tess and Jess. Here again the theories diverge. Of course, if we modified our syntax (and semantics) to allow for a flatter underlying structure, as in (8):

(8)



the interpretations might not differ.[2]

Summarizing then, the sentences that get interpreted differently by the two theories all contain a conjoined noun phrase one of whose conjuncts is itself plural (formed by conjunction or common noun pluralization). Note further, that the range of interpretations assigned by the union theory includes individuals and sets of individuals and nothing more complicated than that. In the sets theory, on the other hand, semantic complexity mimics syntactic complexity. For example, the subject of (7),

(7) Ray and the boys wrote poems.

has more syntactic structure than the subject of (2),

(2) The boys clapped.

and the interpretation of the former is of a higher type than the interpretation of the latter, on the sets theory. These observations lead to the definitions of D^* in (9) and (10), both of which conform to the constraint given in (5) above, repeated here:

(5) Any non-empty subset of D is a member of D^*.

(9) Union theory: D^* is the set of all non-empty subsets of D.

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[2] This seems to be what von Stechow (1980:95) has in mind. He has a syntactic rule, $S12^n$ according to which, if $a_1,\ldots, a_n$ are singular names, then a_1 and... and a_n is a plural name. The corresponding semantic rule is F_{S12n} where:

$$F_{S12n}(\delta_1,\ldots,\delta_n) = \{\delta_1,\ldots,\delta_n\}.$$

(10) Sets theory[3]:

$$D_0 = D$$
$$D_{n+1} = D_n \cup POW_{\geq 2}(D_n)$$
$$D^* = \bigcup_{n < \omega} D_n$$

To ease exposition, I would like to introduce terms to refer to the elements of these domains. I will call elements of D^* that are not in D, pluralities. And I will call elements of D singularities. So John is a singularity, while *John and Mary* refers to a plurality. Clearly the sets theory requires many more pluralities in the domain of discourse than does the union theory. One of the central questions to be addressed in subsequent discussion will be whether or not these extra entities are indeed required for the analysis of the (English) plural.

1.3 Some Data

Now that we have seen how these theories work, I would like to give some idea of what they can do and of the type of issues addressed by formulators of theories of this ilk.

A hallmark of Bennett (1974)'s approach was his semantic classification of predicates into those that select for "individual-level" and those that select for "group-level" arguments. These labels correspond roughly to our singularity-plurality distinction. As we have seen, a predicate such as *clapped* applies to both plural and singular noun phrases. However there is a class of predicates that do not generally apply to singular noun phrases. Compare (11) and (12):

(11) The boys met in the morning / scattered / split up.
(12) #The girl met in the morning / scattered / split up.

Data of this sort might be handled by constraining $\| \cdot \|$, the interpretation function, in such a way that these predicates are always interpreted as a set of entities in D^* - D, the domain of pluralities.

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[3] $POW_{\geq 2}(X)$ is the set of all the non-empty non-singleton subsets of X. This inductive definition is taken from Hoeksema (1983:81), where it is credited to Johan van Benthem.

A host of sub-issues arise out of concern for these predicates. The first has to do with collective nouns such as *group* or *committee*. Syntactically singular forms of these nouns can appear with the class of predicates under consideration, for example:

(13) The group met in the morning / scattered / split up.

According to Bennett such noun phrases denote pluralities (even in the singular), so for him the data in (13) is expected. I will argue in chapter 9 that in fact collective nouns denote singularities or entities in D. This in conjunction with (13) requires a revision of our analysis of the data in (11-12).

Another question that arises here is whether or not there are predicates that are defined only for singularities. The predicate *be one person* would appear to be as plausible a candidate as any, though B. Partee suggested the following counterexample, which she judged felicitous:

(14) Groenendijk and Stokhof are one person.

In Schwarzschild (1994), I discuss this question of singularity-only predicates in more detail and I argue that there are such things but that the evidence for them is rather more subtle than assumed here.

A final and important point regarding the type of predicates occurring in (11-12) is this. The property of requiring a plural subject is really a sub-case of a more general property of "plurality seeking" which some lexical items have. A plurality seeker is a lexical item that requires a plural NP somewhere in its syntactic domain. *together* is a prime example of a plurality seeker that is not a verb:

(15) The boys sat together.
(16) #The girl sat together.

Other examples include *unanimously*, *respective* and floated *each*.

An interesting context that is also restricted in this way, is the *of*-complement of group nouns:

(17) #The set of John.
(18) #The set of an individual / a group.
(19) #The set of each man vs. The set of all men vs. The description of each man.
(20) #A group of two women was preceded by *a group of a man*.
(21) #A list of a name was given to the CIA.

(22) A list with one name on it was given to the CIA.
(23) A set containing only John

These data do not appear amenable to an explanation in terms of syntactic agreement. In English, nouns do not generally agree in number with their *of*-complements. Furthermore a syntactic account would stumble on the following contrast:

(24) Two lists of CIA agents.
(25) Two descriptions of CIA agents.

CIA agents can be understood as a dependent plural in (25) (one agent per description) but not in (24).

The next issue addressed by investigators of the plural involves a phenomenon I will refer to as "cumulativity." This is the phenomenon whereby a predicate that applies truthfully to each of a series of elements in the domain will be true as well of the plurality formed from those elements.[4] This phenomenon is exhibited in the inference from (26) to

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[4]Landman (1989:590) uses the term "cumulative reference" here. "Cumulative reference," he says, "is the phenomenon that properties of entities are inherited on their sums, as in:

(45) If David is a pop star and Tina is a pop star then David and Tina are pop stars."

As far as I can tell this term originates with Quine (1960:91). "Mass terms," according to Quine, "have the semantical property of referring cumulatively: any sum of parts which are water is water." It seems like Quine might have something slightly different in mind here. It is not clear that anything in (45) refers cumulatively. For this reason, I chose the term "cumulativity." Also it rhymes with its counterpart "distributivity."

This should not be confused with the related notion of "cumulative quantification" discussed in Scha (1984:§7). This involves special readings of sentences containing a predicate taking two or more quantificational arguments. Scha's example is:

(i) 600 Dutch firms have 5000 computers.

He claims that this sentence "has a reading which can be paraphrased as:

(27) and (28), where we assume that Ray and Tess are the authors:

(26) Ray awoke early. Tess awoke early.
(27) Ray and Tess awoke early.
(28) The authors awoke early.

Similarly, cumulativity is at work in the inference from (29) to (30):

(29) The authors awoke early. The workers awoke early.
(30) The authors and the workers awoke early.

This phenomenon might also be handled by placing a restriction on $\|\cdot\|$, the interpretation function. In this case it will matter which of our two theories is adopted. In a union theory, the restriction is simply that predicate denotations must be closed under union. In a sets theory, we would apparently need to allow only sets closed under set formation as possible predicate denotations. These restrictions include the assumption that cumulativity is a property of all predicates. However, there is some doubt as to whether this can be maintained, given our broad construal of the term "predicate" (i.e. to include anything that is a VP). It seems that at least some predicates that contain plurality seekers are not cumulative. For example, (32) does not follow from (31):

(31) The students in Mr. T's shop class are all of the same sex. The students in Miss Murphy's home economics class are all of the same sex.
(32) The students in Mr. T's shop class and the students in Miss Murphy's home economics class are all of the same sex.

The inference from (33) to (34) is dubious as well:

(33) The authors ate lunch together. The workers ate lunch together.

(ii) The number of Dutch firms which have **an** American computer is 600 and the number of American computers possessed by **a** Dutch firm is 5000.

[This cumulative quantificational reading] cannot be expressed in a formula containing quantifiers with a one-to-one correspondence to the noun phrases in the sentence."

(34) The authors and the workers ate lunch together.

In chapter 6, we return to this question, after having introduced an analysis of reciprocals.

The final issue I want to mention here is distributivity, which is somewhat the reverse of cumulativity. Distributivity is the phenomenon whereby we deduce that some predicate is true of each member of a plurality given that that predicate or something very much like it applies to the plurality itself. The least controversial examples of this phenomenon involve what some have called a distributivity operator, such as *each*. One such example is (35), from which one is entitled to deduce (36):

(35) Jess, Tess and Bess each made a mess.
(36) Jess made a mess. Tess made a mess. Bess made a mess.

As Dowty and Brodie (1984) showed, cases like these can be handled by giving a semantics for a distributive VP-operator. To this end, we might add the following rule to both of our theories:

[9] If α is a VP then *each*-α is a VP and
$\forall S\, [\, S \in D^{*} \rightarrow (S \in \; \| \text{each } \alpha \| \leftrightarrow$
$S \subseteq D$ and $|\, S \,| \; \geq 2$ and $\forall x\, [x \in S \rightarrow x \in \; \| \alpha \| \;])$.[5]

Certain predicates, such as *sleep* or *walk*, are described as inherently distributive. This is because they often support a distributivity inference like the one from (37) to (38) even when no distributivity operator is present.

(37) Ray and Tess were sleeping.
(38) Ray was sleeping. Tess was sleeping.

Such cases are handled through the use of a meaning postulate for the predicate in question (cf. Bartsch 1973, Scha 1984, Hoeksema 1983) and/or by invoking an implicit distributivity operator having a semantics like that of *each*.

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[5]This rule is simplified somewhat. The statements "$S \subseteq D$ and $|\, S \,|$ ≥ 2" should probably have the status of presuppositions. I would want the sentence *John each left* to come out undefined rather than false. Likewise for *the boys each each left*, which comes out false on the rule as given, as pointed out to me by Angelika Kratzer (pc).

Another type of predicate-specific distributivity inference, discussed by Leonard and Goodman (1940), is exemplified in (39) and (40).

(39) Popeye and Brutus and Wimpy were shipmates.
(40) Popeye and Wimpy were shipmates. Popeye and Brutus were shipmates. Brutus and Wimpy were shipmates.

In this case, the predicate distributes to sub-pluralities rather than to singularities as was the case with *sleep*. Such examples are not amenable to an analysis in terms of an invisible *each* which, at least according to [9], distributes to singularities. Note the strangeness of (41):

(41) #The men were each shipmates.

This completes my preview of topics relevant to the theories laid out in the beginning of this chapter. Let me note that this preview is meant merely to illustrate some of the concerns of the authors of theories of this kind. It is not exhaustive. Before I go on to mention these authors themselves, I would like to consider one final example which will serve to summarize the discussion so far.

I take it that the inference represented in (42) is valid:

(42) a. Ray awoke early.
b. Tess awoke early.
c. Ray and Tess met in the ballroom.

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d. Ray and Tess awoke early and met in the ballroom.

We can account for this inference as follows. By a. and b., Ray is in the set $\|$ awoke early $\|$ and so is Tess. Given a cumulativity restriction on $\| \cdot \|$, $\|$ awoke early $\|$ must contain $\|$ Ray and Tess $\|$ as well. Now, $\|$ met in the ballroom $\|$ will not contain either Ray or Tess because of the type of predicate it is. However, it will, given c., contain $\|$ Ray and Tess $\|$. This means that $\|$ Ray and Tess $\|$ is in the denotations of both predicates and therefore is in the (set) intersection of these two denotations. By rule [3] above, $\|$ awoke early and met in the ballroom $\|$ is just this intersection, hence d. is true.

This particular inference is important for the following reason. Many have analyzed the plural subject of a predicate such as *awoke early* differently than if that same NP was the subject of a predicate such as *met in the morning*. This is done because *awoke early* is perceived to licence a distributivity inference whereas *met in the morning* doesn't. And rather than capture this difference in the semantics of the predicate as discussed above, it is captured in the semantics of the subject. For example, the subject of (43a) would be given a meaning like that of (43b) which guarantees that it will entail (43c) and the subject of (44a) is assigned the meaning of (44b) guaranteeing that it will entail (44c) (cf. Bennett 1974:193,229).

(43) a. Ray and Tess awoke early.
b. λP [P(Ray') $\wedge$ P(Tess')]
c. Ray awoke early. Tess awoke early.
(44) a. The authors awoke early.
b. λP [$\forall x$ [author'(x) $\rightarrow$ P(x)]]
c. Every one of the authors awoke early.

It has however been pointed out (cf. Massey 1976:103) that this strategy will not in general be feasible, precisely because of examples like (42d). If (43b) was the meaning of the subject of (42d) then it would follow that:

(45) # Ray awoke early and met in the morning. # Tess awoke early and met in the morning.

which cannot be. So (43b) cannot be the meaning for the subject of (42d). Nonetheless, if *awoke early* is distributive in (43a) then it is in (42d) as well. The conclusion then is that distributivity is a property of predicates and not of (referential) NPs.[6] There are other factors that enter in here, such

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[6]This argument would probably not go through if, instead of (42d), we used (42'd):

(42'd) Ray and Tess awoke early and they met in the ballroom.

Ray and Tess could get interpreted as in (43) and *they* would not be bound by this NP. Compare:

(i) Every applicant awoke early and they met in the ballroom.

Furthermore, even (42d) might fail to justify the argument made here for analyzing distributivity as a property of predicates and not noun phrases if (42d) was analyzed as having a covert pronoun where (42'd) has an overt one. But if one does seek to undermine the argument made here by positing an underlying pronoun in (42d), he would have to explain the as the presence of predicates that are ambiguous with respect to the distributive/non-distributive distinction and the distributive/non-distributive distinction for non-subject NPs. Chapter 5 is devoted to the topic of distributivity and these issues will be discussed there.

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contrast between (i) and (ii):

(ii) # Every applicant awoke early and met in the ballroom.

Why can't a covert pronoun in (ii) do what the overt one does in (i)?

Chapter 2
Precursors

2.1 Introduction

Thus far I have presented an approach to the semantics of plurals in the form of two rather similar grammars for a fragment of English. And I have given a few examples of the kinds of things one can say within this approach. Although the grammars we have are not borrowed wholesale from any previous work, they are meant to capture two prominent positions taken in other papers. Of course, these other papers were concerned with various issues, not only the ontological question. The purpose of this chapter is to profile a few of those earlier papers to give the reader a taste of the context in which the ontological question has been raised. Link's (1983) paper was chosen in part because it has become a standard reference for the union approach. Hoeksema's paper was chosen in part because it covers the question of how to embed the semantic theories of chapter 1 in a generalized quantifier framework. The last paper reviewed here is Landman (1989a). One of the decisions I made in an effort to create a coherent and focussed story was to introduce two opposing views and to pin the difference between them on the meaning of the conjunction *and*. Landman's paper is a useful 'antidote' in this regard because he sketches an analysis that is in some sense intermediate between the sets and the union approaches and because some of the important properties of the sets approach are achieved there without a sets meaning for *and*. After reviewing that paper we will consider whether we're missing anything by telling the story begun in chapter 1.

2.2 Link (1983)

For now, we turn to Link (1983) the goal of which is to produce a logic with a model theoretic interpretation that can handle both plural and mass terms. Link is interested in capturing with a single formalism properties that are shared by both kinds of terms. An example of such a property is what Link calls cumulative reference and what we have called, at least when the property is manifested in the plural domain, cumulativity. Both plural and mass nouns form cumulative predicates, as this example from Link's paper is meant to show:

(46) a. If **a** is water and **b** is water then the sum of **a** and **b** is water.
b. If the animals in this camp are horses, and the animals in that camp are horses, then the animals in the two camps are horses.

A mass term (noun phrase) is not interpreted as denoting a set of entities because "inherent in the notion of a set is atomicity which is not present in the linguistic behavior of mass terms" (Link 1983:305). Therefore, in order to preserve the "structural analogy between the two cases," Link rejects the use of sets to map plural terms. Instead he employs lattice theoretical notions in his semantics to establish the related mass, singular and plural domains. Nonetheless, the point has been made that at least the plurals portion can be redone in terms of sets (see Lasersohn 1988:131, Landman 1989a:568-571) without doing violence to the mass-plural connection. Our union theory is essentially a set theoretic version of Link's (1983) interpretations of plural noun phrases.

2.3 Hoeksema (1983)

The paper by Hoeksema, entitled *Plurality and Conjunction*, covers a host of topics, two of which, a semantic theory of number concord and a semantics for conjunction, are reviewed here. We dwell at some length on Hoeksema's work because it addresses the issue of how to embed the theories we outlined above in a framework in which all or some noun phrases are interpreted as generalized quantifiers. Since our theories will remain in their current form in subsequent discussion, it is important to show that they are a part of and not an alternative to a more complete account of the semantics of noun phrases (for more recent discussion of plurals in a generalized quantifier setting, see van der Does 1992,1993).

Hoeksema's paper begins with a specification of the domain of discourse, which is that of our sets theory. Working in a generalized quantifier framework in which all noun phrases denote functions from subsets of the domain of discourse into the set of truth values, Hoeksema analyzes the infelicities in (47) and (48) as follows:

(47) #John are walking.
(48) #The boys is walking.

John denotes a function from subsets of D (the domain of singularities) into truth values. In any model in which the predicate *are walking* denotes a non-empty set, it fails to denote a subset of D. The function $\|$ John $\|$ is then undefined for this argument, hence the infelicity in (47). Similarly for (48), $\|$ the boys $\|$ is undefined for its argument, the set of singularities denoted by *is walking*. The idea of having a semantic theory of number concord is certainly attractive, though difficult problems arise once a broader range of data is considered. Lasersohn (1988:Ch.4) considers a number of these problems and proposes a more elaborate theory taking Hoeksema's theory as a point of departure. We will return later in this section to this part of Hoeksema's work after presenting his analysis of NP conjunction.

The two theories proposed in chapter 1 differ solely by the interpretation they give for NP conjunction. Because of the importance we have placed on NP conjunction, Hoeksema's analysis will be covered in some detail here. The discussion here, based in part on revisions found in Hoeksema (1987a), will begin with a description of the semantic rules, followed by some examples to show how they work and then a discussion of the type of data Hoeksema is trying to account for.

Hoeksema's semantics is done in a PTQ type framework in which expressions of English are translated into a lambda calculus. I will presuppose familiarity with that framework. Relevant and important aspects of this system will be revealed as we go along. I will be using the symbol "$==>$" to relate (subscripted) expressions of English to formulas of the translation language. "A $==>$ B" is shorthand for "B is the translation of A or is logically equivalent to the translation of A."

Hoeksema proposes two translations for the NP conjunction *and*. I present them in (49) and (50) below with subscripts **i** or **c** on the English word *and* indicating which translation rule applies to it. This subscripting is not part of the formal system but it has expository value. The term "intersective conjunction" refers to the conjunction *and* under its intersective reading; similarly for "collective conjunction." "π" and "Φ" are generalized quantifier variables.

(49) Intersective conjunction.
$\text{and}_i \; ==> \; \lambda\pi\, \lambda\Phi\, \lambda P\, [\, \Phi(P) \wedge \pi(P)]$

(50) Collective conjunction. (cf. Hoeksema 1987a:35)
a. **Grp** is a two place function.
$\| \mathbf{Grp}\,[a,b] \| \; = \{\; \| a \|,\; \| b \| \;\}$.
b. $\text{and}_c \; ==> \; \lambda\pi\, \lambda\Phi\, \lambda P\, [\, \Phi(\, \lambda x.\pi(\lambda y.\, P(\mathbf{Grp}[x,y])))]$

The interpretation for intersective conjunction given in (49) is the standard

PTQ-style NP conjunction. Applying a predicate to an intersective conjunction of NPs is equivalent to applying the predicate to each of the NP-conjuncts and conjoining the result, for example:

(51) Every man and_i every woman solved the crossword puzzle.
$\Leftrightarrow$
Every man solved the crossword puzzle and every woman solved the crossword puzzle.

The interpretation for collective conjunction given in (50) is the counterpart of our sets-theory interpretation for *and* in a generalized quantifier system. Hoeksema arrived at (50) by taking the sets theory *and* which is, in effect, of syntactic type $<e,<e,e>>$ and producing an expression of type $<T < T, T> >$, where $T = <<e,t>,t>$, the type of generalized quantifiers. He used the rules of type change for the version of the Lambek calculus found in van Benthem (1986).

To see the connection between the two interpretations consider what we get for *the teacher* $\textit{and}_c$ *the students*. Even though Hoeksema doesn't actually give a meaning for definite plurals, I think it is fair to assume the following type $<<e,t>, t>$ versions of the interpretations presented at the beginning of this chapter:

the students $==>$ $\lambda R.R(S)$ (S is the set of students)
the teacher $==>$ $\lambda Q.Q(t)$ (t denotes the teacher).

Now plugging the translation of *the students* in for π in the subformula $\lambda x.\pi(\lambda y.\ P(\mathbf{Grp}[x,y])$ from (50), we get:

$\lambda x.\ \lambda R.R(S)\ (\lambda y.\ P(\mathbf{Grp}[x,y]) =$
$\lambda x.\ P(\mathbf{Grp}[S,x])$

So $\textit{and}_c$ *the students* translates as:
$\lambda\Phi\ \lambda P\ [\ \Phi(\lambda x.\ P(\mathbf{Grp}[S,x])]$
and

(52) *the teacher* $\textit{and}_c$ *the students* $==>$
$\lambda P[\ \lambda Q\ .Q(t)\ (\lambda x.\ P(\mathbf{Grp}[S,x])]$
$= \lambda P[\ P(\mathbf{Grp}[S,t])]$

Now by (50a), the interpretation of Grp[S,t] is just the set that contains the teacher and the set of all the students. So Grp[S,t] is exactly the interpretation of *the teacher and the students* on our original sets theory.

What (52) says is that the collective conjunction of *the teacher* and *the students* is interpreted as the generalized quantifier whose generator is just the interpretation of the conjunction of these two NPs on our sets theory. This correspondence holds for all collective conjunctions of definite NPs. One might describe Hoeksema's system as a type-shifted version of the sets theory.

It is important to notice that it is not the generalized quantifier framework itself that forces Hoeksema into a sets theory. Assuming Quine's Innovation, the definition in (50) could be modified slightly to arrive at a generalized quantifier version of the union theory as follows:

(53) Collective conjunction for a union theorist.
a. **Grp** is a two place function.
$\| \mathbf{Grp}\ [a,b] \| = \| a \| \cup \| b \|$
b. $\text{and}_c \Longrightarrow \lambda\pi\ \lambda\Phi\ \lambda P\ [\ \Phi(\lambda x.\pi(\lambda y.\ P(\mathbf{Grp}[x,y])))]$
(π,Φ are generalized quantifier variables)

Hoeksema's theory is of course not limited to definite noun phrases, the way ours are. To give a more accurate picture of what he is up to, I will give translations for some other kinds of noun phrases, beginning with the conjunction of indefinites translated in (54):

(54) *a cow and$_c$ a pig* ==>
$\lambda P\ \exists x\ \exists y\ [\text{cow}'(x) \wedge \text{pig}'(y) \wedge P(\mathbf{Grp}[x,y])\ ]$

(a cow and$_c$ a pig) and$_c$ a horse ==>
$\lambda P \exists x \exists y \exists z[\text{cow}'(x) \wedge \text{pig}'(y) \wedge \text{horse}'(z) \wedge P(\mathbf{Grp}[z, \mathbf{Grp}[x,y]]]$

Assuming Hoeksema's interpretation for **Grp**, (54) tells us that *(a cow and$_c$ a pig) and$_c$ a horse* will denote the set of properties that hold of some two-membered set containing a horse and a set of a pig and a cow. This is the generalized quantifier that would correspond to the sets theory interpretation for *(the cow and the pig) and the horse* assuming there was only one of each of these in D. If we departed from Hoeksema in taking **Grp**[x,y] to denote the union of x and y, the denotation of *(a cow and$_c$ a pig) and$_c$ a horse* would be the set of all properties P such that P holds of a plurality consisting of a cow, a pig and a horse.

An advantage of the formulation of collective conjunction given here from Hoeksema (1987a) over the one in Hoeksema (1983) is that it works for universal noun phrases as well. According to the present formulation *every soldier and$_c$ every officer met* will be true if and only if for every pair of an officer and a soldier, the soldier met the officer (and vice-versa).

Unfortunately, there are cases in which, despite Hoeksema's (1987a:35, 38fn3) claims to the contrary, the rule in (50) makes incorrect predictions. In particular, it seems to give incorrect results for downward entailing quantifiers such as *no*, *few* and *not every*.

(55) No soldier and$_c$ no officer met ==>
$$\neg\exists x\, [\text{soldier'}(x) \wedge \neg\exists y\, [\text{officer'}(y) \wedge \text{met'}(\mathbf{Grp}[x,y])]]$$
$$= \forall x\, \neg[\text{soldier'}(x) \wedge \neg\exists y\, [\text{officer'}(y) \wedge \text{met'}(\mathbf{Grp}[x,y])]]$$
$$= \forall x\, [\neg\, \text{soldier'}(x) \vee \exists y\, [\text{officer'}(y) \wedge \text{met'}(\mathbf{Grp}[x,y])]]$$
$$= \forall x\, [\text{soldier'}(x) \rightarrow \exists y\, [\text{officer'}(y) \wedge \text{met'}(\mathbf{Grp}[x,y])]]$$

If every soldier met some officer then the translation in (55) is true even though in such a situation it is false that no soldier and no officer met. The meaning of the English sentence in (55), on the other hand, seems to be the negation of the meaning that would be assigned to (56) using (50):

(56) Some soldier and$_c$ some officer met.

A stop-gap solution to this problem may be available if we allow different translations for the collective conjunction depending on the entailingness of the conjuncts. In fact there is precedent for this in von Stechow (1980) where different rules are used to interpret a (collective) NP conjunction depending on the semantic character of the conjuncts. Furthermore, it cannot be a coincidence that Barwise (1979) and others give different branching quantifier interpretations for conjoined NPs depending on the entailingness of the conjuncts. This problem will be left unsolved as we move on to the data that Hoeksema sought to explain by introducing two interpretations for conjunction.

Hoeksema observed that, depending on the type of NPs that are conjoined, sometimes a conjunction of singular NPs must combine with a plural verb phrase and other times a conjunction of singular NPs may combine with a singular verb phrase. This is illustrated in (57) and (58):

(57) a. A man and a woman {were/*was} arrested.
b. The man and the woman {were/*was} arrested.
c. Ray and Tess {were/*was} arrested.

(58) a. Every day and every night was spent in bed.
b. No peasant and no pauper was ever President.

Names and definite and existential NPs are in the first class requiring a plural predicate while apparently all other NPs are in the second class.

Hoeksema further noted that you can usually replace a conjunction of NPs with one of the conjuncts without changing the truth-value, if the NPs are in the second class. He contrasts (59) in which a. entails b. with (60) in which a. does not entail b.

(59) a. Every man and every woman has/have solved the crossword puzzle.
b. Every man has solved the crossword puzzle. Every woman has solved the crossword puzzle.

(60) a. Tim and Grace have/*has solved the crossword puzzle.
b. Tim has solved the crossword puzzle. Grace has solved the crossword puzzle.

These observations are correlated with the two interpretations for conjunction as follows. Recall, according to Hoeksema singular NPs correspond to functions from subsets of D, the domain of singularities, into truth values. Given the definition in (49), an intersective conjunction of two such NPs will again be a function from subsets of D. So two singular NPs conjoined intersectively will combine with a singular verb phrase. On the other hand, a collective conjunction of two singular NPs denotes a function from sets containing pluralities into truth values and hence must combine with a plural verb phrase. With this account in mind and narrowing our gaze for a moment to just the data in (57-60), we accept the following stipulation:

(61) Singular names, definite NPs and indefinite (existential) NPs conjoin collectively, all other NPs conjoin intersectively.

The verb phrases in (57) are plural because the conjunction is collective, while those in (58) are singular because the conjunction is intersective. Furthermore the presence of an intersective conjunction in (59a) explains the entailment to (59b), while a collective conjunction in (60a) would correctly fail to licence the entailment to (60b).

I find this account of the data in (57-60) appealing. At the very least, one can view it as an interesting argument for an ambiguity in the meaning of *and*. Nonetheless, difficult questions remain. Before accepting this account one would want to know two things, first, where does the stipulation in (61) come from? Secondly, to what extent is the data in (57)-(60) representative?

Before turning to an explanation of (61), I want to mention one way in which the data is unrepresentative. If a conjunction of NPs takes singular agreement, it usually does so optionally:

(62) Every boy and every girl was/were happy.

Regarding such examples Hoeksema (1987a:38fn2)'s "position is that most facts about number agreement can only be explained (as opposed to described) semantically, but that there remains some arbitrariness which must be ascribed to syntactic encoding." How broadly this caveat can be construed surely depends on having a concrete theory of this "syntactic encoding" and on having a full account of the exceptions to the semantic theory. More exceptions will come to light once I have given an account of (61).

While there is a semantic characterization of the class of collectively conjoining NPs in the 1983 paper, there is no explanation there for why these NPs should conjoin collectively. In Hoeksema (1987a) an attempt is made at explaining the stipulation via an appeal to the non-quantificational view of indefinites. Hoeksema drops the assumption that all NPs are of type <e,<e,t> > and assumes instead that names and definite NPs are e-type and that indefinites introduce an e-type variable. Let us call these e-NPs. All other NPs remain of type T = <e,<e,t> > and we'll call them T-NPs. Collective conjunction is then defined as in our sets theory and is therefore of type <e <e,e> >. Intersective conjunction remains of type <T <T,T> >. The stipulation in (61) is now reformulated in (63):

(63) e-NPs conjoin with a collective <e,<e,e> > conjunction.
T-NPs conjoin with an intersective <T,<T,T> > conjunction.

At the very best (63) is a default rule since exceptions arise in all directions. To begin with e-NPs can conjoin with T-NPs, (e.g. *John and every other student*) yet there is no <e,<T,T> > or <e,<T,e> > conjunction. Furthermore, we have seen cases of T-NPs conjoined collectively:

(64) Every soldier and$_{c}$ every officer met.

Finally, languages have special mechanisms to signify the intersective conjunction of NPs, including e-NPs. An English example is the *both...and...* conjunction:

(65) Both Bill and Sue left (*together).

As Ross (1967:92) points out, the French equivalent involves the repetition of the conjunction (*et Bill et Sue*). Hoeksema (1983:82fn8) mentions examples of this kind in Dutch as well.

Hoeksema handles all these cases with a type-shifting mechanism to raise the types of NPs and of the collective conjunction (to achieve the rule given in (50)) and then (63) is reduced to a rule requiring the use of minimal types. Thus while *Ray* and *Tess* could be raised to type T and conjoined intersectively, this is not done in (57c). This kind of account might also help us understand why conjoined numerical NPs like *two men* do not seem to conjoin as T-type expressions with the collective interpretation. Thus, as Angelika Kratzer has observed to me, there doesn't seem to be a reading of (66),

(66) Two men and two women met.

in which one of the NPs has scope over the other, as contrasted with the closely related (67):

(67) Two men met two women.

An explanation for this discrepancy[7] might go as follows. Numerical NP expressions have e-type (or <e,t> type) group interpretations in which the number is adjectival and they have T-type interpretations in which the number is a quantifier (cf. Partee 1987). The missing reading would require opting for the higher type for the NP as well as the type-shifted form of the collective interpretation for conjunction. This reading can be blocked if we disallow 'gratuitous' type shifting (cf. Partee & Rooth 1983). This explanation requires extending the demand for minimal types to the interpretation of conjunction as well as to the interpretation of NPs.

Summarizing, Hoeksema presents us with an ambiguity account of NP conjunction. One meaning is the familiar PTQ-style intersective NP conjunction. The other, collective, meaning is essentially the one on which we have based our sets theory. A <T,<T,T>> version of this conjunction allowed for a more general account than the one we proposed, however, even this account was not fully general as it gave incorrect results for the conjunction of NPs denoting downward entailing quantifiers.

Positing an ambiguity in the meaning of NP conjunction enabled Hoeksema to propose a partial semantic explanation of number concord by

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[7]In Kratzer's opinion the difficulty that arises here is of a kind with that of example (55), *No soldier and no officer met.* In both cases, Hoeksema's theory involves a scope relation between noun phrase conjuncts when there shouldn't be one.

assigning different conjunction interpretations to different NP types. It explains why only some conjunctions licence the entailment pattern in (68):

(68) A and B VP.

A VP and B VP.

Finally, the presence of these two interpretations is useful in explaining the difference between the a. and b. examples below ((70) is Modern Hebrew):

(69) a. Ray and Tess solved the puzzle.
b. Both Ray and Tess solved the puzzle.

(70) a. Ray vI-Tess patru 'et haxida
Ray and Tess solved ACC the puzzle.
b. Gam Ray vI-gam Tess patru 'et haxida
also Ray and also Tess solved ACC the puzzle.

In the context of this discussion, the rules presented in chapter 1 can be thought of as the syntax and semantics of **collective** conjunctions of definite NPs.

2.4 Landman (1989)

Up to now I have mentioned the analysis of plurals found in Link (1983) on which our union theory is based and Hoeksema (1983,7a), a precursor of our sets theory. I want now to introduce the work of Landman (1989a) who takes what appears to be an intermediate position, not quite captured by either the union or the sets theory.

A leading idea in Landman's article is that cumulativity and distributivity are two sides of the same coin and the formal theory should reflect this. In addition, Landman seeks to elaborate the idea introduced in Link (1984) that distributivity and cumulativity are concepts relating not only singularities to pluralities, but also pluralities to higher order pluralities. Thus if a predicate is true of each member of a set of singularities, it is true, by cumulativity, of the plurality corresponding to the set. Likewise, if a predicate is true of each member of a set of pluralities, it is true, by cumulativity, to the plurality corresponding to that set. Instances of cumulativity of this second, "higher," kind defy analysis in our union theory because that theory never assigns higher than first order pluralities as the meaning of definite NPs. More will be said about this in the next chapter.

Landman's work is based in large measure on Link's. So we first reconstruct a piece of Link's account of distributivity in terms of the union theory we set up in chapter 1. The analysis will be only briefly introduced here, but it will come under more careful scrutiny in chapter 4. According to this account, inherently distributive predicates such as *be a pop star* denote subsets of D; they are true, in the singular, only of singularities. Plural versions of these predicates are translated with the "star-operator." *P denotes the closure under union of $\| P \|$. So from $^*P(J+M)$ where $\| J+M \| = \{j,b\}$ we can conclude P(J) and P(B) (where $\| J \| = j$, $\| B \| = b$) and from P(J) and P(B) we can conclude $^*P(J+M)$. This reasoning corresponds to the deduction from *John and Bill are pop stars* to *John is a pop star* and *Bill is a pop star* and vice versa. In his 1984 paper, Link extends this picture to account for 'higher order' distributivity (and reciprocity). He achieves this by allowing plural noun phrases to be ambiguous, between a set-denoting interpretation and a (singular) entity denoting interpretation. The set denoted by a plural is called a sum and the non-set entity is called a group. This immediately raises the prospect of iteration: a set of groups is again a sum and the corresponding group is itself a group of groups.

Landman argued that such iteration was called for and he designed a system with higher orders of distributivity and cumulativity. His modus operandi is to model both singular individuals and groups of individuals as singleton sets. The one element in the singleton corresponding to an singular individual is that individual. To prevent confusion, I will call this singleton an "individual singleton," departing slightly from Landman's terminology. The one element in the singleton corresponding to a group is a set containing the members of that group. In order to handle distributivity, Landman's theory includes sums, which are distinct from groups and which are not singletons. A set of individuals is a sum. It is a sum (= union) of the individual singletons. The singleton containing that sum is the corresponding group. If a set $\| P \|$ contains only singletons, groups or individual singletons, then its closure under union, $\| {}^*P \|$, will contain sums of the individual singletons or groups in $\| P \|$. By taking the extension of every "basic" predicate (I assume "basic" means without a "*") to include only singletons, an inference of the following sort is rendered valid:

(71) Let α denote a non-singleton set. Let S_1, S_2, $\cdots$ S_n be a series of terms such that:

a. For each i, $1 \leq i \leq n$, $\| S_i \|$ is a singleton.

b. $\| S_1 \| \cup \| S_2 \| \ldots \cup \| S_n \| = \| \alpha \|$

then:

$$^*P(\alpha) \Leftrightarrow P(S_1) \wedge P(S_2) \ldots \wedge P(S_n)$$

This inference can be used to map both distributivity and cumulativity of P, regardless of whether an arbitrary S_i denotes an individual singleton or a group (singleton containing a set of elements of D.). For example, the distributive reading of *John and Mary died*, is captured by letting *John and Mary* denote a sum, letting *John and Mary* substitute for α in the above scheme with *John* substituting for S_1 and *Mary* substituting S_2.

At this point, I give a sketch of Landman's grammar as an extension of our union theory. In particular, *and* is interpreted as union on this theory. Since for Landman noun phrases are ambiguous, we first translate the part of English we are interested in into a disambiguated language which we will call Γ-English. The relation between the two languages is as follows:

[A] A noun phrase of English is a noun phrase of Γ-English.
[B] A verb phrase of English is a basic verb phrase of Γ-English.
[C] If α is a noun phrase of Γ-English, then $\Gamma(\alpha)$ is a noun phrase of Γ-English.[8]
[D] If ß is a verb phrase of English then *(ß) is a verb phrase of Γ-English.

The semantics of Γ-English is just the semantics of our **union** theory along with the following rules:

[9] $\| \Gamma(\alpha) \| = \{ \| \alpha \| \}$.[9]

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[8]'Γ' stands for group. '$\Gamma(\alpha)$' corresponds to Landman's '$\uparrow(\alpha)$' and to Link's '$<\alpha>$'.

[9] Our adoption of Quine's innovation would, I believe, improve on Landman's theory here. For in this theory, *John* denotes not only {j} but also, given the rules in [C] and [9], {{j}}, {{{j}}} etc. This will have consequences if we attempt to explain the following pair:

i. #John met.
ii. The men met.

in terms of the type or order of the subject (cf. Landman 1989:593, "collective predicates like *meet* take groups [singleton sets of sets] but not singular individuals in their extension"). Given Quine's innovation, j={j}={{j}}={{{j}}}..., and so i.-ii. can be explained by saying that *meet* has no elements of D in its extension.

[10] $\| {}^*(ß) \| =$ The closure under union of $\| ß \|$.
[11] If ß is a basic verb phrase then:
$\forall x\, [x \in \| ß \| \rightarrow x$ is a singleton set$]$

A computation of some of the interpretations of the noun phrase *the cows and the pigs* should give a sense of how this theory works. We use the symbol "==>" to mean, "translates into Γ-English as." We will not distinguish singular individuals from their singleton sets here, adopting Quine's Innovation (see Appendix).

The Γ-English expression *the cows* denotes the set of all the cows. Let's assume that there are only three cows and three pigs, then we can represent the cows as {a,b,c}. ‖ the pigs ‖ will be represented as {m,n,p}.

(72) the cows and the pigs ==> the cows and the pigs
‖ the cows and the pigs ‖ $= \{a,b,c\} \cup \{m,n,p\}$
$= \{a,b,c,m,n,p\}$.
(73) the cows and the pigs ==> Γ(the cows) and the pigs
‖ Γ(the cows) and the pigs ‖ $= \{\{a,b,c\}\} \cup \{m,n,p\}$
$= \{\{a,b,c\},m,n,p\}$
(74) the cows and the pigs ==>
Γ(the cows) and Γ(the pigs)
‖ Γ(the cows) and Γ(the pigs) ‖ $= \{\{a,b,c\}\} \cup \{\{m,n,p\}\}$
$= \{\{m,n,p\}, \{a,b,c\}\}$

The interpretation in (72) is just the interpretation that the union theory gives for this noun phrase. The one in (74) is the interpretation the sets theory would give. The one in (73) cannot be gotten on either theory, hence if it can be shown that we need that interpretation then we must choose this theory over the other two. Furthermore, a theory which assigns the meanings of (72) and (74) by simply positing an ambiguous *and* with a sets and a union interpretation (cf. Lønning 1987:109) will still not assign the interpretation in (73).

Here is an example in which all of these interpretations come into play:

(75) The cows and the pigs carried a piano upstairs.

Landman (1989a:594) would claim that this sentence has a number of readings and he would use different interpretations for the subject to capture these readings. (72) would be used for the reading in which each animal carried a piano. Although Landman doesn't actually discuss such an example, (73) would presumably be used for a reading according to which each pig carried a piano and the group of the cows carried a piano. (74) would be used for the reading in which there were two carryings, one by the cows and one by the pigs. In each of these cases the verb phrase would be translated: **(carried a piano upstairs)* since in each case there is distributivity of one sort or another. Let us look a little closer at the case in which the subject of (75) is translated as in (74) and the star is employed in the translation of the verb phrase. In this case we have an instance of the schema given in (71); Γ*(the cows) and* Γ*(the pigs)* substitutes for α. This expression indeed denotes a non-singleton or what Landman would call a sum. Given [11], the basic, unstarred, predicate *carried a piano upstairs* could not include this sum in its extension. But the starred, **(carried a piano upstairs)* could, given [10]. In fact, it could if and only if the singletons {{a,b,c}} and {{m,n,p}} were in ‖ carried a piano upstairs ‖ . Hence on this reading, (75) entails that the cows carried a piano upstairs and the pigs carried a piano upstairs.

There is yet another collective reading in which there is one carrying by all the animals at once and for that reading the noun phrase would be translated: Γ*((the cows) and (the pigs))* and the verb phrase would have a basic translation, without the "*". Notice that the denotation of Γ*((the cows) and (the pigs))* is a singleton and rightly so since basic, starless, predicates have only singletons in their extensions.

As pointed out above, the number of readings that Landman's theory allows for seems not to be captured on either of the theories set out in chapter 1. One might therefore wonder if we shouldn't instead compare his theory to the union theory in our discussion. There are two reasons why I did not do this. The first has to do with the nature of the arguments to be presented. Thinking just in terms of the domains on the two theories, the union theory is the poorest, a subset of the other two, while Landman's is the richest. The arguments to be presented here will be arguments against the richness of the sets theory ontology. These arguments remain intact for the even richer ontology of the mixed theory. In that case, we may as well stick with the simpler comparison, as set out in chapter 1. The second reason for doing this has to do with an aspect of Landman's theory not yet mentioned. Recall, in chapter 1, it was observed that a distributively read verb phrase could be conjoined with a non-distributively read verb phrase. Since in the theory just sketched, the presence of a distributive reading is determined in part by the interpretation of the noun phrase (which 'decides' what is distributed over: animals, groups of animals etc.), these examples require an amendment to the theory. To this end, in Landman (1989a:2.4), a family of type-shifting operations are introduced. For example, there is an operation, $\downarrow 2$ which 'converts' an expression with the meaning in (74) to one with the meaning in (72).

Using this operation, we can lift a predicate P which applies to a set of individuals into $\lambda x P(\downarrow 2(x))$ yielding the equivalence below:

(76) let α denote {{a,b,c},{m,n,p}} and let ß denote {a,b,c,m,n,p}, then: $[\lambda x P(\downarrow 2(x))](\alpha) = P(ß)$.

If the meaning in (72), here expressed by ß, were not available as a noun phrase meaning, nothing would be lost, since the same readings would crop up through type-shifting using the meaning in (74), here called α. Similarly, there is a type-shift, which can convert α into Γ*((the cows) and (the pigs))*, so the latter appears dispensable as well. It appears then, that once these type-shifts are taken into consideration, Landman's theory would not make different predictions were it built upon the sets theory. Now, the one case that is not so clear is (73). In principle, one can introduce a new function which like Landman's type-shifting operations would apply to arguments to give values of a different type and which in particular would apply to {{m,n,p}, {a,b,c}}, the meaning in (74), to give you {{a,b,c},m,n,p}, the meaning in (73). One might guess that this is not a proper type-shift, like the ones Landman proposes. However, it seems that such a function would be needed to account for a case of conjunction where one VP has a reading requiring the (74) meaning and one requiring the (73) meaning. Once the full range of type-shifts are spelled out, it seems to me that the overall theory would not be changed by removing those parts of the semantics of noun phrases that make this theory different from the sets theory. On this perspective, Landman (1989a) is the sets theory along with a specific proposal on how to handle distributivity. So we remain at this point with our two basic theories and in chapter 5 the question of how they each handle distributivity will be raised.

This completes our review of the kind of work that forms the background to the two theories outlined in chapter 1. The purpose of these two theories is to capture in as simple a format as possible an important consideration that runs through much recent work on plurals despite differences in terminology, formal framework and particular linguistic concerns. In the forthcoming pages, a choice will be made between the union and the sets theory. It is hoped that the choice and the justification for it will have relevance for the work for which our two theories go proxy.

Chapter 3
Preview of the Arguments: Data and Methodology

3.1 Data

In chapter 1, we evaluated the following sentences:

(77) Ray and Tess wrote poems.
(78) Ray and the boys wrote poems.
(79) Ray and Tess and Jess wrote poems.

and concluded that our two theories part ways when it comes to the interpretation of a conjoined noun phrase one of whose conjuncts is itself plural (formed by conjunction or common noun pluralization), as in (78) and (79). As a result of the fact that set formation is a non-associative operation[10], on the sets approach syntactic complexity is mapped into semantic complexity, while such is not the case on the union approach and this difference starts to have effects when a conjunct is plural. The sets approach requires many more types (in the logical sense) of entities in the domain of discourse than does the union approach. This difference is recorded in the relationship between D and D^* on the two approaches:

(80) Union theory: D^* is the set of all non-empty subsets of D.

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[10] O is an associative operation iff for any a,b,c in the domain of O: (a O b) O c = a O (b O c). By set-formation we mean the operation * such that $a{*}b = \{a,b\}$. $(a{*}b){*}c \neq a{*}(b{*}c)$.

(81) Sets theory[11]:

$$D_0 = D$$
$$D_{n+1} = D_n \cup POW_{\geq 2}(D_n)$$
$$D^* = \bigcup_{n < \omega} D_n$$

If it can be shown that the "extra" entities of the sets approach are required of a model that interprets plural expressions, then the sets theory is to be preferred over the union theory. The purpose of chapters 4-9 is to examine various arguments supporting the need for the sets domain. This chapter is meant as a preview of the different kinds of arguments to be discussed.

Assuming a sets model and a union model that agree on the domain of singularities, it is possible to find a pair of noun phrases that have identical denotations on a union interpretation but different denotations under a sets interpretation. For example, if D, the domain of singularities, contains exactly one boy and exactly three girls, then the noun phrases *the boy and the girls* and the noun phrase *the children* will (assuming they are felicitous) have the same denotation for the union theory but not for the sets theory (cf. chapter 1, page 7). One line of attack on the union theory has been to identify predicates that are sensitive to these differences. I will argue that predicates of the required type are not in fact found in English. In chapter 4, I will give a general account of the obstacles to any argument in favor of the sets theory which capitalizes on differences in denotation between plural noun phrases that emerge on that theory but not on the union theory.

In chapter 5, I will take up a specific subcase of the type of argument discussed in chapter 4. This subcase involves examples of sentences which, on their distributive readings, argue for the sets theory. For example, consider a context in which the following statements are true:

(82) Every woman is either an author or an athlete and all authors and athletes are women.

(83) a. The authors are outnumbered by the men.
b. The athletes are outnumbered by the men.
c. But, the women, altogether, outnumber the men.

---

[11] $POW_{\geq 2}(X)$ is the set of all the non-empty non-singleton subsets of X. This inductive definition is taken from Hoeksema (1983:81), where it is credited to Johan van Benthem.

There are those who would say that in such a context (84) below is ambiguous, having one true reading. That true reading would be described as one in which there is distributivity on the subject argument. It is captured in the unambiguous (85).

(84) The authors and the athletes are outnumbered by the men.
(85) The authors are outnumbered by the men and the athletes are outnumbered by the men.

Now, on the union theory alone, given (82), the subject noun phrase of (84) has the same denotation as the subject noun phrase of (86):

(86) The women are outnumbered by the men.

hence presumably (84) and (86) should have the same truth value in this context. However, given (83c), (86) is false. This is a specific example of the type of anti-union argument identified above. A predicate is isolated which distinguishes noun phrases that are co-referent on the union theory. One of the reasons for treating it separately is that distributivity holds a unique place in the literature on plurals. Moreover, the anti-union arguments of chapter 4 rely on finding **specific** predicates of English that are sensitive to semantic differences that emerge only on the sets theory. In contrast to this, all predicates can have distributive readings.

In chapter 5, I will take issue with specific assumptions underlying analyses of distributivity. I will argue that even without the results of chapter 4 it is not clear that distributivity offers any hope for distinguishing our two theories. In particular note that the argument outlined with the help of examples (82)-(86) crucially relies on having a truly ambiguous VP in (84). By this I mean, that the VP in (84) is said to have two distinct denotations. It is the "distributive denotation" of that VP which is being used here to argue against the union theory. I will argue against some of the assumptions underlying this analysis, in particular its failure to recognize the context-dependent aspects of distributivity. The anti-union argument outlined here will not survive the analysis of distributivity that I will propose.

As Lønning (1989) has argued, probably the most convincing arguments for the sets theory have been made using predicates with reciprocals such as *infuriate each other*. So in the first part of chapter 6, I discuss reciprocals focussing on what they have to tell us about the union-sets debate. In the second half of the chapter, I give an analysis of reciprocals drawing on the context dependent analysis of distributivity from chapter 5 and the work of Heim, Lasnik and May (1991a,b) and Sauerland

(1994).

Chapter 7 is devoted to remarks concerning floated quantifiers. Floated quantifiers have been used as a starting point in the development of theories of distributivity including the one in chapter 5. In chapter 7, we return to compare the resulting theory of distributivity with the behavior of floated quantifiers. Another issue briefly discussed is the relation between floated quantifiers and their non-floated counterparts. In the second part of the chapter, attention is turned to the floated quantifier *both*, said to involve a notion of duality. A speaker who uses the expression *both camels* presupposes that there are two and only two camels under discussion. Peter Lasersohn has used this duality presupposition of *both* to probe the semantics of plural noun phrases using the example in (87):

(87) both Awbery and Jones and Thomas.

He concludes that the sets theory is correct on the basis of this evidence. In chapter 7, I respond to his argument claiming that in examples like (87), *both* is part of a complex conjunction and in fact has no semantic duality requirement.

At the heart of chapter 8 is a potential argument in favor of the sets theory based on the richness of the domain of discourse, D^*, on that theory as compared with D^* for the union theory, again assuming the two start off with the same domain of singularities, D. Recall from (81) above, the elements of D^* in the sets theory come in an infinite variety of (logical) types. If this theory is correct, you might expect the richness of the domain of discourse to be exploited by the language. One place predicates of English, denoting subsets of D^*, might very well be organized type-theoretically. Particular predicates might be defined only for pluralities of a certain order. Imagine that you had a verb like that, say V_2 of type 2. If that were the case then the truth or well-formedness of sentences of the form NP V_2 would depend in part on the syntactic complexity of the subject NP. For example, *the children* V_2 could but *the boys and the girls* V_2 couldn't be true. Such verbs would constitute strong evidence in favor of the sets theory. On the other hand, if it turns out that there are no such verbs, then all else being equal we should opt for the simpler union theory.

Chapter 9 is devoted to the semantics of collective nouns. Collective nouns are characterized in Jespersen (§4.8) as follows:

> A **collective noun** is defined in the NED [New English Dictionary by Murray, Bradley, Craigie. Oxf. 1884] as 'a substantive which (in the singular) denotes a collection or number of individuals.' We

> may accept this definition (though it does not always agree with practice followed in that dictionary), and give as examples *a library* = 'collection of books', *a train* (railway-carriages), *a forest* (trees), *a nation* (men and women), *an army* (soldiers). All of these may be used with such words as *one* (*one library*) or *that*; and we may use them in the plural: *libraries*, *trains*, etc.
>
> According as the idea of plurality is more or less prominent in the mind of the speaker, there is in all languages and at all times a tendency to forget the fact that collectives are grammatically singular, and we often find plural constructions, partial or total. ... It should, however, be noticed that it is only with collectives denoting living beings that the plural construction is found: words like *library* or *train* never take the verb in the plural.

This view of collective nouns suggests that rule [7] from chapter 1:

[7] If α is a singular common noun, then $\| \alpha \|^{M} = V(\alpha)$ and $V(\alpha) \subseteq D$.

is not fully general. Rather, it appears that collective nouns, at least the animate ones, denote subsets of D^*. In more recent times collective nouns have been treated this way in formal accounts of the semantics of English[12]. These accounts give formal expression to the synonymy of pairs such as the following:

(88) a. The committee voted.
b. The members of the committee voted.

(89) a. The members of the group gathered in the park.
b. The group gathered in the park.

To see why this is relevant to the choice of the sets or the union theory we need to consider examples in which a collective noun forms part of a (syntactically) plural noun phrase, for recall, the two theories part ways once pluralization is iterated. If one maintains that in the extension of *committee* there are (non-singleton) sets, pluralities, then given a domain in which the noun phrase *the committees* is felicitous, it will denote (assuming rules [6] and [8] of chapter 1) the set of all committees, each of which is a set, hence a set of sets. This is troublesome for the union theorist because

[12]In the formal semantics tradition, this practice goes back at least to R. Montague (cf. Bartsch 1973:79).

his domain of discourse has to be enlarged to accommodate these entities. He must now adopt a domain more like that we've come to associate with the sets theory. Moreover, having accepted this analysis for collective nouns, the attack on the union theory can be mounted even with respect to the interpretation of conjunction as follows. A context is chosen in which there are exactly two committees, A and B, and then the referents of the subjects of the following pair are identified:

(90) The committees voted.
(91) The members of committee A and the members of committee B voted.

This identification forces us into a denotation for the subject of (91) that is predicted by the union theory to be impossible (assuming *member of committee A* denotes a subset of D).

This constitutes a serious blow to the union theory, if the position outlined so far is tenable. However, we should not be too quick to identify the denotation of a noun phrase such as *the committee* with the denotation of *the members of the committee*, since there are predicates that distinguish them. As an illustration consider that if a normally seven-membered committee loses five of its members and the remaining members are both seven feet tall then:

(92) The committee is small.

but:

(93) The members of the committee are not small.

Furthermore, while we can say:

(94) The members of the committee are tall.

we cannot, as Bennett (1974:223) pointed out, say:

(95) *The committee is tall.

In fact then, pairs of noun phrases such as *the committee / the members of the committee* or *the team / the players* seem not to be extensionally equivalent. In chapter 9, we will consider the conflicting data of (88)-(91) and (92)-(95). Further, we will follow the lead of Jespersen and Dougherty (1970) in devising plausible tests for semantic plurality in an attempt to decide when and whether collective noun phrases denote pluralities.

3.2 Methodology

I would like now to end with a somewhat lengthy methodological note. Much of the argumentation in this book turns on a comparison of pairs of noun phrases in contexts in which they are assigned the same denotation in one theory and different denotations in the other. For example *the boy and the girls* and *the children*, if felicitous, are co-referent according to the union theory, but not according to the sets theory. Let us say that two or more noun phrases **share** a predicate if applying the predicate to both of them yields the same truth value. Generally, arguments for or against coreference of noun phrases turn on predicate sharing. For example, the sets theorist might argue for the non-coreference of the noun phrases *the boy and the girls* and *the children* by isolating predicates that are not shared by the two. This method of argumentation is fairly straightforward so long as we stick to the two extremes: either the noun phrases share all predicates of the language or they don't share any. Consider first two noun phrases that share all (appropriate) predicates of the language. In this case, coreference is plausible even if not inevitable. A diehard multiplier of entities could still maintain that the two noun phrases denote distinct entities differing with respect to properties that are not expressible in the language.[13] Nonetheless, in this case one normally chooses the more intuitive option of inferring coreference from the sharing of all predicates of the language. Assigning the two noun phrases the same denotation, that is treating them as coreferent, is in a sense a way of capturing in our semantics the fact that all predicates are shared by the noun phrases in question. At the other extreme we have noun phrases that do not share any predicates. In this case, it is hard to see any basis for assuming coreference. In sum then, the sharing of all predicates is associated with coreference while the sharing of no predicates is associated

[13]This connection between predicate sharing and coreference is similar to Leibniz's principle of the Identity of Indiscernibles, though it differs in its reference to language. We connect predicate sharing and noun phrase coreference whereas Leibniz's principle is about property sharing and identity of objects. An earlier example of a linguistic interpretation of Leibniz's principle is found in Wilson (1953) who writes "The principle of the identity of indiscernibles may be taken to mean that if two objects O_1 and O_2 are numerically different then they are qualitatively different, they differ in some mentionable respect."

with non-coreference. Expressing approximately this idea, Link (1983:304) writes:

> Our guide in ontological matters has to be language itself, it seems to me. So if we have, for instance, two expressions **a** and **b** that refer to entities occupying the same place at the same time but have different sets of predicates applying to them, then the entities referred to are simply not the same.

Unfortunately, neither of the extremes examined so far is representative. Rarely, if ever, do two noun phrases share **all** predicates. The unintuitive conclusion drawn in (96) based on Link's dictum illustrates this:

(96) a = 'George and Mike'
b = 'Mike and George'
P = 'are running with Dan and Lloyd respectively.'
P(a) $\wedge$ not P(b).
----
a and b do not refer to the same entity.

This means that "total predicate sharing" is hopeless as a criterion for coreference. Total non-sharing of predicates fares even worse as a criterion for non-coreference. Quite often, two intuitively non-coreferent noun phrases share some predicates. Think of all the predicates that hold both of *the number two* and of *the number four* or of *Joe* and *Joe's brain*. Thus, the observation that a pair of noun phrases share some predicates is not sufficient grounds to identify their referents. The key then in making sense of the connection between coreference and predicate sharing is to develop theories rich enough to allow the definition of a subset of predicates all of which must be shared by coreferent noun phrases. The most well-known example of this is the distinction between extensional and intensional contexts. Noun phrases that are found to share all predicates classified as extensional can safely be counted as coreferent even though they may differ in the sense they express and hence not share some intensional predicates. Theories concerned with discourse afford another distinction which can be appealed to here. These theories make reference to the potential of an expression to change the discourse context. A noun phrase's context change potential is a function of but not identical to its reference. Two noun phrases may have different context change potentials while remaining coreferent. Predicates whose interpretation makes crucial use of discourse properties of noun phrases will not be counted in deciding coreference. An example of such a predicate, I would argue, is the verb phrase in (96) above containing the adverb *respectively*. This adverb relies for its interpretation on the linear order in which discourse referents are introduced. Some have used this property of *respectively* in determining the kind of things noun phrase conjunctions denote (cf. section 2.10 of Link to-appear; Lasersohn 1988:139). However, I would argue that linear order is a property of the discourse itself and not of the entities referred to. Evidence for this claim derives from examples in which this ordering information is not contributed by a conjoined noun phrase subject but rather enters the discourse from outside the sentence containing *respectively*. Here are two such examples; the first is from the text of Jackendoff (1972:325, italics are mine):

(97) ... there are the ambiguous readings of (8.22) and (8.23).
(8.22) They're fighting about nothing.
(8.23) I will force you to marry no one.
One reading of these sentences is synonymous with (8.24) and (8.25), respectively.
(8.24) It is not so that they're fighting about anything.
(8.25) It is not so that I will force you to marry anyone.

(98) The first book is 2,000 pages long and it barely fits in the book bag. The second one is only 20 pages long, you can put it in your pocket. I refer to these books as the fat book and the skinny book, respectively.

Other expressions that behave like *respectively* are *correspondingly*, *analogously*, *equivalently* and *in that order* (for examples cf. Dougherty 1970:896). Comparisons in general often depend on linear order for their interpretation.

Verb phrases containing pronouns provide another clear class of predicates whose failure to justify non-coreference claims is explained with the help of a theory of discourse. One such example occurs in (99) and (100) below:

(99) Ray and the women relate that by late August each person was aware that he had only six months to live.

(100) The authors relate that by late August each person was aware that he had only six months to live.

Assume that both (99) and (100) are initial utterances in a discourse between two speakers who are aware of who Ray, the women and the authors are and that Ray and the women are the authors. (99) has a reading in which *he* is interpreted as referring to Ray. (100) lacks this reading. One might argue that this difference arises from the fact that the subjects of (99) and (100) are non-coreferent. This would constitute an argument against the union theory and for the sets theory which predicts non-coreference here. However, I would argue that an adequate theory of discourse would assign these noun phrases different context change potentials, though not necessarily different referents. Note that the verb phrase in question distinguishes as well between the noun phrases *Ray and Tess* and *the authors* which, assuming now that the authors were just Ray and Tess, even the sets theory counts as coreferent.

A debate about the coreference of definite noun phrases is a debate about predicate sharing but in a trickier way than at first envisioned. It is a two stepped affair. First one needs to determine whether predicates are shared or not. If certain predicates are found that are not shared then we must wonder whether there is some explanation for this other than the referential properties of the noun phrases. Clearly, what drives the discussion to begin with is some initial intuition that the noun phrases in question are coreferent. These intuitions are very much in the background of the debate in this book. They have cropped up already in the form of identity statements such as:

(101) a. The children are just the boy and the girls.
b. The players are the team.

In the following chapters we try to determine whether the **relevant** predicate sharing is found to accord with these intuitions.

Chapter 4
General Arguments from VP Denotations

In this section, our focus will be on arguments in favor of the sets theory based on possible VP denotations. The discussion will run as follows. First I will make some preliminary adjustments to our theories in order to accommodate the kinds of examples we need to consider. Next I will present a number of examples from work by Hoeksema, Link and Landman which argue for the sets approach. I will temporarily adopt this theory. Then I will argue for the introduction of two shifting operations which can apply to predicates to allow them to apply to entities of different types. Next, I will show that once these operations are in place, the motivation for the sets approach is eroded. I end this section by returning to the simpler union approach.

Let us assume for the remainder of our discussion that we have some male and female cows and some male and female pigs, that the cows and the pigs comprise all the animals there are, and that the males are young and old and so are the females. In order to talk about these various cows and pigs we add to our theories the category IADJ (intersective adjective) whose members include *young*, *old*, *male* and *female*. We also add the following rules to both theories:

[9] If α is an IADJ then $\| \alpha \|^{M} = V(\alpha)$ and $V(\alpha) \subseteq D$.

[10] If α is an IADJ and β is a CN then $\alpha\beta$ is a CN and $\| \alpha\beta \| = \| \alpha \| \cap \| \beta \|$.

and we assume for a noun phrase like *the young pigs* that *young pigs* is the plural of *young pig*.

The noun phrase *the cows* denotes the set of all the cows. The noun phrase *the pigs* likewise denotes the set of all the pigs and the noun phrase *the animals* will denote the set of all the animals. So far we have three distinct noun phrases and three distinct entities. Now we come to the noun phrase *the cows and the pigs*. On the union approach we get the union of the cows and the pigs which is the set of all the cows and pigs which is just the set of all the animals. So the cows and the pigs are just the animals on this approach and we still have only three entities. On the sets approach, the noun phrase *the cows and the pigs* denotes a set of two sets, a cow set and a pig set. This is different from the noun phrase *the animals* which denotes a set of individuals, not a set of sets. So now, on the sets approach, we have four entities: a purely bovine plurality, a purely porcine plurality, an animal plurality, and finally a plurality composed of two pluralities. Of course, this last one is not the only new animal entity that the sets approach has but that the union approach lacks. For there is also the denotation of *the young animals and the old animals*, another set of two sets and there is the male animals and the female animals, yet another distinct entity. And so on. All we want now is some linguistic evidence to show that we need these extra entities.

The list in (102)-(104) below, inspired by examples in Link (1984) and Landman (1989a), contains the evidence we need for the extra higher order entities of the sets approach. Let me note that I will be ignoring distributive readings throughout. The issue of distributivity will be taken up in chapter 5.

(102) a. The cows and the pigs were separated.
b. The young animals and the old animals were separated.

(103) a. The cows and the pigs talked to each other.
b. The young animals and the old animals talked to each other.

(104) a. The cows and the pigs were given different foods.
b. The young animals and the old animals were given different foods.

Each example consists of an a. and b. pair which seem, in the context we're assuming here, to be independent in the sense that one could be true while the other is false. Consider the pair in (102). It has been claimed that we do not want it to follow necessarily from the fact that the cows and the pigs were separated that the young animals and the old animals were separated, even with our assumption that the animals are just the cows and the pigs. On the union approach the noun phrase subjects of the a. and b. sentences would have the same denotation, namely something corresponding to the set of all the animals. This would mean that if any of the a. sentences was true the corresponding b. sentence would also have to be true. In order to avoid this undesirable consequence, we adopt the sets theory, under which the noun phrase *the cows and the pigs* and the noun phrase *the young animals and the old animals* have different denotations, and hence the a. and b. sentences remain independent.

We have just considered examples the main predicates of which appear to distinguish sets of higher than first order. Since such sets are not found in the domain of the union approach, we had cause to adopt the sets approach. But, of course, not all predicates are like the ones in (102)-(104). Some predicates, such as *fill the room* and *are asleep*, intuitively appear to hold of first order sets. This fact, by itself, is not a problem for the sets-approach whose domain includes all the elements in the domain of the union approach, including first order sets. However, these intuitively first-order predicates have a property that is somewhat surprising, given the assumptions of the sets approach. Consider the following:

(105) a. The animals filled the barn to capacity.
b. The cows and the pigs filled the barn to capacity.
c. The young animals and the old animals filled the barn to capacity.

(106) a. The animals were sleeping in the barn.
b. The cows and the pigs were sleeping in the barn.
c. The young animals and the old animals were sleeping in the barn.

If (105a) is true then in the context we are assuming, (105b) and (105c) will follow. On the sets approach which we have just adopted, nothing guarantees this since the subject noun phrases in (105a)-(105c) are not coreferent. The inference from (105a) to (105b) and (105c) is an example of what I call the Upward Closure Phenomenon, whereby

(107) Upward Closure Phenomenon
An English predicate that is true of a first order plurality G (non-singleton set of individuals), is true as well of all higher order pluralities formed using all the members of G.

We need to add something to our sets theory now which will guarantee that the Upward Closure Phenomenon holds for the sentences generated and interpreted by this theory. We do this by constraining the interpretation function, $\| \cdot \|$, so as to eliminate any predicates that do not have the Upward Closure property:

(108) LIFT constraint on $\| \cdot \|$.
For any predicate of English, δ, and $Y \in D^*$:
if $\{x \in D \mid x \in^* Y\} \in \|\delta\|$ then $Y \in \|\delta\|$

$\in^*$ is meant to indicate the transitive closure of $\in$ defined as follows:

$$\forall x,z[x \in^* z \Leftrightarrow (x \in z \quad \vee \quad \exists y[x \in^* y \wedge y \in z \quad \wedge \ y \neq z])]$$

According to (108), if δ is true of some first order plurality A, δ will be true of a plurality of any order if the individuals involved are just the members of A. For example:

$$\{a,b,c,d\} \in \ \| \delta \| \quad \rightarrow \{\{a,b\},\{c,d\}\} \in \ \| \delta \|$$

To see how this works, reconsider the example in (105). Assume that (105a) is true. If that is the case, then the plurality composed of all the individual animals is in || fill the room to capacity || . The LIFT constraint now guarantees that any set of any order whose urelements are the animals will be in || fill the room to capacity || . The subject noun phrases of (105b) and (105c) both denote such sets, hence these sentences would also come out true.[14]

It is worth noting here that the problem surrounding (105)-(106) would not have arisen had we chosen the union theory instead of the sets theory. This is so because according to that theory all the subject NPs in (105)-(106) have the same denotation provided the domain of discourse is as assumed here where the animals are just young and old cows and pigs.

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[14]This LIFT constraint is written in such a way that it will apply to all predicates, not just verbal predicates. This generality is desirable since the Upward Closure phenomenon shows up not only with verbs, but also for example with nouns:

i. The cows are mammals.

entails that:

ii. The young cows and the old cows are mammals.

However, this causes a problem for our interpretation of definite plural noun phrases. A plural noun can no longer be taken to denote the power set of the denotation of its singular counterpart minus the empty set, but must now denote the "lifted" version of this set, that is one that conforms to the LIFT constraint. Furthermore, we can no longer be content with saying that the denotation of the definite article is a function that takes a set of sets and returns the largest one. Rather, we must say that it returns the largest first order set. This will still work for the singular case, since singletons are first order.

One might be tempted therefore to suggest that the conjunction *and* is ambiguous with a union interpretation associated with the examples in (105)-(106) and a sets interpretation associated with the noun phrases in (102)-(104). This will not work however, because, as pointed out in Landman (1989a:§2.4), there are examples such as (109) in which predicates of the (105)-(106) type are conjoined with predicates of the (102)-(104) type:

(109) The Cows and the Pigs account for more than half the population of New Blinks but hate each other intensely.

(110) a. The Cows and the Pigs account for more than half the population of New Blinks.
b. The Cows and the Pigs hate each other intensely.

To see the problem here, let us assume for the moment that *and* is ambiguous between a union and a sets interpretation and that we do not have something like the LIFT constraint. The first VP conjunct in (109) is one that would be true in virtue of some fact about a first order set of individuals; it is like *fill to capacity*. The denotation of the subject NP could be in the extension of such a VP if we interpreted it using the union interpretation of *and*. The second VP is of the type that was used by Link (1984) to argue for a higher order theory like our sets theory (cf. (103) above). The denotation of the subject NP could be in the extension of such a VP if we interpreted it using the sets interpretation of *and* (assuming a reading in which Cows love Cows and Pigs love Pigs but Cows hate Pigs and vice versa). We assume that VP conjunction with *but* has the same truth conditions as with *and*, and so it is interpreted as set intersection. The problem is that nothing guarantees that the intersection of the denotations of these two VPs will contain either type of NP denotation even if the sentences in (110) were true and this is counterintuitive. The reader may recognize this argument as a higher order version of the one given at the end of section 1.3 against an ambiguous interpretation for *and*.

Because of examples like (109), we stick to the sets theory and introduce the LIFT constraint. This then guarantees that we can safely use the sets interpretation of *and* in (109), and assuming the sentences in (110) are true, (109) will be true as well. This way of doing things is essentially an adaptation of the type-shifting operations introduced in Landman (1989a:§2.4) or the meaning postulates of Hoeksema (1987a:28-29).

Reviewing briefly, because of the examples in (102)-(104) repeated below:

(102) a. The cows and the pigs were separated.
b. The young animals and the old animals were separated.

(103) a. The cows and the pigs talked to each other.
b. The young animals and the old animals talked to each other.

(104) a. The cows and the pigs were given different foods.
b. The young animals and the old animals were given different foods.

we adopted the sets theory. In order to prevent the inference from the truth of an a. sentence to the corresponding b. sentence, we interpret conjunction as set-formation and this insures that the noun phrases *the cows and the pigs* and *the young animals and the old animals* will have different denotations. Next, we saw that certain predicates which are true of first order pluralities seem to be true as well of all higher order pluralities formed from the same individuals, thus blurring the distinctions introduced with the adoption of the sets theory. To handle this Upward Closure Phenomenon, we constrain $\| \cdot \|$ in such a way that a predicate of English will be true of a higher order plurality in D^* if it is true of the set of individuals which are the urelements of that higher order plurality.

The LIFT constraint is worded in such a way that it applies to any predicate of English. As far as intuitively first order predicates like the ones of (105)-(106) are concerned, I think this is correct. As far as non-first order predicates like those in (102)-(104) are concerned, the constraint would appear to be irrelevant, since its application is limited to predicates having first order sets in their extension to begin with. But this last statement, relies on an assumption which I would like now to challenge. I would like to claim that not only is there an upward closure phenomenon in English but there is a downward closure phenomenon as well. I claim that:

(111) Downward Closure Phenomenon

1° There are no predicates of English that have higher order pluralities in their extension but that cannot also have first order pluralities in their extension.

2° If a predicate of English is true of a plurality G of any order, it will also be true of that first order plurality G' which is composed of the individuals used to generate G.

The first part says that there are no predicates of English that have exclusively higher order pluralities in their extension. In other words, there are no predicates that are strictly typed for higher order groups. Support for this claim comes from the fact that the predicates used in (102)-(104) to argue for adopting the sets theory can be applied to noun phrases denoting first order sets. Examples of this appear in (112).

(112) a. The boys were separated.
b. The boys talked to each other.
c. The boys were given different foods.

We return to this conjecture in chapter 8.

The second part of (111) says that if a predicate of English is true of a plurality G of any order, it will also be true of that first order plurality G' which is composed of the individuals used to generate G. This is, in a sense, a stronger version of the first part. It speaks not about the kinds of things that can be in a predicate's extension, but about specific entities that we find there. Evidence for this claim follows in examples (113)-(115). Recall that distributive readings are ignored here and that we are assuming that the animals are just the cows and the pigs. I claim that in each example the b. sentence follows from the a. sentence.

(113) a. The cows and the pigs were separated.
b. The animals were separated.
(114) a. The cows and the pigs talked to each other.
b. The animals talked to each other.
(115) a. The cows and the pigs were given different foods.
b. The animals were given different foods.

An appropriate context for these sentences might be one where a speaker says a. and his hearer replies with b. adding that he is not interested in **how** it was done, just that it was done. Another context for these examples might be one in which the a. sentence is true, but the speaker didn't have enough information to say that, either because he didn't realize that there were only cows and pigs or he simply could not distinguish a cow from a pig.

So far, there is nothing in the system we are working with that will guarantee the types of inferences exemplified in (113)-(115) since the sets theory assigns the noun phrase *the animals* a different denotation from that assigned to the noun phrase *the cows and the pigs*. We need to add something to our sets theory which will guarantee that the Downward Closure Phenomenon holds for the sentences generated and interpreted by that theory. Again we do this by constraining the interpretation function, $\|\cdot\|$, so as to eliminate any predicates that would falsify the generalization:

(116) LOWER constraint on $\| \cdot \|$.
For any predicate of English, δ, and $K \in D^*$:
if $K \in \| \delta \|$ then $\{x \in D \mid x \in^* K\} \in \| \delta \|$
[$\in^*$ is the transitive closure of $\in$]

According to (116), if δ is true of a plurality G of any order, then δ will be true of that first order plurality G' which is composed of the individuals used to form G, for example:

$$\{\{a,b\},\{c,d\}\} \in \| \delta \| \rightarrow \{a,b,c,d\} \in \| \delta \|$$

To see how this works, reconsider the example in (113). Assume that (113a) is true. If that is the case, then $\|$ were separated $\|$ will contain, among other things, a two membered set consisting of the set of all the cows and the set of all the pigs. Since $\|$ were separated $\|$ contains this set, it will also have to contain the first order set containing all the cows and pigs; that is what the LOWER constraint requires. Since the animals are just the cows and the pigs, it follows then that (113b) is true.

Reviewing again, because of the examples in (102)-(104) we assume the domain of discourse D^* given by the sets theory and we interpret conjunction as set-formation. This means that the noun phrases *the animals* and *the cows and the pigs* cannot be coreferent. But then we come to find out that English does not want to cooperate. Predicates of English are just not fine-grained enough. So the next thing we need to do is introduce two constraints on the interpretation function that serve to blur the distinctions. At this point I want to give some thought to the interaction of these two constraints.

For our first example, I want to return to (105) repeated below:

(105) a. The animals filled the barn to capacity.
b. The cows and the pigs filled the barn to capacity.
c. The young animals and the old animals filled the barn to capacity.

I claimed above that (105a) implies (105b) and (105c). That intuition was incorporated into our theory in the form of the LIFT constraint. In fact, the entailment goes the other way as well. Namely, (105b) and (105c) (on their non-distributive readings) entail (105a). This entailment is not covered by the LIFT constraint. However, it is covered by the LOWER constraint. In effect then, the combination of the LIFT and the LOWER constraints guarantee that as long as the animals are just the cows and the pigs, (105a)-(105c) are truth conditionally equivalent.

Now we go the other way, reexamining the examples that motivated LOWER to see what effect LIFT has on them. I will do this by way of a piece of reasoning given in (117) which is explained by appeal to these constraints.

(117) Given:

a. The young animals and the old animals are just the cows and the pigs.

Assume:

b. The young animals and the old animals were separated.

Then:

c. The animals were separated. (by LOWER)
d. The animals were separated by age.
e. The cows and the pigs were separated by age.(LIFT)
f. The cows and the pigs were separated.

The intuition that c. follows from b. is explained by the LOWER constraint. (117d) seems to follow from (117b) and (117c) and the meaning of *by age*. Now from (117d) I think we can conclude (117e). This step is more evidence for the LIFT constraint. If || separated-by-age || contains the set of all animals, then it must, by the LIFT constraint, contain all sets whose urelements are the animals. In particular, it must contain the two membered set denoted by the subject of e. Finally, the step from e. to f. comes about because *by age* is a standard modifier, that is, it obeys the following schema:

(118) NP VP *by age* --> NP VP. (NP is monotonically increasing)

If some things are separated by age then they are separated. I take the inferences traced out in (117) to be intuitively correct, and yet they have allowed us to go from (117b) to (117f). Now I do not deny that (117f) is a misleading thing to say, if you could have said (117b). It is misleading, but not false. (117f) follows from (117b) because English does not respect the distinctions that the sets theory makes. Here is another example of reasoning in which LOWER and LIFT appear to interact:

(119) Scene: four lawyers: Robert (defense), John (defense), Marcia (prosecution), Hank (prosecution).

Given:

a. The defense lawyers and the prosecution lawyers used to fight each other in court every day.

Then:

b. The lawyers used to fight each other in court every day. (LOWER)

c. That woman and those three men used to fight each other in court every day. (LIFT)

Here again the steps from premise to conclusion seem intuitively correct. And again the subject NP of our premise and the subject NP of the conclusion have in common that they denote sets built from the same urelements. A tendentious way to put this would be that what they have in common is that they are assigned the same denotation by the union theory. We can summarize this pattern by combining our two constraints as follows:

(120) LIFT and LOWER constraints combined.
if $K \in \| P \|$ then $\{x \in D \mid x \in^* K\} \in \| P \|$
if $\{x \in D \mid x \in^* Y\} \in \| P \|$ then $Y \in \| P \|$
(K,Y are variables over elements of D^*)

It follows from (120) that:

(121) if $K \in \| P \|$
and $\{x \in D \mid x \in^* K\} = \{x \in D \mid x \in^* Y\}$
then $Y \in \| P \|$

What (121) says is that we can go directly from (122) to (123):

(122) The cows and the pigs were separated.
(123) The young animals and the old animals were separated.

But now if LOWER and LIFT can conspire like this our original motivation for moving from the sparse universe of the union theory to the more complicated world of the sets theory is undercut.

Recall, our original motivation was to achieve a logic that would allow a sentence like (122) to be true, without it following, in the relevant context, that (123) was true. Having accommodated the Upward Closure Phenomenon and the Downward Closure Phenomenon, we now have a system that precisely allows us to go from (122) to (123).

I elaborate. (122) and (123) differ in meaning. No question about that. The issue here is that the argument based on these examples in favor of the sets theory rests on the belief that the difference between (122) and (123) can be captured in a semantics which takes predicates to denote sets of objects which are themselves distinguished by a set-theoretic principle of extensionality. In particular, given two different sets formed from the same urelements, for example {{a,b}, c} and {a,{b,c}}, this account rests on the possibility of having a predicate of English whose denotation includes one of these sets but not the other. It is this belief that I am challenging here.

In order to argue for a sets theory we need to have predicates that distinguish plural entities which differ only by the way they are grouped. We thought we had this. However, English has two properties that conspire against us. The Downward Closure Phenomenon guarantees that a predicate of English that is true of a particular grouping of a set of singularities will be true of that set itself. On the other hand, the Upward Closure Phenomenon guarantees that predicates of English that are true of a set of singularities to be true of those individuals on any grouping. Putting these two together, it turns out that a predicate of English that is true of a set of singularities on some complicated grouping will be true of the set itself, and hence true of those singularities on any grouping, so groupings cannot matter.

Of course, (122) and (123) differ in meaning. Both say more than (124).

(124) The animals were separated.

In (122) we understand the animals to be separated by species, in (123) by age. I also grant that this added information is coming from the NP subjects. So I do not dispute that (122) and (123) differ and that that difference has to do with the meaning of the subject NPs. What I do dispute is that the difference can be handled by an account that rests on having predicate denotations be sets of entities that are as fine grained as the sets theorist needs to support his theory. Extensions of predicates of English do not have this kind of structure.

The differences here do have to do with NP meanings, but not with the objects that NPs refer to. In the terminology introduced in section 3.2 we may say that those predicates not shared by our putatively non-coreferent noun phrases are not relevant here.

For completeness I would like to turn now to a slightly different version of the argument made here for the sets theory, due to J. Hoeksema. Consider (125) from Hoeksema (1983):

(125) [[Blücher and Wellington] and Napoleon] fought against each other near Waterloo. ⇹ [Blücher and [Wellington and Napoleon]] fought against each other near Waterloo.

Hoeksema argues on the basis of the example in (125) that the interpretation of *and* must not be associative otherwise the bracketing on the conjunction would not affect the denotation of the noun phrase subject. The problem with this argument is that, as with the examples used above, it relies on having predicates that are sensitive to these groupings. In this particular example, the extension of the predicate *fight against each other* would have to encode information not only about who was fighting but also about who was allied with whom in the battle. However as I have argued up to now, English predicates do not seem to be as fine grained as the sets theorist requires. As above, the first thing to note is that the Downward Closure Phenomenon crops up with the predicate in this example. Were I embarrassed about the fact that I couldn't pronounce *Blücher* correctly, I might report the events of (125) as:

(126) Those famous European generals fought each other at Waterloo.

(126) follows from (125). If a higher order plurality built from those three generals is in ‖ fought each other at Waterloo ‖ , then so is the first order plurality having each of them as a member.

The example in (127) makes the case even stronger:

(127) Despite their current membership in a common market, only 50 years ago, *Germany, England, France and Italy were battling each other* in one of the worst wars in history.

I take (127) to be true. If Hoeksema is correct and the alignment of the forces is encoded in the extension of the predicate *were battling each other* then (127) should only be true if the subject noun phrase denotes a set of two sets, one containing Germany and Italy and the other France and England. But even the sets theory doesn't assign this denotation to the subject of (127). (128) below is yet another example of this type:

(128) John and Mary and Bill and Sue played tennis with each other. In the first match, the men played the women, and in the second match John and Mary played Bill and Sue.

A non-associative *and* might seem attractive on the basis of the second match, but must be abandoned on the basis of the first match.

Finally one bit of circumstantial evidence in favor of the position taken here comes from pairs of the following sort:

(129) a. The women from the two communities hated each other.
b. The women who belonged to the two organizations hated each other.

Consider a context in which the women from the two communities are just the women from the two organizations, the memberships of the two organizations are totally non-overlapping and each organization has members from both communities. The examples in (129) differ in way that is reminiscent of our earlier Linkian examples, repeated here:

(103) a. The cows and the pigs talked to each other.
b. The young animals and the old animals talked to each other.

In (103a) and (103b) the individuals doing the talking are the same while the grouping of the conversationalists differ. In (129a) and (129b), the individuals doing the hating are the same; the battle lines are drawn differently. The sets theorist attempts to account for the differences in (103) by incorporating the groupings in the denotations of the noun phrases. This is achieved through a judicious choice of interpretation for *and*. What (129) purports to show is that the phenomenon is not limited to noun phrases involving conjunction. To convince us that he is correct, the sets theorist will have to show how the correctly "grouped" denotations are arrived at for the subjects of (129). A similar point is made with (130) below, reminiscent of (102):

(130) The delegates from each of the countries were separated.
(102) The cows and the pigs were separated.

The verdict based on this section is in favor the union theory. The data that I used to demonstrate the Upward Closure Phenomenon and the Downward Closure Phenomenon now have a simpler explanation. The examples in (131) below all have the same truth conditions because all the subject NP's have the same denotation in the context we are assuming.

(131) a. The animals filled the barn to capacity.
b. The cows and the pigs filled the barn to capacity.
c. The young animals and the old animals filled the barn to capacity.

If the sentence in (122) is true,

(122) The cows and the pigs were separated.

then (124),

(124) The animals were separated.

can be uttered truthfully in the context we've assumed up to now, since the subjects of (122) and (124) are assigned the same denotation in the union theory and the predicates are identical.

While a case has been made here for the union approach, there is something that still remains unexplained. On the sets approach, (122) and (124) are truth-conditionally distinct and furthermore that difference depends on a difference in the reference of the subjects of those sentences. I have just argued against these two claims. Nevertheless, the fact remains that (122) and (124) do differ in some way and one would like to know why that is so according to the union theorist. In the following chapter, five, we will take up a different sort of argument for the sets approach, this will involve the phenomenon of distributivity, ignored to this point. The approach we take there to distributivity will, I believe, shed some light on the data examined in this section, so in chapter 6 we return to the questions left open here.

Chapter 5
Distributivity

5.1 A Challenge to the Union Approach

As noted in chapter 3, sentences of the following type:

(84) The authors and the athletes are outnumbered by the men.

have been used to argue for a more complex theory of plural reference (cf. Landman 1989a; Scha and Stallard 1988). (84) is claimed to have a distributive reading that (86) lacks:

(86) The women are outnumbered by the men.

even in a context in which the authors and the athletes are just the women. It is argued that this difference must be captured in part by distinguishing the possible denotations assigned to the subjects of (84) and (86). This constitutes a challenge to the union theory, which, in the context assumed here, assigns these noun phrases the same denotation.

This challenge to the union theory relies on the view that the denotation of a distributively read verb phrase differs from that of its non-distributive counterpart (see Lasersohn 1995 for extensive discussion of that view and alternatives). Even for those who accept that view, as we shall here, the source of that difference in denotation remains open and that turns out to be a crucial issue for the debate between the union and the sets theory. It is usually assumed that distributivity is a purely semantic matter: a plural predicate has one meaning on its distributive reading and a different meaning on it non-distributive reading, and these meanings differ in such a way that in some situations the two readings lead to different extensions. However, there is another possibility. It could be that a plural predicate has a single meaning, but that that meaning is context-dependent, and will lead to different 'readings' in different contexts. On the purely semantic view, it makes sense to trace the differences between (84) and (86) to differences in the referents of their subjects. However, if this latter, context-dependent alternative is correct, then a difference in the context-change potentials of the subjects in (84) and (86) may account for the fact that they do not share (in the sense of section 3.2) the distributively read verb phrase common to (84) and (86).

In this section I will, through successive attempts, arrive at an account of distributivity that has a context-dependent element to it. The data in (84) and (86) when analyzed on that account no longer pose a threat to the union theory.

My presentation here will depart slightly from the practice of chapter 1. The account will be cast, at least initially, in a framework in which English is translated into a semantically interpreted language. The purpose of this departure is to remain somewhat closer to existing accounts of distributivity upon which mine is based.

5.2 A Quantificational Account

5.2.1 Cumulativity

Our story begins with the oft cited connection between distributivity and cumulativity. For example, while (133) is gotten from (132) by cumulativity:

(132) John moved the car and Mary moved the car.
(133) John and Mary moved the car.

(132) follows from a distributive construal of (133). Our first guess then, is that by accounting for cumulativity we thereby account for distributivity. This leads to what Lasersohn (1988) calls a closure-condition account. By this we mean that all predicates of the language have a simple translation as well as a translation which is interpreted as the closure under union of the simple translation. Letting α represent a metavariable over predicates of English we have:

(134) α translates as: α' and as $^*(\alpha')$
$\| {}^*(\alpha') \|$ = the closure under union of $\| \alpha' \|$.

We have employed here the "*" operator familiar from the work of G. Link, though with a slightly different semantics in terms of set union rather than lattice theoretical sum (see Appendix on closure under union of a set of individuals). The cumulative inference of (132)-(133) is now mapped as follows:

(135) $[\text{moved-the-car'}(J) \wedge \text{moved-the-car'}(M)] \rightarrow {}^*(\text{moved-the-car'})(J+M)$

Assuming that J+M is interpreted as the union of John and Mary (this is just the set of John and Mary, see the Appendix), the interpretation of the star-operator in (134) guarantees the inference in (135).

Turning now to distributivity, this setup allows us two translations, one with and one without a star, corresponding respectively to the distributive and the non-distributive or collective construals of a given predicate. Presumably, the inference from (133) (on its distributive construal) to (132) would be mapped as in (136):

(133) John and Mary moved the car.
(132) John moved the car and Mary moved the car.
(136) ${}^*(\text{moved-the-car'})(J+M) \rightarrow [\text{moved-the-car'}(J) \wedge \text{moved-the-car'}(M)]$

Unfortunately, (136) is not guaranteed by (134) the way (135) was. To see this, consider a situation in which John and Mary moved the car together but neither John nor Mary moved the car individually. Since (133) is true, the set of John and Mary must be in the extension of either *(moved-the-car') or moved-the-car'. Since it is false that John moved the car, John is not in the extension of either *(moved-the-car') or moved-the-car' and likewise for Mary. This means that the set of John and Mary can't have gotten into the extension of *(moved-the-car') by closure under union, hence it must be in the extension of moved-the-car' and then by definition it must also be in *(moved-the-car'). This means that in the situation described, the antecedent of (136) is true and the consequent is false.[15] In other words, the arrow of (136) is not justified by adding (134) to our system.

The upshot of this result is that in a grammar where distributivity

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[15]One might think that the star-operator should be redefined as follows:

$\| {}^*(\alpha') \| =$ the closure under union of $\| \alpha' \|$ excluding the elements of $\| \alpha' \|$ itself.

The problem is that this would incorrectly make:

i. John and Mary moved the car.

false on its distributive reading if they moved the car together, even if they also moved it individually.

is accounted for with a rule like (134), there is no translation of (133) from which (132) follows:

(133) John and Mary moved the car.
(132) John moved the car and Mary moved the car.

The prevailing view seems to be that (132) should follow from (133) on some reading (cf. Gillon 1987 and Lasersohn 1988:§2.1). In fact, it is only under this view that the argument presented at the outset against the union theory holds weight, since that argument relied on an entailment of this sort: *The authors and the athletes are outnumbered by the men* entails *The authors are outnumbered by the men and the athletes are outnumbered by the men.* While I am not entirely convinced that the prevailing view is correct, I will adopt it here and with it abandon our first attempt at an analysis of distributivity within the union theory.

Before moving on to the next attempt, let me note one more possible flaw in the current system, which was mentioned chapter 1. Theories which include something like (134) seem to overgenerate. They predict that cumulativity is independent of the predicates involved. However, I am uneasy with the following entailments:

(137) The boys look alike and the girls look alike → The boys and the girls look alike.
(138) The students left as a group and the teachers left as a group → The students and the teachers left as a group.

Lønning (1989:125) makes a similar point concerning this example:

(139) a. The black children played with each other and the white children played with each other.
b. The (black and the white) children played with each other.

5.2.2 The D-operator

The next attempt starts with the observation that distributivity can be overtly marked with the floated adverb *each*:

(140) John and Mary each moved the car.

(140) unambiguously entails that John moved the car and Mary did too. On the basis of this observation, one posits an adverbial D-operator in the translation language with the following semantics, where x,y are variables

over elements in the domain of discourse:

(141) $x \in \| D(\alpha) \|$ iff $\forall y[(\text{singularity}(y) \wedge y \in x) \rightarrow y \in \| \alpha \|]$

An operator of this type is found in Link's work as well as in Lønning (1987), Roberts (1987) and elsewhere.

The ambiguity of (133) is now captured by allowing the predicate to be translated either as in (142a) or as in (142b).

(133) John and Mary moved the car.
(142) a. moved-the-car'
b. D(moved-the-car')

The distributive entailment from (133) to (132):

(132) John moved the car and Mary moved the car.

is mapped as in (143):

(143) D(moved-the-car')(J+M) →[moved-the-car'(J) ∧ moved-the-car'(M)]

This entailment is guaranteed by the semantics given in (141). Here I've assumed that the simple translation moved-the-car' denotes a set containing singularities and pluralities. Each member of the set is responsible for a moving of the car.

The introduction of a quantifier into the logical form of distributive predicates is further justified by evidence of scope interaction between it and other quantifiers. One example of this concerns the interaction between the D-operator and indefinite noun phrases as analyzed in Roberts (1987). To see this effect, consider first the simple example in (144) in a context where there is more than one boy:

(144) Every boy killed a dog.

This example has a plausible reading in which the existential has narrow scope with respect to the universal and an implausible reading involving multiple killings of a single dog. As is well-known, the singular indefinite can serve as the antecedent for a singular pronoun later in the discourse only if it has wide scope. Thus we get only the implausible reading when (144) is embedded in a discourse having such a pronoun, as in (145):

(145) Every boy killed a dog. It turned out to have nine lives.

Now consider the example in (146):

(146) John and Mary killed a dog.

This example has two distributive readings. On one reading, (146) is true if John killed a dog and Mary killed a dog. On the other, implausible, distributive reading, (146) is true if there is a dog and John killed it and Mary killed it. The presence of the two distributive readings is explained by taking the indefinite to have narrow or wide scope with respect to the D-operator. Once again, the implausible wide scope reading is the only one possible in a discourse where the indefinite serves as the antecedent for a subsequent singular pronoun:

(147) John and Mary killed a dog. It was buried in the parking lot.

((147) also has a collective reading, involving a single collaborative murder). Another example of scope interaction involving the D-operator was pointed out to me by Angelika Kratzer. In this case, the interaction is with the modal predicate *likely*:

(148) John and Mary are likely to win the lottery.

(148) has the following two distributive readings:

a. there is a good chance that John will win the lottery and that Mary will win the lottery.
b. John and Mary each have a good chance of winning the lottery.

This difference is explained by taking the D-operator to have scope under the modal in the (a) reading (attached to the lower verb) and over the modal in the (b) reading.

Reviewing so far, we have now helped ourselves to an account that fulfills the basic requirement of guaranteeing the distributive entailments and which analyzes the distributive-collective distinction as one of ambiguity. Furthermore, essential use of a quantifier in the translation of distributive predicates is independently confirmed by its participation in scope interactions.

One might wonder at this point whether or why this approach is an improvement on the approach taken for example by Bennett (1974:193,229) in which definite noun phrases were optionally translated with a universal quantifier, essentially giving a definite plural the meaning of a universal noun phrase. The present approach has an advantage. As noted in section 1.3, conjoined verb phrases need not be understood both collectively or both distributively even when they combine with a single subject. This is unexpected on an account in which the ambiguity is located in the noun phrase.

5.2.3 Intermediate Readings: Context Sensitivity

With all that is positive about the D-operator account of distributivity, one significant problem remains. By employing the D-operator, we envision two kinds of situations in which a verb phrase will hold true of a plurality: either the property expressed by that predicate holds of each of the singularities that are parts of the plurality, this is the distributive case, or the property holds of the plurality itself, this is the collective case. Research on plural constructions has uncovered a third case, however. In their work on reciprocals, Fiengo and Lasnik (1973) observed that whereas for simple cases like (149),

(149) John and Bill were hitting each other.

we can say that a reciprocal VP of the form V-*each other* is true of a plurality if, and only if, the relation expressed by V holds between any two members of the plurality reciprocally, such is not the case with an example like:

(150) The men were hitting each other.

when there are more than two men. If the men are divided into groups, and there is reciprocal hitting between any two members of each group, Fiengo and Lasnik say that (150) might be considered true even if there is no hitting between members of different groups. In other words, reciprocity holds within subpluralities of the plurality denoted by *the men*. Langendoen (1978) extended this idea of distributing down to sub-pluralities in an analysis of non-reciprocal sentences.[16] Within this tradition,

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[16] A reviewer pointed out that Katz (1977:127) expresses a similar sentiment:

> "the units of attribution can be individuals, pairs, triplets, and so on, up to the entire membership of the set DES(t_i) [roughly, the denotation of the relevant argument of the attributed predicate RSS]. The frequently discussed notions

Higginbotham (1981:100) adopts the following interpretive principle:

(151) $[_S\ NP_{plural}\ VP]$ is true iff there is a partition C of the plurality P denoted by NP such that VP is true for every element in C.

A partition is a kind of **cover**, where:

(152) C is a cover of P if and only if:
1. C is a set of subsets of P
2. Every member of P belongs to some set in C.
3. $\varnothing$ is not in C

C is a **partition** of P if, and only if, C covers P and no two members of C overlap. In fact, there is some question whether (151) shouldn't make reference to covers of all types rather than just to partitions. Gillon (1987:212) provides the following example in support of this change:

(153) The men wrote musicals.

> Suppose *the men* denotes Rodgers, Hammerstein, and Hart. (153) is true, on at least one reading, when they are the denotation of the subject noun phrase. However, there is no partition of the set containing those three men in which *wrote musicals* is true of each member. Rather, the sentence is true because Rodgers and Hammerstein collaborated to write musicals and Rodgers and Hart also collaborated to write musicals.

On the strength of this example, we make the recommended change in (151):

(154) $[_S\ NP_{plural}\ VP]$ is true iff there is a cover C of the plurality P denoted by NP such that VP is true for every element in C.

If the claim in (154) is correct, then surely something is lacking in our analysis in terms of a collective reading and a D-operator based distributive

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> of the *distributive* and *collective* features of quantifiers represent two extremes of this range of possible units."

Incidentally, Katz rejects the notion that there is a genuine ambiguity here, a question to which we return below.

reading, where the distribution is to singularities only. But is the claim correct? Lasersohn (1989) doesn't think so. He asks us to consider a situation in which a department pays each of its three TAs (teaching assistants) $7,000. In such a case (155) is true on a distributive reading, (156) is true on a collective reading and (157) is false:

(155) The TAs were paid exactly $7,000 last year.
(156) The TAs were paid exactly $21,000 last year.
(157) The TAs were paid exactly $14,000 last year.

However, according to (154), (157) should be true as well since the VP in that sentence is true of any set of two TAs and hence will be true of each member of a cover of the TAs containing two two-membered sets. Lasersohn proposes instead that we remain with the simple two-way collective-distributive distinction. He reanalyzes Gillon's (153) by adopting a meaning postulate that guarantees the following:

(158) $\| \text{write} \| (w,y) \wedge \| \text{write} \| (x,z) \rightarrow \| \text{write} \| (w \cup x, y \cup z)$

Since the union of the set of Rodgers and Hammerstein and the set of Rodgers and Hart is just the set denoted by *the men* in (153), that sentence is guaranteed to be true on the construal Gillon is after.

Lasersohn's use of a meaning postulate to handle an "intermediate" distributive reading is in the spirit of Scha (1984) and Scha & Stallard (1988), to be discussed below. While I believe that the statement about the meaning of *write* made in (158) is likely correct, I think it is misleading to capture this information with a meaning postulate and, more importantly, it is incorrect to account for distributivity in strictly semantic terms. Both of these points deserve elaboration.

Accounting for the difference between (153) and (157) in terms of a meaning postulate amounts to claiming that the presence of the intermediate reading in (153) is a direct result of the presence of *write* as the main verb and that (157) lacks the intermediate reading because the verb *write* has been avoided. Observe, however, that (153) can be continued with:

(159) They were paid exactly $2,000 per musical/for their musicals.

If, in fact, the musicals went for $2,000 apiece (159) is true on the same intermediate reading, that is the one corresponding to the same cover as in (153). The main verb of (159) is similar to the one that was used to deny the presence **in general** of intermediate readings. This indicates that the presence of the intermediate reading in (153) is not intimately connected with choice of main verb.

Now, regardless of how we capture facts about the extensions of plural predicates like that in (158), we will not achieve a complete analysis of distributivity. This is because there is a pragmatic element to distributivity which is nicely illustrated in Gillon's reply to Lasersohn. Gillon guessed that the adverb *exactly* was responsible for the possible lack of the relevant reading in Lasersohn's (157) and suggested we consider his (160) as well:

(160) The T.A.'s were paid their $14,000 last year.

in a context which he describes as follows:

> A chemistry department has two teaching assistants for each of its courses, one for the recitation section and one for the lab section. The department has more than two teaching assistants and it has set aside $14,000 for each course with teaching assistants. The total amount of money disbursed for them, then, is greater than $14,000. At the same time, since the workload for teaching a course's section can vary from one section to another, the department permits each team of assistants for a course to decide for itself how to divide the $14,000 the team is to receive. Suppose that it turns out, as it very well could under such circumstances, that no teaching assistant is paid exactly $14,000 . Yet it seems to me that either of the sentences in (157) or (160) could be truly affirmed, though neither sentence, by hypothesis, is true in virtue of either a collective or a distributive reading.

What Gillon has done here is to change the context in which Lasersohn's example is uttered. In other words, whether or not a certain intermediate reading is available seems to have to do with the context not with the semantics of particular lexical items. The phenomenon we are looking at is pragmatic, not semantic. The claim I am making can be cast in terms of a revision of the generalization made in (154) above repeated here:

(154) $[_S\ NP_{plural}\ VP]$ is true iff there is a cover C of the plurality P denoted by NP such that VP is true for every element in C.

(154) makes reference to covers of a plurality. Now, in different contexts,

different covers may be salient, that is, a given plurality may have parts that are relevant in one conversation but not in another. So (154) should be modified to:

(161) $[_S\ NP_{plural}\ VP]$ is true in some context Q iff there is a cover C of the plurality P denoted by NP which is salient in Q and VP is true for every element in C.

The examples we've seen so far in which an intermediate reading was claimed to have arisen have all involved transitive verbs with bare plural or amount denoting object noun phrases. Before turning to an analysis which captures the generalization in (161), I would like to provide an example of a different form in which an intermediate reading arises.

Imagine a situation in which two merchants are attempting to price some vegetables. The vegetables are sitting before the merchant, piled up in several baskets. To determine their price, the vegetables need to be weighed. Unfortunately, our merchants do not have an appropriate scale. Their grey retail scale is very fine and is meant to weigh only a few vegetables at a time. Their black wholesale scale is coarse, meant to weigh small truckloads. Realizing this, one of the merchants truthfully says:

(162) The vegetables are too heavy for the grey scale and too light for the black scale.

In order to save space in our explanation, let us reword his utterance:

(163) a. The vegetables are too heavy for the grey scale.
b. The vegetables are too light for the black scale.

(163a) is false on its distributive reading, the one corresponding to a translation employing the D-operator of (141). It is true on its collective reading but that is not what the merchant intended. (163b) is false on the collective reading, the one corresponding to a translation without the D-operator. It is true on its distributive reading, but again that is not what the merchant intended to say. The physical arrangement of the vegetables in baskets suggests a cover of the vegetables with cells of the cover corresponding to baskets of vegetables. (162) is true and informative on the intended intermediate reading because the verb phrase is true of every member of that cover.

Reviewing now, our discussion began with the acceptance of those theories which model collective-distributive distinction with the help of the D-operator interpreted as in (141):

(141) $x \in \| D(\alpha) \|$ iff $\forall y[(\text{singularity}(y) \wedge y \in x) \rightarrow y \in \| \alpha \|]$

This approach has two advantages. It delivers a clear distributive and collective reading and it accounts for certain ambiguities in terms of a scope interaction between the D-operator and modals and between the D-operator and indefinite noun phrases. The trouble with this approach is that it fails to make enough distinctions. In certain contexts, sentences with definite plural noun phrase arguments are found to have intermediate readings that are not predicted on this approach. We need a new account that will allow for more readings. This account must do justice to the pragmatic aspect of these readings, referred to in the generalization in (161).

5.2.4 A Generalization of the D-operator

Our current defective proposal involves the following semantic rule for the D-operator:

(141) $x \in \| D(\alpha) \|$ iff $\forall y[(\text{singularity}(y) \wedge y \in x) \rightarrow y \in \| \alpha \|]$

We are happy with the universal quantifier attached to y and would like to retain it. The problem lies in the restriction to singularities. In the intermediate readings there is universal quantification, that is distribution, but not necessarily down to singularities. What would happen if we simply dropped this restriction:

(164) $x \in \| D(\alpha) \|$ iff $\forall y[y \in x \rightarrow y \in \| \alpha \|]$

This doesn't do very much given the kind of model we are assuming (that of the union theory). Being on the left side of the membership sign, y is effectively restricted to singularities since our domain has in it only singularities and sets of singularities. So we need to change the membership sign to subset:

(165) $x \in \| D(\alpha) \|$ iff $\forall y[y \subseteq x \rightarrow y \in \| \alpha \|]$

We don't lose any values for y in this process, since Quine's Innovation (see the Appendix) guarantees that:

(166) $\forall y \forall x([\text{singularity}(y) \wedge y \in x] \rightarrow y \subseteq x)$

The problem with (165) however is that it now requires too much for a distributive reading. To see this consider a situation in which the sentence:

(167) The bottles are light enough to carry.

is true but *only* on its distributive reading and that even two or three bottles would be too heavy to carry. If we go to map the true distributive reading with the operator defined in (165), we end up requiring that every set of bottles be in the extension of *be light enough to carry*. But then the translation of (167) with the D-operator is false, when in fact (167) is true on its distributive reading.

Getting rid of the singularity restriction was fine but we need some new restriction to replace it. The claim in (154) above, suggests the following:

(168) $x \in \| D(\alpha) \|$ if and only if
There is a cover C of x: $\forall y[\, y \in C \rightarrow y \in \| \alpha \| \,]$

Reconsider (167) in a situation in which each bottle by itself is light enough to carry though two or more bottles together would be too heavy to carry. The set of all the bottles is a cover of itself. This follows from the definition of cover:

(152) C covers A if:
1. C is a set of subsets of A
2. Every member of A belongs to some set in C.
3. $\emptyset$ is not in C

along with our adoption of Quine's Innovation, according to which each bottle is a subset of the set of all the bottles. The predicate of (167) is true of every member of this cover. Translating (167) with a D-operator interpreted as in (168) yields a formula that is true in this situation. In addition, notice that if we left the D out we would get the collective reading and hence a formula that is false.

(168) represents progress. It retains the quantificational analysis of distributivity, and though it still allows for situations in which there is distributivity to singularities it is flexible enough to allow for intermediate distributive situations. Nonetheless it is flawed in two ways. First, we no longer have a true distributive (to singularities) reading, much as in the case of our original cumulativity-based analysis ((134), page 58). That is, distributive entailments no longer hold in our system. For example, if *the bottles* refer to three bottles named A, B and C, the entailment mapped as:

(169) D(are-heavy')(A+B+C) $\rightarrow$ are-heavy'(A) $\wedge$ are-heavy'(B) $\wedge$ are-heavy'(C).

is not **guaranteed** by (168). This is because there may be another cover, say the one in which all the bottles occupy one cell, such that each member of that cover is in the extension of *be heavy*. The other problem with (168) is that it makes no reference to context. But we learned in the previous section that the availability of certain readings was dependent on context; not all covers are equal.

The source of both of these problems is the existential quantifier in the phrase "there is a cover C" in (168). The semantics should make reference to a specific cover, the choice of which is a matter for the pragmatics. This can be done by leaving the variable C free. In this case, the actual truth conditions which a sentence receives on a particular occasion of utterance are determined not by its translation alone, but by the translation interpreted with respect to a certain value assignment to its free variables, which is determined by pragmatic factors. There is some leeway in how we change (168). Here is one possibility:

(170) $x \in \| D(Cov)(\alpha) \|$ if and only if
$\| Cov \|$ is a cover of $x \wedge \forall y[\, y \in \| Cov \| \rightarrow y \in \| \alpha \| \,]$

Cov is a free variable over sets of sets. The value of Cov is determined by the linguistic and non-linguistic context. For example, in our vegetable example (163), the non-linguistic context provided a partition of the vegetables corresponding to their physical arrangement. This partition would have been assigned to Cov in the evaluation of (163). A slightly different way to amend (168) is as follows:

(171) $x \in \| D(Cov)(\alpha) \|$ iff $\forall y[(y \in \| Cov \| \wedge y \subseteq x) \rightarrow y \in \| \alpha \| \,]$

In this version Cov is variable over covers of the whole domain of quantification. In future discussion we will assume this alternative, briefly returning to the choice between the two at the end of section 5.3.

In all versions of the semantics of the D-operator there is implicit restriction to the domain of quantification, as with all natural language quantifiers. The change then from (165) repeated here:

(165) $x \in \| D(\alpha) \|$ iff $\forall y[\, y \subseteq x \rightarrow y \in \| \alpha \| \,]$

to (171) is simply that we have quantification restricted to contextually specified covers over the domain rather than to the domain itself.

I would like to end this discussion by showing how we have regained the distributive (to singularities) **reading** of (167). Before doing that I want to make a notational modification. From now on, let us leave the one place D-operator familiar from the literature with exclusive rights to that name and rename our operator "Part" :

(172) $x \in \| \text{Part}(\text{Cov})(\alpha) \|$ if and only if
$\forall y[(y \in \| \text{Cov} \| \wedge y \subseteq x) \rightarrow y \in \| \alpha \|]$

Turning now to the distributive (to singularities) reading, recall our earlier example:

(167) The bottles are light enough to carry.

which on its non-collective readings would get translated as:

(173) (Part(Cov)(are-light-enough-to-carry')) (the-bottles')

To simplify, let's assume that the domain of discourse doesn't include non-bottle entities. In that case, the reading we are after is the one in which Cov is assigned a set containing each of the bottles. This cover is salient in the discourse (it has been mentioned as the subject of the sentence) so its assignment to Cov is plausible. On this reading, (167) entails that each of the bottles is light enough to carry. This is what we have come to call the distributivity entailment.

This example pointsp10%Xpossible misunderstanding in the use of the term "reading". Throughout this discussion, I use the term "reading" to mean particular interpretation, including the choice of a meaning for ambiguous lexical items as well as the factoring in of specific aspects of context that affect interpretation. In this sense, there is a reading of (167) involving distribution to singularities. Some would limit the terms "reading" and "ambiguity" to differences in meaning deriving from lexical or syntactic ambiguity. On that view, according to the grammar envisioned here (to be modified below), (167) might be said to have two readings: one collective (translated without the Part operator) and one distributive, not necessarily to singularities.

5.3 Incorporating the Account into the Grammar

In this section, I would like to take a closer look at how the grammar needs to change in light of the analysis sketched in (172) below from the previous section:

(172) $x \in \| \text{Part}(\text{Cov})(\alpha) \|$ if and only if

$$\forall y[(y \in \| Cov \| \wedge y \subseteq x) \rightarrow y \in \| \alpha \|]$$

To begin with, we need a new translation rule, something like the following:[17]

(174) Distributive VP rule:
If α is a plural VP with translation α', then Part(Cov)(α') is also a translation for α.

Next, a semantic rule is needed to interpret these translations. We take e-type expressions to denote elements of D^*, and type <e,t> expressions to denote subsets of D^*. The cover variable is of type <e,t> and the Part operator is interpreted as follows:

(175) Let α and ß be variables whose values are object language expressions of type <e,t> and let u,v be variables whose values are entities in D^*. For all α,ß,u:

$$u \in \| Part(ß)(\alpha) \| \text{ if and only if}$$
$$\forall v[(v \in \| ß \| \wedge v \subseteq u) \rightarrow v \in \| \alpha \|]$$

Finally, a word about the pragmatics. In the introduction I said that interpretation would be with respect to a model and that I would write simply $\| \cdot \|$ instead of $\| \cdot \|^M$, omitting the superscripted M. Since we now have free variables in the translations, we need a mechanism by which they get interpreted. For concreteness, let's assume the pre-DRT view of things, where interpretation is carried out with respect to an assignment function and where the particular function chosen is somehow pragmatically determined (Cooper 1979, for example, discusses this method and attributes it to Montague). This means that from now on, $\| \cdot \|$ is an abbreviation for $\| \cdot \|^{M,g}$ where the superscripted M and g have been omitted.

Returning to the translation rule (174), we see that it allows for plural VPs to have two different translations. This is the source of the distributive-collective ambiguity mentioned at the end of the previous section. It also makes it apparent that the way that the **range** of distributive readings is handled, namely in pragmatic terms, differs from the way the distributive-collective ambiguity is handled. This conflicts with the

[17]This rule will produce translations containing multiple Part-operators. I suspect that this is harmless and will ignore this possibility.

intuition discussed earlier according to which the distributive (to singularity) and the collective readings are just extremes on a scale which includes distribution to subpluralities of various 'sizes'. What I would like to explore then, is a way to modify our grammar to reflect this intuition.

Recall, above, a distributive reading of:

(167) The bottles are light enough to carry.

was analyzed with the following translation:

(173) (Part(Cov)(are-light-enough-to-carry')) (the-bottles')

by taking the assignment to Cov to be a set containing each of the bottles. It is reasonable to assume that by collecting the bottles together under one noun phrase, the speaker makes salient in the discourse another cover of the domain: one in which the bottles occupy a single cell. Assigning this cover to the variable Cov leads to the collective reading. In other words, we now have two sources for the collective reading, one with and one without the Part operator. Since we don't in fact need the translation without the Part operator for anything else, we can simplify the translation rule (174) as follows:

(176) Plural VP rule:
If α is a singular VP with translation α', then the corresponding plural VP is translated as Part(Cov)(α').

On this way of doing things, the Part-operator simply reflects the plural marking on the verb and the collective reading is now just one among many that the semantics and context could potentially yield.[18] Support for this move, comes from the use of the phrase *in a sense*, which occurs when a speaker attempts to bring the so-called distributive-collective ambiguity into focus. For example, if John and Mary each made \$1,000, one might at first reject (177), but then upon reflection utter (178):

(177) John and Mary made \$1,000.
(178) Well, in a sense they did and in a sense they didn't.

[18] It might be harmless to incorporate the Part-operator in singular VPs as well. This would require a different kind of translation mechanism.

Lewis (1970:229) and Kamp (1975:150) have analyzed this phrase in its use with vague adjectives as in *John is clever, in a sense*. The role of *in a sense* according to these authors is to select a context or set of contexts with respect to which the adjective's vagueness is resolved. We might do something similar here. Assume that the predicate of (177) is interpreted with a Part(Cov) operator. In a "collective-context," Cov is assigned a cover in which John and Mary occupy the same cell. In a "distributive context," it is assigned a cover in which John and Mary occupy different cells. In an ambiguous context either assignment is possible. The role of *in a sense* in (178) is to restrict the interpretation now to a collective context, now to a distributive context. On this account then, we say that in the ambiguous context the plural noun phrase makes salient two different covers of the domain, one collective and the other distributive.

While I think this essentially pragmatic view of the distributive-collective ambiguity is correct, there is an apparent problem with the way we've set things up. Earlier (page 63), we argued for the D-operator analysis in part because it could handle the fact that conjoined verb phrases need not be understood both collectively or both distributively even though their conjunction combines with a single subject. On the current view, this type of data becomes a problem. To see this, consider the following example:

(179) These cars were put together in Malaysia and sent to different countries in Europe.

Here I am interested in a construal of the sentence in which the first verb phrase conjunct is understood distributively while the second is understood non-distributively. In other words, the cars were not attached to one another, but rather each car was assembled in Malaysia and each car didn't go to different countries, rather the shipment of cars was dispersed in Europe. Now consider the kind of translation the conjoined VP would receive (assume $\| A \wedge B \|$ is interpreted as $\| A \| \cap \| B \|$):

(180) Part(Cov)(p.t.i.Malaysia') $\wedge$ Part(Cov)(s.t.d.c.i.Europe')

For simplicity, let's assume the domain includes only the cars in question. Following the recently adopted view of the distributive-collective ambiguity, the cover variable in (180) is either assigned a set containing each of the cars, in which case we get the distributive reading of both conjuncts or it is assigned a set containing the set of all the cars in which case we get the collective reading of both conjuncts. Unfortunately, neither of these possibilities corresponds to the desired reading of the sentence.

I think the source of this problem is that we are not yet used to thinking of the distributive-collective ambiguity as pragmatic. On that view, a distributive-to-singularities reading arises because, in some sense, the conversants are thinking of the plurality in question in terms of its singular parts, while the collective reading arises when the conversants think of the plurality in question as a whole. But nothing prevents us from thinking of the same plurality in two ways. The problem in (180) is not the pragmatic view of collectivity, but rather that that representation doesn't allow for this third possibility. In fact, the culprit here too is our translation rule, which forces us into assuming one way of thinking of the given plurality per conversation. The following modification should rectify this:

(181) Plural VP rule:
If α is a singular VP with translation α', then for any index i, $\mathrm{Part}(\mathrm{Cov}_i)(\alpha')$ is a translation for the corresponding plural VP.[19]

Now, a possible translation for (179) would be:

(182) $\mathrm{Part}(\mathrm{Cov}_1)(\text{p.t.i.Malaysia}') \wedge \mathrm{Part}(\mathrm{Cov}_2)(\text{s.t.d.c.i.Europe}$

And, on the intended reading, Cov_1 is assigned the set containing each of the cars, while Cov_2 is assigned the set containing the set of all the cars.

Although the rule in (181) grew out of a consideration of how language users think about pluralities, one could have arrived at this result from a different route beginning with an argument presented earlier for the D-operator (section 5.2.2). It had been noticed that plural predicates display scope interactions, behaving as if they contained a quantifier. The D-operator was a spelling out of that quantifier, as is our Part operator. Later, after having introduced the cover variable, I remarked that quantification in natural language always or almost always involves some sort of discourse restriction of the domain of quantification. The cover variable is a way of formalizing that restriction for the quantifier associated with plural predicates. Continuing this line of reasoning, we note that although domain restriction may be a restriction of the entire domain of quantification, it is something that is done on a per-quantifier basis, as pointed out in Westerstahl (1985). Here too, we should allow for each quantifier associated with plural predication to have its own domain

[19]One might want here a set of rules, one for each index, as Montague (1974) does with Quantifying-In. In that case, each rule provides a unique translation.

restriction. This is what rule (181) does.

I want to end this section with one more piece of evidence in favor of the grammar set up here and in particular the view it takes on the distributive-collective ambiguity. Consider the following incident. Apparently, in the last five years, an unsavory Mr. Slime has made several purchases from a computer store: 4 computers and 1 cartonful of diskettes. These purchases were made over the course of a few years and each time, Mr. Slime paid an initial amount in counterfeit currency and the remainder he paid for with a valid credit card. The following remark is entered in the police report:

(183) The computers were paid for in two installments and the diskettes were too.

First note, that the intention here is a distributive reading of the first verb phrase and a collective reading of the second, elided, VP. An analysis in which distributive and collective readings correspond to different underlying forms would have to explain how the second VP was elided when in fact it was non-identical to the first. What should we say about this example? We will assume the following formula represents the meanings of the conjuncts of (183) with c denoting the computer-plurality and d, the diskette plurality:

(184) $c \in \text{Part}(\text{Cov}_0)(\text{p.f.i.t.installments'})$
$d \in \text{Part}(\text{Cov}_0)(\text{p.f.i.t.installments'})$

Notice, here we cannot explain the different readings of the VP in terms of assignments to different cover variables, since here we are assuming identity of the VPs.[20] In fact, we don't need to assume different cover

[20]It is interesting to compare the reasoning here with that of Klein (1980:15-16). Klein was looking at the contextual evaluation parameters that determine the comparison class for adjectives like *tall* and those that determine the domain of quantification for quantificational noun phrases. Klein observed that an elided VP and its antecedent can differ with respect to the settings of these parameters for material inside the VPs. In contrast, the referent of an indexical pronoun in an elided VP must be identical to the referent of the corresponding pronoun in the antecedent VP. Klein concluded from this that the contextual parameters should not be incorporated like pronouns into the representation. We are not driven to a similar conclusion in the present case, as the reader will shortly see.

variables in this case, since the subjects of the two VPs are not identical. Rather we need to consider how the writer of (183) was thinking about things. As far as the facts of the case were concerned, the purchased items divide up into purchase-parts: one for each computer and one for the set of diskettes. When this cover of the domain (or some extension of it to cover things other than the stolen merchandise) is assigned to the variable Cov_0, the intended reading of (183) results.

It should be pointed out that the analysis just provided rides on the assumption that Cov gets assigned a cover of the whole domain and not just a cover of the plurality that the VP is predicated of, as suggested earlier (section 5.2.4, (170-171)). Lasersohn (1995) and an anonymous reviewer have pointed out that the decision to assign covers of the whole domain allows for cover choices that would effectively eliminate dependence of the truth of a sentence like *John and Mary left* on whether or not John left. This would happen, for example, if the cover puts John in only one cell, with someone other than Mary. While such a cell is in the cover, it is not a subset of the set of John and Mary, hence the truth value assigned to the sentence will incorrectly not depend on John's having left or not, given the rule in (172) above. The following variation on the semantics of the Part operator would take care of this.

Alternative Semantics for the Part operator:

(a) For any Y, a set of sets of individuals, and any y, a set of individuals, Y/x is the largest subset of Y that covers x, if there is one, otherwise it is undefined.

(b) $x \in \| \text{Part(Cov)}(\alpha) \|$ if and only if $\forall y[(y \in \| \text{Cov} \| /x) \rightarrow y \in \| \alpha \|]$

I refrain from adopting this formulation because I believe that pathological values for domain of quantification variables should be ruled out pragmatically and not semantically. This point is elaborated in Schwarzschild (1994:228-233).

5.4 Excursus on Plural Quantification: Partitions

In the previous section we replaced the D-operator which was interpreted with a quantifier (implicitly) restricted simply to the domain of quantification with the Part-operator which involved quantification restricted to a cover of the domain of quantification. Let us call this kind of restricted quantification, partitioned quantification. I use the verb "partition" loosely referring to something that results in a cover of any sort, even one that is not technically a partition. Our discussion gave the impression that partitioned quantification was something unique to the Part-operator. The point of this excursus is to indicate that partitioned quantification is pervasive. To show this, I will briefly review a number of examples whose interpretation is sensible only in case quantification of this sort is assumed. I will not endeavor to analyze these examples in any serious way.

Our first example is of a type common in statistical reports:

(185) One out of every three handguns in America is made by Smith and Wesson.

(185) is not falsified by the fact that three handguns can be found in America all of which are not made by Smith and Wesson. This is because (185) is considered true if there is a partitioning of handguns into threes such that each triplet contains a Smith and Wesson. Interestingly, replacing *every* with *each* or *any* changes the meaning in a way that seems to be related to partitioning:

(186) ? One out of any/each three handguns in America is made by Smith and Wesson.

If (186) means anything at all, it is that for any partitioning of handguns into threes, each triplet contains a Smith and Wesson. This is a roundabout way of saying that with the exception of at most two, all American handguns are Smith and Wessons. The difference noted here between *every* and *any* is especially clear in a situation in which the context provides an obvious partitioning of the domain. Observing a suburban neighborhood in which houses are built in blocks of three, each block in a different style, one may say:

(187) I observed that every three houses {formed a block / were built in the same style}.

but it would be false to say:

(188) I observed that any three houses {formed a block / were built in the same style}.

If the difference between *any* and *every* has been correctly analyzed, then I do believe there is a lesson here for our move from the D to the Part operator. The D-operator was modeled on *each* and for many speakers, floated *each* quantifies over singularities only. For this reason it seemed natural that a covert distributivity operator should also quantify over singularities. However, the comparison between *every* and *any* shows that quantifiers can differ with respect to the partitioning of the domain of quantification. Floated *each* requires a partition into singularities while the Part operator does not.

Our next example comes from 'the discussion in Lasersohn (1988:Ch.IV) of quantifiers and group-level properties. He distinguishes between three different types of situation in which the sentence:

(189) John and Mary made $10,000.

is true. Either John and Mary each made $10,000 or in the "pure collective" case they made $10,000 in a joint enterprise or in the "cumulative" case, the combination of their individual incomes amounts to $10,000. Lasersohn points out however that these three situations are not equally relevant for the negative quantifiers *no* and *only*. To see this, assume that in fact (189) is true and that in addition it is true that:

(190) Bill made $10,000.

If no other individuals besides those mentioned so far made any money, is (191) below true?

(191) Only Bill made $10,000.

Lasersohn contends that the answer depends on which of the situations described above make (189) true. If John and Mary each made $10,000 or if they made $10,000 in a joint enterprise then (191) is false. But if $10,000 represents the combination of their individual incomes (and no other money was made by them) then (191) is true. In short, negative quantifiers do not pay attention to the cumulative case.

Lasersohn (1988:190) discusses the following putative counterexample to this last claim:

> Consider the budget of a small city. The payroll for the police department totals $1,000,000, the payroll for the fire department also totals $1,000,000, and the payroll for the sanitation department totals $500,000. In this situation, sentence (192) seems false:

(192) Only the police officers get paid $1,000,000.

> The sentence is false because the firefighters also get paid \$1,000,000. Since it is the combined income of the firefighters that is in question, this appears to be a case where *only* excludes a group from having a property even if it has that property only by virtue of a totaling operation on the properties of the group's members.
>
> Compare another example, however. Suppose now that the fire department payroll is only \$500,000. In this case, (192) is true -- despite the fact that the combined income of the firefighters and the sanitation workers is \$1,000,000. What is different about this case? It seems clear that the reason why (192) was false in the original situation but true in this one is that in the original situation there were two distinct payrolls which (each) totaled \$1,000,000, while in the new situation there is only one. To calculate the truth value of the sentence, one compares the lump sums allocated to single entries in the overall budget.

Elaborating on this explanation we might say that the context naturally partitions the workers into three sets of workers and *only* is sensitive to this partition.[21] In the first case there is another member of the partition besides the police officers that gets paid one million dollars, while in the second case there isn't. Reference to a partition is important here. We cannot simply say that the domain includes only three entities that get paid. The following could be felicitously uttered in a conversation including (192) without affecting the facts outlined above:

(193) Every worker receives his paycheck on the same day so the city estimates it must have at least \$50,000 in the bank at all times.

In other words the domain must include individual workers as well.

Another case of partitioned quantification occurs in the use of the word *majority*. Consider first the indefinite term *a majority*. According to (194),

(194) If a majority votes for this proposal, we are doomed.

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[21]It could be that the partitioning observed here comes in not from the meaning of *only* but rather from a Part operator on the verb phrase.

any group containing most of the voters could spell disaster. Imagine now that a secret ballot is taken, 40 out of 50 voters are in favor and it is now truly announced that,

(195) The majority voted for the proposal.

Who or what does *the majority* refer to?' There is no unique group containing most of the voters, unless we have partitioned the domain. Further, not just any partition will do. A group containing all those who were against plus 20 of those who voted in favor constitutes a majority. That majority in fact did not (all) vote for the proposal. Rather, what is assumed here is a partition into voting blocks.

Partitioning as a prerequisite for quantification is not limited to pluralities. Various people have noted that partitions are assumed in the counting of kinds (Carlson 1977:346ff)[22], facts (Kratzer 1989:608ff) and events.

The omnipresence of partitioned quantification suggests the following open question. If partitioning is a prerequisite for quantification then isn't a generalization missed by including this as a part of the Part operator? Shouldn't it simply fall out of a general mechanism in the grammar for interpreting quantifiers?

5.5 Two Place Predicates and Distributivity

Various people have discussed the phenomenon of distributivity as it relates to two or more arguments of a verb at a time. The purpose of this section is to consider some examples, particularly those of Scha (1984)

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[22]Carlson requires that in order to count members of a set of kinds, that set must form a partition, not just a cover. That is, the set of kinds counted must be such that no two kinds have the same realization. His reason is that we cannot say *three kinds of dogs are in this room* if just one dog is in the room even if that dog instantiates three kinds, e.g. collies, females, loving dogs. Carlson's requirement is probably too strong. I think it is fine to say:

(i) Three kinds of professionals will attend this conference--- doctors, lawyers and college professors.

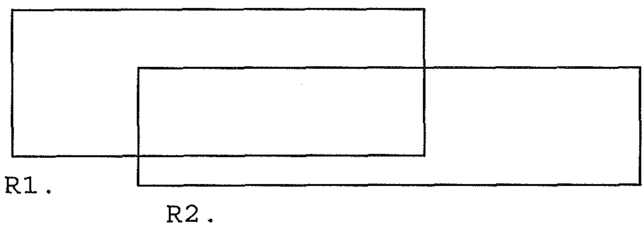
despite the fact that there may be an individual who is both a doctor and a lawyer.

and Scha and Stallard (1988), which have been used to identify special distributional readings associated with two place predicates and to extend the ideas on distributivity presented above to these cases.

Scha considers the following sentence in connection with the figure in (197):

(196) The sides of R1 run parallel to the sides of R2.

(197)



He claims that (196) has the reading given in (198):[23]

(198)
$$\forall x \in SR1 : \exists y \in SR2 : \ PAR[x,y] \ \wedge$$
$$\forall x \in SR2 : \exists y \in SR1 : \ PAR[x,y]$$
[SR1 = the set of sides of R1]
[SR2 = the set of sides of R2]

Scha analyzes (196) with the following formula:

(199) PAR[SR1, SR2]

Following the method of Bartsch (1973), the reading in (198) is derived by adding the following meaning postulate to the grammar:

(200)
$$PAR[u,v] \Leftrightarrow \forall x \in u : \exists y \in v : \ PAR[x,y] \ \wedge$$
$$\forall y \in v : \exists x \in u : \ PAR[x,y]$$

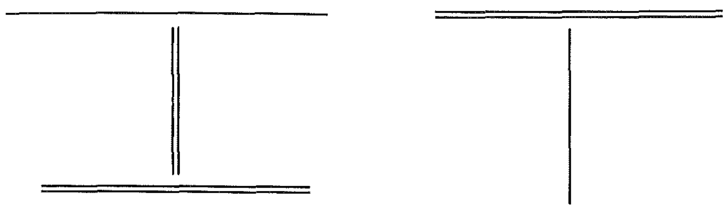
---

[23]Scha also includes as part of the reading that sets SR1 and SR2 are non-empty. We leave this out here and in the meaning postulate to be given in (200). Also, Scha maps individuals as singleton sets which are always distinguished from their members. I have adapted his formulae to the approach taken here, as discussed in the Appendix. In this adaptation, x,y are variables over singularities, while u,v are variables over pluralities and singularities.

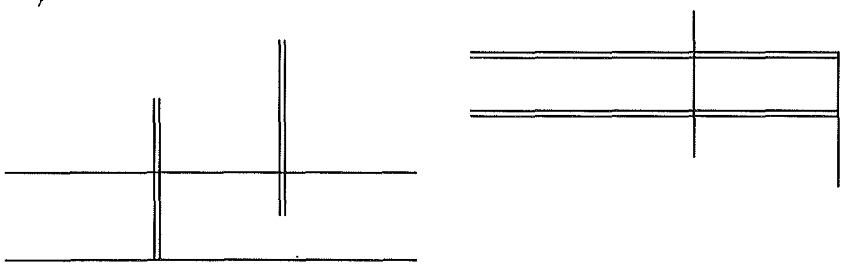
This analysis is similar to Lasersohn's approach to Gillon's examples discussed above. As in that case, I would like again to show that the meaning postulate approach cannot account for the effects of varying context. To that end consider the following sentence in connection with either of the diagrams in (202) or (203):

(201) The double lines run parallel to the single lines.

(202)



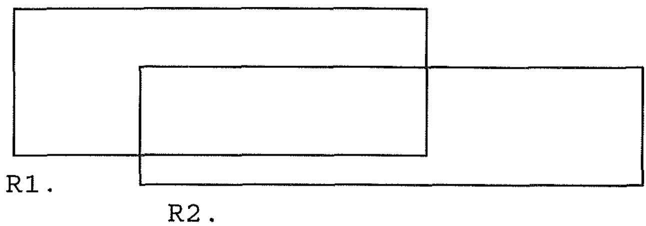
(203)



I find the sentence false in both situations or maybe difficult to judge. But the meaning postulate in (200) would have it otherwise. Letting SR1 now be the set of the double lines and SR2 the set of the single lines, the formula in (198) is true. This means that if the meaning postulate is correct, (201) should be true. My feeling is that again factors that arise in the interpretation of a sentence in a specific context (197) are mistakenly identified as part of the lexical meaning of the predicate in question. Pursuing the program begun above, I would like to find a way to have the relevant contextual information enter into the interpretation without incorporating it once and for all in the meaning of lexical items.

In order to develop a plan for using necessary contextual information in the interpretation, we first need to decide what the relevant information is. Let's look again at the diagram in (197) repeated below, to determine why it is that we agree the sides of the first rectangle run parallel to those of the second.

(197)



It appears that we compare the horizontal sides of the rectangles and the vertical sides of the rectangles independently or perhaps we compare the top horizontals, the bottom horizontals and left and right verticals. This diagram differs from those in (202) and (203) in that it provides us with an intuitive partition of the lines in question. Whereas in previous discussion we relied on the partitioning of sets of elements, here we need to partition sets of pairs. Building on our earlier analysis, we need an operator like Part and a variable like Cov that work on pairs. To do that, we need to extend the notion "cover" to pairs:

(204) T is a **paired-cover** of $<A,B>$ iff:
there is a cover of A, C(A), and there is a cover of B, C(B), such that:
i. T is a subset of C(A) X C(B).
ii. $\forall x \in C(A)\ \exists y \in C(B)$: $<x,y> \in T$
iii. $\forall y \in C(B)\ \exists x \in C(A)$: $<x,y> \in T$

If T is a paired-cover of $<A,A>$
then T is a paired-cover of A

Now we introduce a two-place version of the Part operator, PPart (short for paired Part). We let X,Y be variables whose values are pairs of elements in the domain and we use the symbol $\subseteq_2$ to combine two pair denoting terms where $<a,b> \subseteq_2 <c,d>$ iff $a \subseteq c \wedge b \subseteq d$. We call this relation pair-subset. We assume now that some contexts provide a value for the variable PCov and that that value is a paired cover of the domain. Our semantics for PPart is given as:

(205) $X \in \|\ \mathrm{PPart(PCov)}(\alpha)\ \|$ if and only if
$\forall Y[\ (Y \in \|\ \mathrm{PCov}\ \| \wedge Y \subseteq_2 X) \rightarrow Y \in \|\ \alpha\ \|\ ]$

Let us see how this works in our test case. The paired cover assigned to PCov in the context of Scha's diagram consists of pairs whose members are both horizontal or both vertical and it will not contain mixed pairs. Let (SR1,SR2) denote that pair of sets whose first element is the set of sides of rectangle 1, and whose second element is the set of sides of rectangle 2. Take an arbitrary element Y of PCov. If its first element is a subset of SR1 and its second element is a subset of SR2, then Y $\subseteq_2$ (SR1,SR2). Furthermore, Y $\in$ $\|$ run-parallel' $\|$ because of the way PCov was set up. That is, in (197), any two lines that are both horizontal or both vertical are parallel. So the following holds:

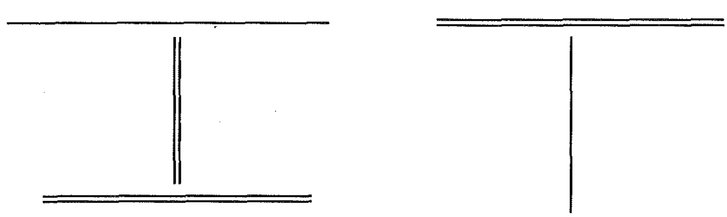
$$\forall Y[(Y \in \| \text{PCov} \| \quad \wedge \quad Y \subseteq_2 \| (\text{SR1,SR2}) \|) \rightarrow Y \in \| \text{run-parallel'} \|]$$

Assuming *run parallel* is translated PPart(PCov)(run-parallel') and the usual rules for assigning meaning to transitive clauses are employed, the semantics given in (205) guarantees that *the sides of R1 run parallel to the sides of R2* is true for Scha's diagram, (197). The required translation entails a rule of the following sort:

(206) Plural TVP rule:
If α is a singular transitive verb phrase with translation α', then for any index i, PPart(PCov$_i$)(α') is a translation for the corresponding plural transitive verb phrase.

In order to further justify the PPart operator, I would like to present some more examples whose interpretation seems crucially to rely on a pair-partitioning of the domain. Before doing that we might ask why (201) is not true of (202):

(201) The double lines run parallel to the single lines.
(202)



Our answer will be somewhat tentative, for reasons to be explained in the next section. It may be the case that mention of the double and single lines introduces a paired partition into the discourse consisting of all pairs of a double line and a single line and that this is the only value assignable to PCov. Now there are pairs of non-parallel lines in this cover that are pair-subsets of the pair whose first element is the double lines and whose second element is the single lines. It would follow then that (201) with *run parallel* translated as PPart(PCov)(run-parallel') is false.

We move now to other instances of the paradigm examined so far. The first is based on an example that I have discussed elsewhere (Schwarzschild 1990). Imagine you arrive on the first day for a literature class on the relation between fiction and non-fiction. While introducing the course requirements, the lecturer directs your attention to the chart below and says that:

(207) The fiction books in the chart complement the non-fiction books.

Fiction	Non-fiction
Alice in Wonderland	Aspects ; Language (Bloomfield)
Fantastic Voyage	Gray's Anatomy
David Copperfield, Hard Times	Das Kapital, The Wealth of Nations
Oedipus Rex, Agamemnon	Freud's Intro. to Psychology
Richard III	Machiavelli's The Prince

You are required to read three fiction books and their non-fiction complements. It hardly needs saying that the truth of (207) depends on a comparison of adjacent pairs of books. Note a number of things. The domain is partitioned into pairs of adjacent entries. Some of the pairs have non-singleton sets as members. (207) is true if for every pair in the pair-partition, if it is a pair-subset of (‖ the fiction books ‖ , ‖ the non-fiction books ‖) then the first element complements the second element. Crucially, non-adjacent pairs are irrelevant here.

In the two examples we have seen so far the value assigned by the context to PCov was determined by non-linguistic, graphic information. For balance I mention a few other kinds of cases. Scha and Stallard (1988), whose work was intended for use in accessing information about the capabilities and readiness conditions of the ships in the Pacific Fleet of the US Navy, discuss the following example:

(208) The frigates are faster than the carriers.

They speak of two translations for this sentence. The first, called a universal-universal translation, leads to a reading where every frigate is faster than every carrier. The other translation, which I will call universal-existential, requires that every frigate is faster than some carrier and that for every carrier there is a frigate faster than it. It is not very hard, however, to envision a situation in which neither of these represents the correct reading of the sentence. We just need to think partitionally. Imagine for example, that (208) is uttered in a context in which it is clear that these ships are sent out in teams to different areas of the globe with each team consisting of frigates and carriers. It may be that one area calls for very fast action while another will tolerate a sluggish response. If that were the case, I would judge (208) true just in case the frigates in a given area were faster than the carriers of that area, regardless of what speed relations obtained between ships of different areas. In this situation the universal-universal reading is too strong and the other reading is too weak. A semantics that incorporates the notion of a contextually determined partition accounts for these facts without having to drum up new translations.

Consider finally an example where the value for PCov is determined linguistically within the sentence containing PCov:

(209) Even though the couples in our study were not married, the men did display aggressive behavior towards the women.

Here the concessive clause raises the salience of a paired-cover in which men and women are paired into couples. (209) seems to be about aggressive behavior within pairs. The point is strengthened if *all* is added:

(210) Even though the couples in our study were not married, the men all displayed aggressive behavior towards the women.

In this case every man would have had to display aggressive behavior towards his female pair-mate, but crucially he would not have had to be aggressive to non-pair-mate women for (210) to be true.

I would like to end this section by briefly mentioning directions in which the present account could be further pursued. The two operators introduced so far are covert. The floated quantifier *each* could now be thought of as an overt counterpart of Part with a particular assignment to Cov, namely one where the cells are singularities. The adverb *respectively* might similarly correspond to the PPart operator. It has the effect of a PPart operator with a particular assignment to PCov. Other phrases that seem to restrict the values of Cov and PCov are *together*, especially in its sentence initial position as well as phrases such as *one by one* and *in groups of three*. In each of these cases, the lexical item puts restrictions on the value that can be assigned to a free variable. This is similar to analyses of temporal adverbials where they are said to restrict the possible values assigned to a contextual variable over times.

The Part operator is for one-place predicates and the PPart operator is for two places. It is natural then to consider 3 and more place predicates. The following alternative formulation of the semantics of two-place distributivity in terms of functions should suffice to show how things could be extended for more places.

(211) Alternative Semantic Rule for PPart:

Let ß be a variable of type $<<e,t>,t>$, α' an expression of type $<<e,t>,t>$ and a,b,u,v, variables over elements of the domain, D^*, then:

$$\| \mathrm{PPart}(ß)(\alpha') \|^{M,g}(a)(b) = 1 \text{ iff}$$
$$\forall u \forall v[(g(ß)(u)(v) \wedge u \subset a \wedge v \subset b) \rightarrow \| \alpha' \|^{M,g}(u)(v)]$$

5.6 On Collective Readings

The approach that I have outlined here in terms of contextual paired-coverings has been offered as an alternative to Scha's analysis based on meaning postulates. I think that the comparison between the approaches is worth pursuing particularly in light of the elaboration and modifications that are presented in Scha and Stallard's article. My original motivation for employing the PPart operator was simply that the meaning postulate in (200) fails in certain situations. Roberts (1987:133-4) lodges another objection to Scha's program. She points out that certain verbs are ambiguous, having distributive and collective readings and so if the source of distributivity is a meaning postulate one is forced to claim that meaning postulates can be optional. This, Roberts claims, is incoherent and she goes on to propose an analysis in terms of a distributivity operator. But Scha and Stallard have found a solution to this problem. Essentially, they give multiple translations to English expressions and these translations are associated with the various readings.[24] For example, the English verb *eat*

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[24]Scha and Stallard's system actually involves double translation. English is translated into a language which itself gets translated.

has at least these two translations:

(212) $\lambda u,v: \forall y \in v : \exists x \in u : \text{EAT'}[x,y]$
(213) $\lambda u,v: [[\forall y \in v : \exists x \in u : \text{EAT'}[x,y]] \wedge [\forall y \in u : \exists x \in v : \text{EAT'}[y,x]]]$

These particular translations are motivated by Scha and Stallard's belief that the sentence *the children ate the pizzas* has different quantificational readings which differ in whether or not each child has to have eaten a pizza or not. Scha and Stallard allow that different readings are imposed by context, though they do not elaborate on this claim.

Given this new way of incorporating various readings in the grammar, there may now be an answer to my charge that the meaning postulate in (200) leads to incorrect predictions in some situations, since that meaning postulate is now attached only to one particular translation of the phrase *run parallel*. That translation is salient, so the story would go, in the context of Scha's original diagram but not with the figures I presented as counterexamples (202) and (203).

To me this approach is misguided in the role that it attributes to the context. In the examples we have seen so far the context is not providing information about which quantificational formula is appropriate, but rather about specific groupings. It tells us which elements are to be compared, which elements are to be checked and how, in order to verify the sentence. It does not determine a quantity of elements to check nor how many of this type must bear the relation in question for every one of that type.

There is, I think, another more fundamental flaw implicit in Scha and Stallard's agenda. The driving force of that analysis seems to be to translate away plural predications into quantification over and predication of singularities, whenever the predicate in question is applicable to singularities. It is doubtful whether this goal is ultimately attainable. Lønning (1987:124)'s discussion of the sentence *the boys ate the cakes* illustrates the difficulties one encounters in pursuing this goal. He points out that this sentence is true in a situation in which two boys jointly partake of each of two cakes. Notice first that the Scha and Stallard translations for *eat* given in (212) and (213) will not work here. In fact, without moving to quantification over sub-singularities (parts of cakes), it seems well nigh impossible to formalize this as a reading in any meaningful way. Matters get even worse once you consider what Lasersohn (1988,1990) terms "team-credit extensions." These are examples in which a team gets credit for the actions of one of its members. For example, if John and Mary are a couple we may report that John and Mary made

\$20,000 last year, even if in fact, only one of them actually worked. Expanding on the discussion in Carlson (1977:102ff), Roberts (1987:147) notes that

(214) The Marines invaded Grenada.

is true, in one sense, even though not all members of the U.S. Marine Corps went to Grenada.[25] The problem these examples pose for the agenda I have attributed to Scha and Stallard is as follows. Team credit extensions have a non-logical aspect to them. They cannot be analyzed simply by providing a translation for the verb phrase that has an existential quantifier in it, (e.g. λu: $\exists y \in u$: invaded-Grenada[y]). Thus for example, it cannot be said that Mozart and Einstein won the Nobel Prize even though one of them did, because Einstein and Mozart were not a team in any sense.

The conclusion that many have reached based on the foregoing examples, and with which I concur, is that even predicates applicable to individuals can have a simple collective reading. On this reading, we should not, indeed can not, specify in the grammar how many of the singularities that make up a plurality must satisfy the predicate in order for that plurality to satisfy it. In the system I sketched here, this reading arises when the cover does not partition the plurality in question into more than one part. In this case, the Part and PPart operators don't do any real work. And they shouldn't, for they are not present in the grammar in order to specify quantificational refinements of the collective reading; this we have just said is fruitless.

Some of the examples mentioned above might be useful in demonstrating the distinction I am making here. Recall the sentence *the frigates are faster than the carriers* uttered in a context where the ships are sent out in crews to different areas. If all of the carriers in some high-speed area are faster than all of the frigates in some low-speed area, the sentence isn't false. The construal we are after which employs the PPart operator tells us not to compare ships across areas. On the other hand, exactly how many frigates have to be faster than how many carriers in a given area is left unspecified. There may be exceptional quick carriers. Next we have

[25] Similarly, Gillon (1984) notes that if the soldiers in F-Troop are chasing a band of Indians and the soldier in front sees them we can say the soldiers of F-Troop spotted the Indians. However, if a member of F-Troop sees an Indian while on vacation, we do not say the soldiers of F-Troop spotted the Indians.

the book chart example from (207) in which the PPart operator tells us which particular entries are complementary. It does not tell us how many are complementary. Notice, that if the list was twice as long as it is, we still would not expect complementarity within the fiction or non-fiction column. And again, although the context determines which entities are related to which, there are singularities about which it says nothing. Consider one particular pair of adjacent books, say Oedipus Rex and Agamemnon on the one hand and Freud's Introduction to Psychology on the other. The sentence in (207) asserts that the former two complement the book by Freud. No relation is claimed to hold here between individual books.

It is important to stress that the distinction I am making here is not simply one of 'quantity' versus 'quality'. The important distinction is that between pragmatics and semantics. Consider again the point made in connection with the Granada example, (214). Here the question is how many and perhaps even which individuals in a group have to possess a property in order for us to say that the group possesses the property. The answer here will depend on the makeup of the group as well as the kind of property ascribed. These are semantic facts, or extralinguistic facts, that I, as a speaker, do not control in uttering (214). Compare this to the point made with the chart example (207). Here the question is what exactly is being said, which proposition is expressed. If the speaker has in mind the context illustrated by the chart, he is simply not claiming anything about non-adjacent book pairs. Think of what happens if the chart is rearranged and the context is changed. In this case, the speaker says something different about these very same books. The facts of the world will not have changed, the speaker is talking about the same books and the same relation of complementarity, yet the proposition expressed will be different.

I would like to end this subsection with an example discussed in the literature. Dowty (1987) expresses the view that it would be appropriate to use (215) to describe a news conference at which only a small number of the reporters present asked questions:

(215) At the end of the press conference, the reporters asked the President questions.

This is so despite the fact that some (or even many) reporters may not have asked questions. Compare this to:

(216) At the end of the press conference, the reporters remained silent.

Here one feels that all of the reporters must have remained silent for the sentence to be true. In both cases, a group is said to possess a property, but this entails different quantities of individual group members possessing the property in the two cases.[26] Whatever the explanation, it will have to do with facts about groups of reporters and about the properties being ascribed.

Now consider the following variation on (215):

(217) At the end of the press conference, the reporters from NBC, CBS and ABC asked the President questions.

Here again some but not all of the reporters would have to have asked questions for the sentence to be true. However, there is a difference. Even if the reporters mentioned in (215) are also from the major networks, indeed the same exact reporters, (215) doesn't seem to require that every network got a question in. On the other hand, (217) in at least some contexts, implies that questions came from one or more members of each of NBC, CBS, and ABC. Mention of these networks introduces a partition of the reporters in the discourse and, on the pertinent reading, this partition is assigned as the value of the variable that provides the domain of quantification for a distributivity operator.

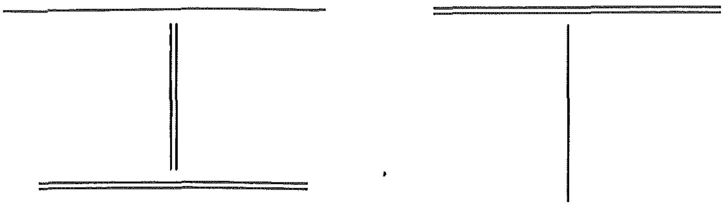
5.7 Plurals in Discourse: The Pragmatics of Distributivity

On the view espoused here, the truth conditions for sentences with plural arguments are often determined in part by the assignment to a free variable over coverings or paired coverings of the domain. We have said that the source of this assignment is pragmatic. Can we say more?

The question of what makes a partitioning of the domain salient in the discourse bears some resemblance to the question of what makes the antecedent for a pronoun salient. In many instances there are linguistic clues, some of which will be discussed below, but arriving at a complete answer surely involves other branches of cognitive science. Such is the case for domain partitioning as well. How we divide up our visual space for example is relevant here and yet that is a question which is properly a matter yet to be settled by experts on vision. Recall above we tried to explain why, in contrast to the diagram Scha used, *the double lines run parallel to the single lines* might be judged false for the diagram in (202):

[26] I have recently learned from Manfred Krifka that differences like these are discussed in Kang (1994).

(202)



A tentative answer was given to this question. A complete explanation of this difference demands an account of why there is no salient paired-cover here like there was in Scha's example. Such an account lies beyond linguistic theory.

So, while non-linguistic sources for partitioning are important to demonstrate that there is a pragmatic element to distributivity, we shouldn't expect to say much within linguistic theory about why a particular partition gets chosen in these cases. On the other hand, just as with pronominal anaphora, there are contexts in which the source of a domain partition or cover is linguistic and presumably these should be covered by some part of linguistic theory. What I therefore want to do now is to discuss aspects of anaphora resolution that appear to shed some light in the area of domain partitioning. Before turning to those parallels, I would like to remark on the status of the discussion to follow. I will be comparing the assignment of a value for a cover variable to the choice of antecedent for a pronoun. Pronominal anaphora is a much-studied case in which the semantics underdetermines meaning leaving conversants to resolve things further. But there are many other instances of this, including for example the choice of comparison class for some adjectives and the choice of domain of quantification for quantifiers. Recent research in this last area, especially as it pertains to adverbs of quantification, has shown how complex and difficult things can get. Although I suspect that these last mentioned cases are more closely related to domain partitioning, I will be focussing here on a comparison with pronominal anaphora resolution because of its relative transparency.

In general, to make the referent of a pronoun salient by linguistic means, one has to mention it explicitly. It is not enough to have mentioned a group containing the individual, as the infelicity of the following example (out of the blue) shows:

(218) The boys think that he will win.

Intuitively, a hearer would have no way of determining which member of the group referred to by the subject of (218) is the intended referent of the pronoun. Apparently this is enough to disqualify members of that group as choices for the pronoun's reference. This is reasonable enough. Somewhat surprising though, are contrasts like the ones in (219) and (220) from Partee (1989:footnote 13) and Carlson (1984:320) respectively, showing just how strong the effect is:

(219) a. One of the ten balls is missing from the bag. It's under the couch.
b. Nine of the ten balls are in the bag. It's under the couch.

(220) a. I did not catch all of the words. They were spoken too indistinctly.
b. I missed some of the words. They were spoken too indistinctly.

In (219a), as opposed to (219b), the remaining missing ball is not explicitly mentioned and hence is an unlikely candidate for reference by the pronoun *it*. In (220b), *they* is likely to refer to just the words missed but this is not possible in (220a) where that group of words is not explicitly mentioned.

The same kind of effect, I would claim, is found when one looks at potential choices for the value of a cover variable. An intermediate distributive reading is pretty much unavailable for an utterance in which the particular intermediate covering is not explicitly mentioned (or salient in the non-linguistic discourse). Consider the following:

(221) The children earned seven dollars.

Even though the children could be partitioned into two groups, say one male and one female, it is difficult, if not impossible to interpret (221) as involving distribution to these two groups. If I have that cover in mind, I must explicitly mention it as in:

(222) The boys and the girls earned seven dollars.

I have assumed here that to mention a particular covering is to name the cells comprising it. For the time being I will stick with that assumption, though other possibilities will be considered later on. Comparing (221) and (222), as in the pronoun case, intuitively, there are many intermediate coverings of the children, since the hearer of (221) has no way of knowing which the speaker might have in mind, none is available to serve as the value of the cover variable.

Now, although the mention of a particular entity is necessary to make it salient, we know that this is not always sufficient. The following is a simple example of this aspect of anaphora:

(223) [The boys and the girls] entered the room (separately). They were wearing hats and they were wearing skirts.

The subject of the first sentence contains three noun phrases, referring, on all accounts, to three entities: the boys, the girls and the children. Nevertheless, the plural pronouns that follow cannot be used, in the absence of other contextual clues, to refer to the boys or to the girls. Exactly why this should be the case, I don't know. Comparison of this example with the following example in which the pronoun can refer to the boys:

(224) The boys told the girls that Mary took their hats.

suggests that one way or another, the correct story for (223) will have to take into account the syntactic relationships among the three noun phrases (cf. Smaby (1979) for an attempt at such a theory). Whatever one says about (223), it shows that simply mentioning something doesn't necessarily make it available for anaphoric reference with a pronoun.

So far, we have seen some examples where entities discussed are not likely referents for a following pronoun. Perhaps the more common situation is for a pronoun to have more than one possible antecedent. In this case, a host of factors come in to play in determining which is most likely to be chosen. These factors include appeal to extra linguistic knowledge as well as properties of the text or conversation itself, such as the relative proximity of the antecedent to the anaphor and general notions of textual coherence. In this last category, are cases in which a referent is chosen to reconcile implied or asserted contrast between utterances. This effect is seen in the following pair:

(225) a. Bill is coming for dinner. John is coming too and will bring his book along.
b. Bill thinks Sam will arrive at 8:00, but John thinks he will arrive at 9:00.

In a., one tends to choose John as the referent for the possessive pronoun, for he is last mentioned and is the subject of the predicate containing the pronoun. In b., John is not the most likely referent of the pronoun, but rather Sam is. In b., John's thought is being contrasted with Bill's. The two thoughts are analogous and hence contrastable if one takes the pronoun to refer to Sam here.

In light of the foregoing observations, we now turn to some parallel considerations affecting the relative availability of various distributive interpretations. First, consider the following pair, based on the examples at the very beginning of our discussion of distributivity, about a group of women athletes and authors:

(226) a. The authors and the athletes outnumbered the politicians.
b. The authors and the athletes entered the room through different doors. We realized at once that they outnumbered the politicians.

(226a) is interpretable as meaning that the authors outnumbered the politicians as did the athletes. The cells of a cover of the women are explicitly mentioned, and this cover is then assigned as the value for the cover variable. This interpretation is not readily available in (226b). Paralleling what we said above, it appears that while mentioning a cover is necessary, it is not sufficient. In b. the noun phrase in which the cover is mentioned is further away from the verb phrase *outnumbered the politicians* than is the noun phrase *they*. Presumably, this works against the assignment of that cover to the variable in the verb phrase.

The following example, based on one from Barry Schein (pc), is a particularly surprising case in which a mentioned cover is nevertheless unlikely to produce the relevant reading:

(227) The vegetables, which are the beets and the carrots, weigh 5 lbs.

Even though the partition into beets and carrots is mentioned, Schein would find the intermediate distributive interpretation impossible. Here, the fact that the covering is mentioned parenthetically and perhaps 'outside' the clause containing the cover variable (cf. McCawley 1982) seems reduce its saliency.[27]

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[27]If I understood him correctly, the source of the problem in Schein's view is that explicit mention of a covering is insufficient and what is needed are individuating **events**. Schein's actual example was:

(i) *The integers which are odd numbers and even numbers are (all) equinumerous.

which he claims cannot mean:

Now just as anaphora resolution is amenable to extra linguistic reasoning and textual clues, so too is the choice of cover values. Compare, the example in (227), with the syntactically similar one below:

(228) The visiting players, who were Italians and Brazilians, outnumbered their opponents.

Here too the relevant covering is mentioned parenthetically, however here, the sentence does seem amenable to the intermediate distributive interpretation according to which the Italian players outnumbered their opponents as did the Brazilian players. Knowledge of what players and opponents do enters in in this case: the cells of the cover correspond directly to games played.

Besides extra linguistic factors, textual clues also have a role to play in the interpretation of plural discourse. Above, concerning (226), we observed that even when a particular intermediate covering is mentioned it may remain unavailable as a value for a cover variable if another cover is mentioned in an intervening noun phrase. However, this effect can be overturned in an effort to understand implied or asserted contrast among utterances in the discourse. The following examples are all cases where this seems to happen (here and there I have used capitalization to indicate contrastive stress):

(229) A: The beets, the potatoes and the carrots (all) cost less than the meat.
B: No, the vegetables (all) cost less than the BEEF, but not less than the chicken.

B's reply is readily interpreted with distribution to the kinds of vegetables mentioned in A's comment. This interpretation would be unlikely out of context. Similarly, in the following:

(ii) The odd integers and the even integers are equinumerous

These examples do not involve (simple) distributivity, ((ii) doesn't say that the odd integers are equinumerous and the even integers are equinumerous) hence I used a different example in the text. However, (i-ii) do involve reciprocity and are therefore relevant to the discussion in the next chapter.

(230) The administration thinks that the physics instructors AND the math instructors cover five courses. In fact, THOSE instructors cover only TWO courses. Only the English teachers cover five courses.

In the next example, a contrastive statement receives a paired-covering interpretation which would otherwise, in the absence of contrast, be unlikely:

(231) We expected the male pigs and the male goats to be more numerous than the female pigs and the female goats. In fact, the males were LESS numerous than the females.

On the relevant interpretation of the second statement in (231), the sentence is false, if, for example, there are more male goats than female goats, even if the total number of male animals is less than the total number of female animals. The paired-cover introduced in the first utterance, is carried over into the second. Although these effects may be related to the process of quantifier domain restriction encountered in the interpretation of a noun phrase, they cannot be reduced to that process. The particular interpretation arrived at here could not be achieved by narrowing or widening the set of males considered or the set of females considered.

This completes our comparison of pronominal anaphora and distributivity effects. The purpose here was not to develop an explicit theory of discourse that assigns a saliency ranking to potential pronoun or cover-variable interpretations. Rather, the goal was simply to further demonstrate that distributivity indeed behaves like a pragmatic phenomenon. As such, the presence or absence of a particular distributive interpretation is to some extent dependent on the kinds of things that more familiar cases of pragmatic phenomenon depend on.

5.8 Conclusion: The Union and Sets Theories Reconsidered

In the preceding pages, I have developed an analysis of distributivity within the context of the union theory.. It is now time to return to our main theme, the choice between the sets and the union theories. Recall, distributivity was raised as an issue for us, with the following pair of examples:

(232) The authors and the athletes outnumbered the men.

(233) The women outnumbered the men.

It was observed that even in a situation where the women just are the authors and the athletes, for (232) but not for (233), there is a distributive interpretation according to which the authors as well as the athletes outnumbered the men. This difference is explained on the sets theory by the fact that the subject of (232) but not of (233), denotes, or may denote, a set of two entities. We need only assume that a sentence is true on a distributive reading of the subject, just in case the verb phrase truthfully applies to each of the entities making up the referent of the subject and this assumption is needed anyway for simpler cases of distributivity. Since on the union theory the subjects in the pair above are coreferent in the situation described, the union theory appeared initially to be counterexemplified. This of course depended on a purely semantic analysis for distributivity, something that we now claim is incorrect. There is a pragmatic explanation available to the union theorist for the difference in the pair above. According to this explanation, as we have recently said, the relevant distributive interpretation requires the assignment to a variable in the VP of a cover that is salient in (232) but not in (233).

At this point, a proponent of the sets theory might argue as follows. Leaving aside the question of whether there is some pragmatic element to distributivity, at least in cases like (232-233), the sets theory is more desirable, since it makes very clear predictions, commensurate with the clarity of the data. The union theorist has to some extent avoided responsibility for the data here, by passing the problem off to some other part of the grammar or out of the grammar altogether.

To begin with the argumentation itself is a bit shaky. Sure, if we leave aside the evidence for a pragmatic analysis, then the union theorist appears to be avoiding responsibility. However, if we take that evidence into consideration, then the proponent of the sets theory needs to explain why the explanation here is semantic. But even if we grant the sets theorist a limited view of the data, things are not as smooth as might be suspected for that analysis. Trouble arises upon reconsideration of some of the examples provided in the last section, this time in terms of the sets theory. Recall, the modified version of (232-233), discussed above:

(226) a. The authors and the athletes outnumbered the politicians.

b. The authors and the athletes entered the room through different doors. We realized at once that they outnumbered the politicians.

(226a) and the last clause in (226b) differ in just the way (232) and (233) do.[28] But notice, first, that the most natural interpretation of the first clause of (226b) is one where the authors came in through a different door than the one used by the athletes. On the sets theory, that interpretation arises because the subject denotes a set of two sets, one of athletes, the other of authors. Since the pronoun *they* in the second clause is anaphoric to the subject of the first clause, it will also denote this set of sets. But this is exactly the denotation that gives rise to the intermediate distributive reading in (233), yet the intermediate reading is missing here. In other words, like with (232-233), (226a) and the last clause of (226b) differ in interpretation, but unlike with (232-233) their subjects are coreferent. The only possible way out here is to assume that the pronoun cannot refer to a set of sets, but just to a set of individuals, in effect, making the pronoun here coreferent with subject of (233), *the women*. Besides being ad hoc, this cap on the space of pronoun denotations won't work, as the following shows:

(234) The authors and the athletes arrived simultaneously but they left at different times.

According to the sets theory, the pronoun in this case would again have to denote a set of sets.

The examples in (226) show that the sets approach presents little advantage over the union approach for explaining examples where the intermediate distributive reading is lacking. No less troublesome are cases discussed earlier where these readings are available, even though the relevant noun phrases lacked any conjunction. The chart example, repeated here:

(207) The fiction books in the chart complement the non-fiction books.

involved an interpretation where there was distribution over parts of the fiction books and parts of the non-fiction books. Aside from the technical

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[28] I rely here on the judgment of a reviewer of the manuscript for this book, who cited an example like this one as a problem for the pragmatic analysis of distributivity. The claim there was that intermediate readings do not arise if the most recently mentioned NP does not describe the intermediate partition. Note, if the cases differ and the intermediate reading is in fact available in (226b), then the discussion of this example in the previous section would require revision as well, and the reviewers initial point would not go through.

problem of extending the sets approach to the two-place case, if this interpretation was to be achieved purely in the semantics, then the noun phrases here would have to denote higher than first order sets, but nothing in the syntax justifies this. A similar point holds for (230), from our discussion of contrast in the previous section:

(230) The administration thinks that the physics instructors AND the math instructors cover five courses. In fact, THOSE instructors cover only TWO courses. Only the English teachers cover five courses.

(230) is interpretable as entailing that the physics instructors cover two courses as do their colleagues in math. A sets analysis for this would require the semantics to assign to the simple noun phrase *those instructors* a set containing two sets, one with the math instructors and one with the physics instructors. Such a semantics would undermine the claims made for the differences between (232) and (233), for it would allow *the women* to corefer with *the athletes and the authors.*

Initially, distributivity was presented as a semantic phenomenon with respect to which the sets approach appeared to have an advantage. What we have lately seen is that a semantic account within the sets approach fairs poorly overall. On the other hand, a case has been made for viewing distributivity as a pragmatic or semantico-pragmatic phenomenon. In particular, the work that is done by the richer ontology of the sets approach in fact should not be handled semantically at all. This leaves us with the simpler union approach, and a pragmatic theory of distributivity, which, along with other pragmatic phenomena, requires further analysis both in and outside of linguistics.

Chapter 6
Reciprocity

6.1 Introduction

In chapter 4, I discussed a number of examples from the literature that were used to argue for the sets theory. The arguments all involved first finding a pair of noun phrases that in some models would be coreferent only on the union theory and then finding a predicate that in certain situations would appear to be true of one member of the pair and not the other. (235) below was an example considered in a model in which the young and old animals are just the cows and the pigs:

(235) a. The cows and the pigs were separated.
b. The young animals and the old animals were separated.

What I argued there was that although there is a difference between a. and b., even in the model described, in at least some speech contexts, a. and b. would say the same thing. I didn't spell out what exactly the source of these differences were and I want to attempt that here.

I have chosen to reopen this issue at this point, after having discussed distributivity, for two reasons. On the one hand, the story I will tell here is very much like the one told in the previous chapter. Here again, I think the sets theorist has misanalyzed pragmatic effects as semantic ones. On the other hand, it is important to have the two discussions near each other because despite the similarity of the two, the context dependence to be studied here is not just an instance of distributivity.

To begin, we review some of the evidence from chapter 4. Besides the pair in (235), we had the following pairs:

(236) a. The cows and the pigs talked to each other.
b. The young animals and the old animals talked to each other.

(237) a. The cows and the pigs were given different foods.
b. The young animals and the old animals were given different foods.

In each case, the subject NPs are different and this leads to a difference of meaning (in a broad sense) between the resulting pairs. One might think that these differences are explained by the theory of distributivity from chapter 5 and this is in fact not far from what we will ultimately say. Nevertheless, these are not just more examples of the chapter 5 kind. This is made obvious by considering the examples in (238) and (239), often claimed to be paraphrases of different readings of the examples in (236):

(238) a. The cows talked to each other and the pigs talked to each other.
b. The young animals talked to each other and the old animals talked to each other.

(239) a. The cows talked to the pigs and the pigs talked to the cows.
b. The young animals talked to the old animals and the old animals talked to the young animals.

It is clear how the theory of chapter 5 would handle the reading in (238) but this leaves us wondering about the reading of (236) in (239). Similar remarks apply to the other examples discussed in chapter 4. So what is it about the verb phrases used in those examples that give rise to the differences appealed to by the sets theorist, differences like those spelled out in (239)?

As Lønning (1989:§6.6) points out in connection with many of the same examples, they critically depend on predicates that are reciprocal. Some of these predicates involve overt reciprocal anaphors such as *each other*. Others, such as *be separated*, while they lack an explicit reciprocal nonetheless have a reciprocal meaning. The addition of an explicit reciprocal is meaning preserving:[29,30]

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[29]I am ignoring another reading of *were separated* which is paraphrased as *were separated from them/him*. Not all predicates for which the addition of an overt reciprocal is meaning preserving have this other reading. For example: *left together* (= *left together with one another*) and *collided* (= *collided with one another*) don't have this other reading.

(240) a. John and Mary were separated.
b. John and Mary were separated from each other.
c. John and Mary ate different foods.
d. John and Mary ate foods that were different from each other.

This data should be compared with that in (241) in which, as has often been pointed out, the addition of a reciprocal is not meaning preserving:

(241) a. John and Mary listened.
b. John and Mary listened to each other.
c. John and Mary met angry men.
d. John and Mary met men that were angry at one another.

Since the predicates that give rise to the phenomenon in chapter 4 are all reciprocal, our attention is now turned to properties of reciprocals.

6.2 Reciprocals

There is a tradition in the study of reciprocals which takes as a premise that the truth conditions for reciprocal sentences, in particular those of the form NP Verb *each other* or NP Verb Preposition *each other*, can be expressed as quantificational statements whose domain is the set of singularities and pluralities that are part of the denotation of the subject NP and whose predicates are the transitive verb whose object is *each other* as well as a distinctness predicate. The most common instantiation of this idea is what Langendoen (1978) calls Strong Reciprocity, according to which the sentence *the boys cheat each other* is true just in case every boy cheats every other boy. Note the elements making up this requirement: quantifier: *every*, main predicate: *cheat*, distinctness: *other*. Strong

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[30]Langendoen (1978:§6) argues based on the discussion in Leonard and Goodman (1940:51) that (i) and (ii) below differ in meaning:

(i) They are similar to one another.
(ii) They are similar.

As I understand it, the claim is that for (ii) to be true there must be some one respect such that each of them is similar in that respect to the other whereas (i) may be true as long as each of them is similar in **some** respect to the other. If this is correct, then both verb phrases in (i-ii) are reciprocal, they are just not synonymous.

Reciprocity works best if one's data is limited to sentences whose subjects denote two-membered pluralities, such as *John and Mary*. But Strong Reciprocity doesn't seem to be required in every case, as we shall shortly see, and so alternatives to Strong Reciprocity have been suggested. These involve varying the domain of quantification to include quantification over pluralities and varying the quantifiers themselves. The following three samples should give an idea of the range of these proposals. Langendoen (1978) discusses a requirement he calls Weak Reciprocity for Subsets. According to this requirement, a sentence of the form NP V *each other* is true just in case every individual in the subject's referent V's or is part of a group that V's a group it's not a member of and every individual is V-ed or is part of group that is V-ed by a group it's not a member of. If these are the truth conditions for Langendoen's *the prisoners released each other* and Max is a prisoner then he must have helped to release some other prisoners and he must have been released by prisoners other than himself. Fiengo and Lasnik (1973) propose that some reciprocal sentences are true if there exists a partition of the denotation of the subject noun phrase such that Strong Reciprocity holds within the cells of the partition. The sentence *the men are hitting each other* would be true according to Fiengo and Lasnik in a situation where the men are standing in pairs (=cells of a partition) and everyone is hitting his and only his pairmate. Finally, in Roberts (1987:141-143) we find a proposal based on a suggestion of Emmon Bach's to use the quantifier ENOUGH which specifies an amount but, as with *many* and *few*, the amount it specifies is context dependent. On this proposal, a sentence of the form NP V *each other* is true if enough individuals V enough individuals distinct from them and enough individuals are V-ed by enough individuals distinct from them.

Most of these proposals appear to impose requirements that are too strong as Langendoen (1978) and Fiengo and Lasnik (1973) have shown. For example *the boys kissed each other* is intuitively true even if not every single boy kissed every other boy, that is, even if there is no Strong Reciprocity. Most speakers agree that that sentence is not falsified, intuitively, just because one inaccessible boy out of a large group was not kissed. This means that the requirement of Strong Reciprocity in cells of a partition is also too strong. Even Weak Reciprocity for Subsets appears to be too strong for this case, though that would depend on whether we want to say that this requirement is met if the inaccessible boy was in a group of boys that did get kissed. Roberts' proposal is not counterexemplified in this case, since presumably enough of the boys kissed and were kissed to make the sentence true.

On the other hand, many of these proposals appear in some instances not to be strong enough as the above authors have also shown.

An example of this problem which will be of interest to us is the following:

(242) The prisoners on the two sides of the room could see each other.

There are readings of (242) in which the predicate *could see each other* applies distributively to prisoner subgroups. Setting these readings aside, (242) is likely to be interpreted in such a way that it is judged false in a situation in which there are prisoners on both sides of the room and there is an opaque barrier between them. However, assuming that a prisoner can see anyone on his side of the barrier, Weak Reciprocity is met since every prisoner sees and is seen by some other prisoner and yet (242) is judged false. Furthermore, there is a way to partition the prisoners, namely into sides of the room, such that Strong Reciprocity is met within each cell of the partition, so Fiengo and Lasnik's condition is met as well. Finally, consider Robert's proposal. On this proposal, if (242) is false in the situation described it is because there are some context dependent amounts of seeing prisoners and seen prisoners required to make it true and there are not enough such prisoners in this situation. However, we could make one of the groups very, very large and the other very small, so that most of the prisoners are in the large group. Now there are more seeing prisoners and more seen prisoners. Eventually we should hit the required amounts. But in fact, no matter how large the larger group is, if the barrier stays opaque, (242) stays false.

Langendoen's Weak Reciprocity for Subsets does seem to be at least partially correct as truth conditions for reciprocal sentences in that it demands that reciprocity hold between parts or subpluralities of the plurality denoted by the subject of the reciprocal predicate. What the above example shows however is that reciprocity need not hold between every two subpluralities nor is it sufficient if it holds between just some subpluralities. Rather there are particular subpluralities — the two groups on either side of the barrier in the case of (242) — between which reciprocity must hold. I would suggest therefore, that all the semantics of reciprocals should say is that there is reciprocity between certain subpluralities of the plurality denoted by the subject of the reciprocal predicate. Identification of the particular subpluralities involved, what I will call the "operative subpluralities," should be left open in the semantics of the reciprocal predicate and will, at least in some cases, be determined by the context. Previous research on reciprocals has uncovered a rich variety of factors that affect the interpretation of reciprocals, however the insistence on a context independent semantics for reciprocals has left us with no place to incorporate these observations into a single semantic rule for reciprocals. My conclusion then is that Roberts was on the right track in including context sensitivity in her proposal. However, the force of the quantifier is not the only factor that is sensitive to context.

In order to get an idea of how one could modify earlier approaches to reciprocity to allow for the right kind of context dependence, I will write a set of truth conditions for a sentence of the form "NP V (Prep) *each other*" based on these earlier approaches.

(243) A reciprocal verb phrase applies truthfully to a noun phrase denoting plurality S, if:

a) There are two or more **operative subpluralities** of S (a subplurality may be a singularity). Every member of S is contained in an operative subplurality.

b) There is a relation Recip among the operative subpluralities. Every subplurality bears the Recip relation to some other subplurality. If $<x,y> \in$ Recip, then x and y are non-overlapping.

c) Recip is a subset of the extension of the main predicate (transitive verb or verb+preposition).

There are at least two places where these conditions are susceptible to contextual refinement. The context may determine the operative subpluralities and it may determine the relation Recip. In the following section we will look at some evidence of the context dependence suggested here. However, even before we take the effects of context into account, we may note some correct predictions made by these conditions. It requires John to have tolerated Mary and vice versa for the sentence *John and Mary tolerated each other* to be true. The requirements in (243a) and (243b) guarantee that John and Mary both be operative subpluralities in this case. Next, note that if every individual in S is a subplurality, in other words if S itself just is the set of subpluralities, and if Recip= $\{<x,y>: x,y \in S, x \neq y\}$, then these conditions amount to Strong Reciprocity.

6.3 Reciprocals in Context

This subsection contains examples that are meant to exhibit the role of context in the interpretation of reciprocals. The first is our familiar:

(244) The cows and the pigs were separated.

The noun phrase *the cows and the pigs* presupposes the presence in the context of two discourse referents, one for each conjunct. A prominent interpretation of (244) involves identifying these referents with the operative subpluralities used in interpreting the reciprocal verb phrase along the lines of (243) above. This requires that the cows were separated from the pigs and the pigs were separated from the cows. It is tempting at this juncture to conclude that the subpluralities mentioned in (243) above behave like pronominal elements and so they are identified with available discourse referents.

In (244), the sources of the operative subpluralities were themselves NP conjuncts in the subject of the reciprocal VP. It was this fact that led the sets theorists astray. However, one can also find examples in which the source of the operative subpluralities is not itself an argument of the reciprocal predicate. A case in point is the following quote from U.S. President Clinton's 1993 Inaugural Address:

(245) But for fate, we - the fortunate and the unfortunate - might have been each other.

It is interesting to note here that the subpluralities are being identified by NPs that occur inside a non-restrictive relative. This effect appears somewhat surprising in light of the observation in the previous chapter (example 227) that non-restrictive relatives apparently cannot be used to provide a partition variable for the Part-operator.

So far we have seen examples that fall under the generalization that operative subpluralities are identified as the referents of noun phrases occurring in the discourse prior to the reciprocal. However, a wider range of examples shows that even this is not always the case. The following examples give some indication of the range of possibilities:

(242) The prisoners on the two sides of the room could see each other.

(246) Farmer Smith and Farmer Jones said that although their cows could stay together, *the pigs had to be separated.*

(247) a. The people in that building come from different but bordering countries. Not surprisingly, they *hate each other*.
b. The people in that building are on varying rent schedules, depending on when they first came into the building. Not surprisingly, they *hate each other*.

(248) a. The lawyers representing the cows and the pigs hated each other.

b. The lawyers representing the young animals and the old animals hated each other.

Up to this point, we have seen examples where the context provides a salient set of operative subpluralities. We have yet to see an example where the context affects the choice for the Recip relation mentioned in (243b,c). One such case is the example in (249) below from Fiengo and Lasnik (1973:454, fn4) in which the linguistic form of the subject NP appears to be involved in determining the relation Recip:

(249) The husbands and wives in the room are similar to each other.

Fiengo and Lasnik interpret this sentence in such a way that all the pairs in Recip are husband-wife pairs. Assuming the noun phrase *the husbands and wives* names a plurality made up of singularities (pace Link 1984), somehow referring to that plurality in this particular way, leads to a choice of Recip along marriage lines. According to (243c) then, the extension of *similar* must include all husband-wife pairs.

As in the case of distributivity, sometimes the relation Recip is presented graphically. In fact, the same example can be use here, this time with a sentence containing a reciprocal:

(250) The books in the chart below complement each other.

Fiction	Non-fiction
Alice in Wonderland	Aspects ; Language(Bloomfield)
Fantastic Voyage	Gray's Anatomy
David Copperfield, Hard Times	Das Kapital, The Wealth of Nations
Oedipus Rex, Agamemnon	Freud's Intro. to Psychology
Richard III	Machiavelli's The Prince

The operative subpluralities are determined in this case by the chart itself along with certain chart reading conventions. The operative subpluralities of books are those that occupy discrete cells in the chart. The relation of "complementing" mentioned in (250) is understood to apply reciprocally between these. If the chart was rearranged, the meaning of the utterance in (250) would change as well, even if the same cells were on the rearranged chart. This means that the relation Recip is also 'spelled out' by the arrangement of the chart. Elements of the Recip relation consist of pairs corresponding to the rows of the chart.

Summarizing then, the interpretation of a reciprocal depends in some cases on the context. This sensitivity is not quantitative but rather qualitative, the context tells us which individuals should bear a relation to which others. Furthermore, as we saw in the previous chapter, a central assumption of the sets theory is that the identity of the operative subpluralities is built into the meaning of the predicates themselves. Thus the two subpluralities of cows and pigs form separate units of an element in the extension of the verb phrase in (244), *were separated*. While this approach may work for (244), it will not work for the other examples given here. The chart example shows this best. A theory that is bent on keeping the operative subpluralities distinct in the extensions of predicates would have the predicate in this case apply to some special type of group whose structure was determined via a mapping from the chart. The noun phrase *the books in this chart* in (250) would then have to denote this complex object and that would explain why a change in the chart would effect the meaning of the utterance. The problem is that there does not seem to be any compositional way to get the noun phrase in this case to denote anything but a simple plurality, assuming that *book in this chart* is a predicate true of any book in the chart.

In some of the preceding examples, the Recip relation was determined non-linguistically or semi-linguistically. As in the case of the partitions discussed in the previous chapter, here too we have reached the limits of our linguistic research. How exactly a given relation is made salient based on non-linguistic or extragrammatical reasoning is a matter that is beyond the scope of the present investigation.

Finally, although we have argued that context may serve to flesh out the truth conditions described in (243) above, that is not always the case. Often, there seems to be some default reasoning. The simple examples that were originally used to argue for Strong Reciprocity seem to show this. In a recent paper, Dalrymple et. al (1994) classify a set of possible 'meanings' for reciprocal statements in terms of their logical properties. They then propose that reciprocal statements express the strongest possible candidate among these possible meanings that is consistent with properties of the relation expressed by the scope of the reciprocal (= the main verb for the kind of cases considered in (243)) as well as other non-linguistic information. It strikes me that this is a precise working out of the default mechanism alluded to here (Sauerland 1994b:18 makes a similar point).

6.4 Reciprocity and Distributivity

Up to now, I have been discussing reciprocity as an issue that is independent of what was said earlier about distributivity. Nevertheless, as pointed out above, much previous research has analyzed the one in terms of the other, often relying on intuitions stemming from the synonymy or near-synonymy of pairs such as:

(251) a. The boys each saw the other.
b. The boys saw each other.

where the distributive marker of (251a) floats into the reciprocal of (251b). Another tie with the discussion of distributivity are the operative subpluralities of the previous section which seem strikingly like the cells of the partitions invoked in our analysis of distributivity.

To show how the two phenomena could be combined, I will present an analysis of the reciprocal *each other* that makes crucial use of the partition operators of chapter 5. This type of analysis of the reciprocal follows closely the approach of Heim, Lasnik and May (1991b) as developed in Sauerland (1994b).[31] Since use will be made of the Part operators, the account will be cast in a framework in which English is translated into a semantically interpreted language as in chapter 5.

As a preview, I will introduce the components of the analysis in terms of the truth conditions for verb phrases with reciprocal arguments given in (243) above, repeated here:

(243) A reciprocal verb phrase applies truthfully to a noun phrase denoting plurality S, if:

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[31] I cite Sauerland since I relied on his paper for the analysis spelled out here, however, the following caveat from his paper should be mentioned. "The largest part of this paper is a spelling out of class notes from Irene Heim's spring 1994 *Advanced Semantics* course at MIT." See also Sauerland (1994a).

a) There are two or more **operative subpluralities** of S (a subplurality may be a singularity). Every member of S is contained in an operative subplurality.

b) There is a relation Recip among the operative subpluralities. Every subplurality bears the Recip relation to some other subplurality. If $<x,y> \in$ Recip, then x and y are non-overlapping.

c) Recip is a subset of the extension of the main predicate (transitive verb or verb+preposition).

The clause in (243a) looks like the semantics for our Part operator, and so we will reduce this to our analysis of distributivity. In particular, use will be made of the same cover variables to select the set of operative subpluralities. Turning next to (243b), for each operative subplurality P in the cover, there should be a different element of the cover which is paired with P in Recip. In the final analysis, we will not make reference to Recip directly, but to something related to it, as follows. Consider first the sum of all the elements of Recip paired with P in Recip. Since there is one such sum for each operative subplurality, we can speak of the function that picks out that sum for each subplurality. This function will be the meaning of the reciprocal, *each other*. This is summarized in (252) below, where EachOther is the translation of *each other*:

(252) For every operative subplurality P in the cover:

$$\| \text{EachOther} \| \ (P) = \cup \{s: <P,s> \in \text{Recip}\}$$

This is roughly the analysis of *each other* to be presented. Changes will need to be made to allow it to fit together with the distributivity part of the proposal. Turning last to (243c), this requirement will simply follow from the composition of the meaning of *each other* with the meaning of the main verb. The translation in (253b) below for (253a) should give an idea of how that will happen:

(253) a. The boys saw each other.
b. $\forall y[(y \subset b \wedge y \in \text{Cov}) \rightarrow \text{saw}'(y)(\text{EachOther}(y))]$

The contribution of the Part operator is evident here in the universal quantification over elements of the cover. Which subpluralities are operative is determined therefore by the assignment of a value to the free cover variable. The expression "EachOther" is also meant to be a free variable, this one of type <e,e>. The value of this variable determines which subpluralities are related to which others. This is where the Recip relation is determined. *Each other* is being treated in a way similar to Cooper's (1979) treatment of donkey pronouns, with a free function variable applied to another variable bound from above. In the case of the reciprocal, the bound variable is bound by the distributivity operator.

In order to make this account work, the semantics for the Part operator needs to be adjusted so that it is capable of variable binding. In addition, more needs to be said about the function EachOther in the translation of the reciprocal. Unlike Cooper pronouns in general, not just any type <e,e> function will do. There are special restrictions that will need to be imposed to capture the notion of reciprocity, including for example the distinctness condition discussed earlier. In the following sections these developments will be made and then we will return to some reciprocal examples to see how the parts fit together.

6.5 The Part Operator as a Variable Binder

Responding to criticism in Williams (1991), Heim, Lasnik and May (1991b) allow that a distributivity operator has the ability to bind variables in its scope. The intuition behind this idea, found in other work on plurals such as Roberts (1987:§4.3.2), comes from paraphrases like that in (254b) of a salient reading of (254a):

(254) a. The men outearned their wives.
b. Each man outearned his wife.

In (254b), the pronoun *his* is bound by the subject noun phrase. In (254a), the operator with universal force responsible for the distribution over men binds the pronoun *their*. Actually, (254a) is amenable to an alternative analysis in which the pronoun refers to the set of men, but where the synonymy with (254b) is achieved via a PPart operator (cf. section 5.4) on the transitive verb which forces distribution to man-wife pairs. For this reason, I mention (255) and (256) below since they seem less obviously amenable to the PPart analysis. In both cases, the b. sentence is meant as a paraphrase of the intended reading of the a. sentence:

(255) a. The students left the room immediately after receiving their grades.
b. Each student left the room immediately after receiving his grade.

(256) a. Those soldiers have received money from a friend in their hometown.
b. Each of those soldiers has received money from a friend in his hometown.

Summarizing then, for the purposes of analyzing the reciprocal we will need to allow our Part operators to be variable binders. Following previous work on this topic, we find independent evidence for this modification of the semantics of distributivity operators in examples where plural pronouns are interpreted as variables whose values range over the domain of quantification of the distributivity operator.

This result should not surprise us. It amounts to saying that distributivity operators behave like quantifiers not only with respect to quantifier scope (cf. discussion of example (146) in chapter 5) and contextual domain selection but also with respect to variable binding. But does our analysis in terms of Part operators actually capture this property of distributivity? The answer to that question depends not only on the analysis of the binders, the Part operators, but also on the analysis of the bindees, the pronouns. If, for example, we merely assume that pronouns are translated as variables interpreted via an assignment function, then our Part operators will not be pronoun binders. Recall the semantics for the Part operators:

(257) Plural VP rule:
If α is a singular VP with translation α', then for any index i, $\text{Part}(\text{Cov}_i)(\alpha')$ is a translation for the corresponding plural VP.

(258) Let α and ß be variables whose values are object language expressions of type $<e,t>$ and let u,v be variables whose values are entities in D^*. For all α,ß,x:

$$u \in \| \text{Part}(ß)(\alpha) \|^{M,g} \text{ if and only if}$$
$$\forall v[(v \in \| ß \|^{M,g} \wedge v \subseteq u) \rightarrow v \in \| \alpha \|^{M,g}]$$

Assume that a Part operator is attached to a VP α, containing the pronoun *she*$_1$, translated as x_1. Since no mention is made in (258) of alternative assignment functions, $g(x_1)$ will be the only value for x_1 that will enter in to the computation, hence there will be no binding. There are two possible ways to further complete the analysis thereby allowing for binding. The first and ultimately more desirable approach would be to include an independent binding mechanism which could apply before the Part-operator. Generalizing an approach to binding found in Cooper (1979), we might envision a setup in which NPs are moved leaving behind a numeric trace and then have a rule like the one in (259a) below, instantiated in b. and c. ('$\approx \approx >$' stands for "is translated as"):

(259) a. $[_{XP}\ n\ [_{YP}\ \alpha]] \approx\approx> \lambda x_n[\alpha'(x_n)]$

b. $[\ 1\ [_{TVP}$ dropped on itself$_1]] \approx\approx> \lambda x_1[$drop-on'$(x_1)(x_1)]$

c. $[\ 1\ [_{VP}$ hit himself$_1]] \approx\approx> \lambda x_1[hit'(x_1)(x_1)]$

The Part-operator (as well as the PPart operator and other generalizations) has the effect of universally quantifying into the open argument position of the predicate to which it attaches. A rule like that in (259) would effectively extend this binding to all pronouns bearing the index of the adjoined numeral. This is essentially the route that Sauerland (1994b) takes following Heim (1993).[32]

This approach would of course need to be justified on the basis of its utility in handling binding by noun phrases as well. Crucially, however, the binding mechanism must be divorced enough from the syntax of NPs as to allow the Part-operator to combine with a VP after the binding has occurred but before the distributed NP (the one that provides the restriction to the universal quantification) has been attached. Montague's Quantifying-In, for example, would not meet this requirement.

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[32]This analysis of binding by a distributivity operator is formally similar to Carlson's (1977:269-270) analysis of the sentence *cats like themselves* on a reading in which cats are claimed to be narcissistic (as opposed to an altruistic reading in which cats like cats). In this case, a modified version of Partee's (1976) rule of Derived Verb Phrase formation is followed to produce a translation in which the pronoun is bound (the superscript 'o' means that the variable ranges over objects):

$$^\wedge\lambda x_5{}^o(\text{like}'(x_5,x_5)$$

next the VP-operator, G, applies to that translation creating a predicate of kinds:

$$G(^\wedge\lambda x_5{}^o(\text{like}'(x_5,x_5))$$

This predicate is true of a kind if it is generally the case that an object realizing that kind likes itself.

Since pronominal anaphora in general is beyond the scope of this work[33], the above sketched account will not be pursued. Instead, I will simply amend the semantics of the Part and PPart operators to allow them to bind variables. The following is the amended rule for the Part operator:

(260) Plural VP rule:
If α is a singular VP with translation α', then for any indices i,j, $Part_j(Cov_i)(\alpha')$ is a translation for the corresponding plural VP.

(261) Let α and $ß$ be variables whose values are object language expressions of type $<e,t>$, and let u,v be variables whose values are entities in D^*. For some index j:

$$u \in \| Part_j(ß)(\alpha) \|^{M,g} \text{ if and only if}$$
$$\forall v[(v \in g(ß) \wedge v \subseteq u) \rightarrow v \in \| \alpha \|^{M,g[xj/v]}]$$

According to the rule in (261), a $Part_j$ operator will bind any free x_j in its scope. To see how this works, reconsider our original example in (262a), paraphrased on the relevant reading in (262b):

(262) a. The men outearned their wives.
b. Each man outearned his wife.

(262a) can now be translated along the following lines, modulo the translation of the possessive:

(263) $(Part_2(Cov_1)(outearned'(the\text{-}z[wife\text{-}of'(x_2)(z)])))(the\text{-}men')$

Now, by taking $g(Cov_1)$ to be the set of singularities in the domain we get the reading in (262b). The Part operator quantifies over the men and binds the variable x_2.

Since the PPart operator is also a quantifier, it, along with other generalizations of the Part operator, is a variable binder as well. The semantics for the PPart operator is therefore modified in the same way as the Part operator was:

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[33]Kamp and Reyle (1993) handle anaphora in distributive contexts within Discourse Representation Theory, however they do not employ a distributive operator. For a DRT account of anaphoric dependencies on the D-operator, see Roberts (1987).

(264) Semantic Rule for PPart (with variable binding):

Let ß be a variable of type $<<e,t>,t>$, α' an expression of type $<<e,t>,t>$ and a,b,u,v, metavariables over elements of the domain, D^*, for some indices j,k:

$\| PPart_{j,k}(ß)(\alpha') \|^{M,g}(a)(b) = 1$ iff
$\forall u \forall v[(g(ß)(u)(v) \wedge u \subset a \wedge v \subset b) \rightarrow \| \alpha' \|^{M,g[xj/u,xk/v]}(u)(v)]$

Evidence for binding by this operator can be produced using ditransitive verbs (or verbal complexes), as in (265):

(265) The men gave their paychecks to the women.

Imagine this is uttered in a context in which there is a salient pairing of individual men and women by marriage. In such a context, (265) might be used to assert that:

(266) Every man gave his paycheck to his wife.

This proposition is rephrased in (267) below in such a way that the role of the PPart operator becomes apparent. Here we are assuming that $g(PCov_1)$ is a set of pairs where the first is married to the second.

(267) $\forall x \forall y$ [$<x,y> \in g(PCov_1)$ and x is a man and y is a woman] $\rightarrow$ [x gave x's paycheck to y].

Using the semantic rule in (264), (267) will have the same truth conditions as the following (again the analysis of the possessive is purely for illustration):

(268) $[PPart_{2,3}(PCov_1)$(give'(the-z[paycheck(x_3)(z)])](the-women')(the-men')

In this example, the second elements of the pairs quantified over by the PPart operator (roughly the agents of giving) are assigned as values of the bound variable. The pronoun is bound in effect by the second index of the operator. The operator has another binding index and evidence for this type of binding is given in the following example:

(269) The men dropped the babies on their beds.

Imagine a context in which there is a salient cover of the men and the babies, one in which elements of the cover are related by birth. In such a context, (270) might be used to assert that:

(270) Every man dropped his babies on their beds.

This proposition is rephrased in (271) below in such a way that the role of the PPart operator again becomes apparent. Here we are assuming that $g(PCov_1)$ is a set of pairs where the first is the father of the second:

(271) $\forall x \forall y$ [$<x,y> \in g(PCov_1)$ and x is a man and y is/are his babies] $\rightarrow$ [x dropped y on y's bed]

Finally, assuming the semantic rule in (264), (271) will have the same truth conditions as the following

(272) [$PPart_{2,3}(PCov_1)$(drop-on'(x_2's bed))](the-babies')(the-men')

In this case, the first index (or 'object index') does the binding.

At this point we have endowed the Part operators with the ability to bind variables in their scope. This move was motivated by examples in which pronouns in the scope of a distributively understood plural verb appeared to be bound. Having made this change we now turn to other aspects of the analysis of reciprocals.

6.6 Reciprocal Pronouns

To facilitate discussion at this point, I will use representations that are intermediate between English and the translation language, such as the following:

(273) The $boys_2$ $Part_1$[showed a picture of $their_2$ creation to $their_1$ parents].

In (273), *the boys* (syntactically) binds the first pronoun and the Part operator binds the second. Provided the cover variable is assigned the set containing the individual boys, (273) could be used to describe a situation where the boys created a monster together and each boy showed a picture of the monster to his parents. In contrast to the binding by the Part operator, the mechanics of the binding by the subject noun phrase has not and will not be discussed here. With intermediate representations of the kind in (273) now at our disposal, we illustrate in b. below, the current stage of our analysis of reciprocals:

(274) a. The boys saw each other.
b. The boys $Part_1$[saw EachOther(x_1)].

Recall, the reciprocal is translated as a Cooper pronoun, containing a variable bound by the Part-operator. Following closely the discussion in Heim et. al (1991b) we will amend this translation by including in it other bound variables. To see why this is necessary, consider that there could be an interpretation of the representation in (274b) according to which the boys saw only girls. This would be the case if the range of the EachOther function contained just girls. To remedy this, we include another variable to be bound by the subject of the reciprocal:

(275) a. The boys saw each other.
b. The $boys_2$ $Part_1$[saw EachOther(x_2)(x_1)].

EachOther itself is a free variable constrained as follows:

(276) for all M,g: $\forall u \forall v$ $\| \text{EachOther} \|^{M,g}(u)(v) \subset u$.

What has yet to be included is the distinctness predicate that is common to accounts of the reciprocal. As it stands, (275-276) allow all the sightings to be self-sightings. To remedy this we modify (276):

(277) for all M,g:
a. $\forall u \forall v$ [$\| \text{EachOther} \|^{M,g}(u)(v) \subset u$].
b. $\forall u \forall v$ [$\| \text{EachOther} \|^{M,g}(u)(v) \neq v$].

Assuming this constraint on interpretation, the analysis of reciprocals consists of our recently amended analysis of distributivity ((260-261) and (264) above) along with the following rule of translation:

(278) for any indices, i,j:
each other$_{i,j}$ translates as EachOther(x_i)(x_j).

EachOther is a variable of type <e,<e,e>>.

In keeping with the discussion in earlier parts of this chapter, this proposal, unlike most previous work in this area, has a significant pragmatic component in addition to the semantic component. The pragmatic component is realized in the form of two free variables: the cover variable of the distributivity operator and the EachOther variable of the reciprocal. In the following section, we will return to those examples that provoked a more pragmatic approach to reciprocals in order to consider how the different readings come about in terms of values assigned to the free variables. The focus in the remainder of this section will be on the semantic component of the proposal.

To get a sense of what kinds of interpretations are possible for representations such as (275), repeated here:

(275) a. The boys saw each other.
b. The boys$_2$ Part$_1$[saw EachOther(x_2)(x_1)].

I will make some assumptions about how the pragmatic parameters get filled in and then later on the various pragmatic options will be considered more carefully. To start, assume that the cells of the salient cover contains just individual boys. In this case, (275) is paraphrased as:

(279) Every boy saw a boy or boys different from himself.

If John is one of the boys, then (275) requires him to have seen a boy or boys other than himself. Which particular boy(s) John saw depends on which function EachOther denotes. If the salient cover consists of several cells corresponding to several teams, and the EachOther function returns for any team, the team that opposed it in the championship, (275) is paraphrased as:

(280) Every team saw the team that opposed it in the championship.

These paraphrases resemble the Weak Reciprocity readings discussed by Langendoen. Note in particular that the semantics of the reciprocal does not add any universal quantification of its own. In this respect, my proposal differs from its progenitors. Sauerland (1994b), following Heim, Lasnik and May (1991a,b), treats the reciprocal itself as a quantificational term which has universal force, in addition to the universal force of the distributivity operator that binds the reciprocal. To some extent, the discussion in section 6.3 above of the meanings of reciprocal sentences can be taken as an argument against this approach. Below, we return to the relevant examples, in a discussion of the pragmatics of reciprocals. But there are some additional reasons to depart from the reciprocal as quantifier approach. As the examples below show, reciprocals can appear in contexts in which universals are disallowed or are difficult to interpret. In (281), *each other* contrasts with universal noun phrases which appear unwieldy when attached to *only*[34]

(281) a. John and Mary talk only to each other.
b. ?John and Mary talk only to every student.

When a phrase beginning with *but* postmodifies a quantificational term, the noun phrase position to the right of *but* excludes universals but not *each other*:[35]

(282) a. Two old men grow lonely when they see noone **but** each other.
b. ?Two old men grow lonely when they see noone **but** every nurse.

Another problem with analyzing the reciprocal as a universal was actually raised in Heim, Lasnik and May (1991b) in connection with their example (48) repeated here:

(283) They told each other's wives lies about each other.

The intermediate representation below is meant to illustrate the intended reading of (283) under the assumption that the cells of the most salient cover contain only singularities:

(284) They$_2$ Part$_1$[told each other$_{2,1}$'s wives lies about each other$_{2,1}$].

The idea is that if A told B's wife lies, then the lies were about B. On the universal interpretation of the reciprocal, (283) ends up meaning something more like the following:

(285) Every man told every other man's wife lies about every other man.

and Heim, Lasnik and May (1991b) need to introduce an absorption

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[34]For recent discussion of *only* attached to universals see Bonomi and Casalegno (1993) and von Stechow (1989).

[35]For a recent discussion of this topic, see von Fintel (1993). He cites Hoeksema (1987a) as the first to observe the restriction I have appealed to here in order to distinguish *each other* from universal quantifiers.

mechanism to get around this problem.[36]

Additional arguments against a quantificational analysis of the reciprocal can be found in Moltmann (1992:§1.2.1).

6.7 Reciprocals in Discourse: The Pragmatics of Distributivity and Reciprocity

To this point we have considered the basic semantics of the reciprocal. To get a complete picture of the reciprocal, we also need to consider how the pragmatic variables, Cov, PCov and EachOther, get filled in. As was the case in the previous chapter, to some extent we are entering here into an area that is not properly linguistic and hence the remarks will be of a more speculative nature. What makes a relation among entities or a partition of a set of entities salient is surely answered, at least partially, as part of a general inquiry into cognitive psychology. This will make it difficult to compare the theory presented here with other attempts to analyze the reciprocals in purely semantic terms. In the absence of an explicit pragmatic theory, the semantic theories, all else being equal, are to be preferred for they make the more precise predictions. The reader will tend to favor a theory like the one proposed here to the degree that he or she is convinced it is correct to divide the problem into semantic and pragmatic components.

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[36]The analysis provided here gets the desired interpretation but it is not clear to me that this is always desirable. Consider the following:

(i) They put pictures of each other in each other's albums.

To the extent that I can understand (i), I think it allows that X put pictures of Y in Z's album, where $Y \neq Z$. This suggests that the two occurrences of *each other* translate into two instances of EachOther which denote different functions. If this analysis is correct, the EachOther variable would need to be indexed as well, giving rise to translations along the following lines:

(ii) *each other*$_{i,j,k}$ $\approx\approx>$ $\mathrm{EachOther}_i(x_j)(x_k)$.

6.7.1 Contextually Assigned Values for Cov and EachOther

Turning now to the theory itself, consider the simplest kind of example:

(286) [Jan and Mary]$_i$ Part$_j$[lifted each other$_{i,j}$].

It is generally agreed that (286) says that Jan lifted Mary and Mary lifted Jan. What does this tell us about Cov and EachOther? For simplicity, we assume that D, the domain of singularities, includes just Jan and Mary. As we know from chapter 5, in the absence of contextual clues to the contrary, there are two possible values for Cov in the interpretation of (286):

(287) a. g(Cov) = {j,m}
or
b. g(Cov) = {{j,m}}.

Let's first consider (287a). The reading one gets for (286) now depends on the interpretation of the reciprocal. Since the first argument of the reciprocal will be the same in both cases, we only need to think about what g(EachOther)(g(x_j)) could be. Let's abbreviate as follows:

(288) eo = g(EachOther)(g(x_j))

The intuitive meaning of (286) is such that:

(289) eo(j) = m eo(m)=j.

But nothing so far rules out the following possibility:

(290) eo(j) = {j,m} eo(m)={j,m}.

For (286) this would mean that Jan lifted Jan and Mary and that Mary lifted Jan and Mary, which doesn't really seem to be a reading of (286). In fact, since it is true that if I lift Jan and myself, then I have lifted Jan, the absence of the reading of (290) is not so obvious. A clearer case would be the following:

(291) Jan and Mary connected each other's boats together.

If the reciprocal is interpreted with a function like in (290), (291) would mean that Jan connected his and Mary's boats and so did Mary. Intuitively, (291) could only mean that Jan put Mary's boat or boats together and that she did the same for him. The interpretation in (289) will give you this. There are various possibilities for explaining why (289) is possible while (290) is not. The following generalization seems a reasonable candidate:

(292) The domain and range of g(EachOther)(g(x_j)) is identical to the value assigned to Cov in the Part operator that binds the reciprocal.

If the participants in a conversation are thinking of the domain of discourse in terms of a certain partition, it seems reasonable that a function on that domain of discourse would 'refer' to the same partition. (292) will rule out (290) as well as other possibilities which seem equally unavailable. Consider the second interpretation for Cov, in (287b). In the absence of (292), we might have the following:

(293) eo({j,m}) = j

This would incorrectly predict that (286) could be true even if Mary was not lifted. In fact, given (292) along with the constraints on EachOther in (277) above, the second interpretation for Cov is ruled out completely.

Next we turn to one of our old farm examples:

(294) The cows and the pigs talked to each other.

Mention of the cows and the pigs induces the assignment to Cov of a partition having a bovine cell and a porcine cell. The generalization in (292) along with the semantics for EachOther yields the most salient reading of this sentence in which the cows talked to the pigs and vice versa. Two remarks are in order here. First, under the reading just described nothing is said about individual cows or pigs. In effect, we have two, 'reciprocal', instances of collective 'readings' of the kind discussed in the previous chapter (section 5.6). Presumably, there would have to have been more than one interspecies conversation going on for (294) to be true. Exactly how many more depends on the same factors that determine how many conversations are necessary for it to be true that the cows talked to the pigs. This reduction to collectives may, at least in some cases, be the source of Roberts' (1987) ENOUGH quantifier. This view of (294), in terms of reciprocal collective action, can be extended to other more elaborate examples such as the following:

(295) The red trays and the blue trays were stacked on top of each other.

Some speakers I consulted understood (295) to describe a situation in which there was a stack of alternating blue and red trays. One possible explanation for this would involve a particular choice for eo, which maps red objects into blue ones and vice versa. But the 'structural' semantics might be much simpler. If analyzed like (294), (295) amounts to the conjunction of a. and b. below:

(296) a. The red trays were stacked on top of the blue trays.
b. The blue trays were stacked on top of the red trays.

Moreover, depending on the perspective of the speaker, either (296a) or (296b) could be used to talk about the situation just described. Thus the color alternation is preserved in the non-reciprocal, simple collectives and probably should not be analyzed as part of the semantics of the reciprocal.

The second remark on (294) has to do with the reasoning behind the generalization in (292) above. The idea is that in the simplest cases, there is a single salient partition of the domain of discourse and this is used in the interpretation of Cov and EachOther. This might provide an answer to a puzzle raised in chapter 1. There I noted that cumulativity seems to be a less general phenomenon than might at first be expected. The following inference is dubious:[37]

(297) The cows talked to each other.
The pigs talked to each other.
____
The cows and the pigs talked to each other.

Understanding this inference as a true instance of cumulativity, means viewing the last line as case of distributivity over a reciprocal predicate, with an intermediate representation as follows:

[37] I judge the inference valid if the conjunction in the conclusion is stressed. For a possible explanation, see Schwarzschild (1994:§3.2, fn. 7). Things also improve if *both* is used in the conclusion:

(i) Both the cows and the pigs talked to each other.

This use of *both* will be discussed in the next chapter.

(298) [The cows and the pigs]$_j$
Part(Cov_1)[$Part_i$(Cov_2) [talked to each other$_{j,i}$]].

In order to get the desired but seemingly unavailable reading, g(Cov_1) must contain two cells, one bovine, the other porcine. Now, if there is a **single** salient cover, then g(Cov_2) must contain the same two cells. Under these conditions, the first Part operator ends up having no effect and we are back to the interpretation in which the cows talked to the pigs and vice versa. It is important to point out that all of this reasoning is under the assumption that the context is no richer than what we have in (297). Thus, we allow the possibility that a context may be rich enough to provide two covers and that speakers could juggle these.

Up to this point, we have considered cases in which the relevant cover contained two cells. In such cases, given the generalization in (292), there is only one possible candidate for the function eo. But if the cover has more cells in it, then the context is relied upon to select among several possible candidates. This is illustrated in examples from section 6.3 repeated below:

(299) a. The books in the chart below complement each other.
b. The husbands and wives in the room are similar to each other.

In (299a), the cover is given by the squares in the chart while eo is the row-mate function: eo(x)=y iff x is in the same row as y and $x \neq y$. In this case, the function is provided graphically by a chart-reading convention. In (299b), eo is the marriage function: eo(x)=y iff x is married to y. Here the source of eo is the use of the relational nouns in the subject. The examples below are variations on this idea:

(300) a. Those twins who were born before 1960 were separated from each other in school.
b. The people who shared their summer apartments spent most of the winter arguing with each other about entry times.

(300b) differs from (299b) and (300a) in that the nature of the relations involved in the latter cases are such that for any argument x, eo(x) is necessarily a singularity (this holds for (299b), assuming there is no polygamy). In (300b), I detect a maximality effect, whereby eo(x)=y iff y is a plurality containing **all** and only individuals who share with x.

Summarizing so far, the context dependence argued for in section 6.3 above is now realized in the form of two free variables, one from the theory of distributivity and the other unique to reciprocals. We have just seen cases in which the context is such as to provide values for each of these. In the simplest cases, when the relevant part of the domain of discourse contains only two pieces, the assignments become trivial, as a result of the distinctness condition. In some cases, when the two pieces are pluralities, the reciprocity itself is trivial, but it is reciprocity between collectives, with all the complexity that that entails.

6.7.2 When the Context isn't Rich Enough

The examples in (299-300) show that the context may provide a value for the variable EachOther, but the theory as described so far would lead one to expect something stronger, namely that the context **must** provide such a value. But, of course, this expectation is not fulfilled. To a large extent, the literature on the semantics of reciprocals is about possible settings for Cov and EachOther precisely when the context is impoverished. In other words, like other pragmatic variables but unlike deictic pronouns, when the context is lacking, the hearer can in fact reason through to an interpretation. I do not know how exactly this reasoning works, however, below I will explore the possibility of reducing much of the calculation to a principle of charity according to which the hearer attempts to find values for the variables that will allow the utterance to be true.

Consider the following example from Fiengo & Lasnik (1973:455):

(301) The trays are stacked on top of each other.

Following the discussion of (286) above, to start with, we assume the assignments in (302) below, where p represents the tray plurality:

(302) a. g(Cov) = p
or
b. g(Cov) = {p}.

In discussing (286), we ruled out a cover like that in (302b) based on the principle in (292) and that led to a choice of an assignment like that in (302a). The difference here is that (302a) will not work either as has often pointed out in connection with this example. (301) under an interpretation with respect to g as in (302a) entails that every tray is stacked on top of some other tray or trays. This is impossible with a finite set of trays. One possible alternative to (302a) that would allow (301) to be true is the assignment of a cover in which half the trays are in one cell and half in the other. This amounts to the reciprocal collective situation we had above with example (295). And, as in that case, this would allow a single stack of trays. Another possibility involves several cells describing a situation in which there are several stacks.

The idea then is that in those cases in which the covers that have been made salient, linguistically or non-linguistically, lead to interpretations that couldn't be true, the hearer assumes other, 'more elaborate' covers that will allow the sentence to be true.

The example just studied is taken from the literature on reciprocals and it is useful at this point to compare what is generally said about these type of examples to what was said here. The reasoning attributed to the language user concerning (301) was set in motion by the fact that the relation "be on top of" is asymmetric: if a is on top b then b cannot be on top of a. This property lead to the abandonment of simple covers which resulted in a cover choice involving non-singular subpluralities. This in turn lead to a collective-reciprocal interpretation in which one group of plates is collectively stacked on another. On earlier approaches the property of the main predicate, asymmetry, is more or less directly tied to a particular weak interpretation of the reciprocal. A potential advantage of the approach taken here arises when one considers an example such as:

(303) My relatives are taller than each other.

(303) seems to be infelicitous or just false, even though it might very well be true that except for my tallest relative, each of my relatives is taller than another of my relatives. In other words, we don't get the linear type of interpretation that arose with (301). Other accounts have taken this to require a further refinement of the semantics of reciprocals, one which can distinguish between the comparative relation and the "on top of" relation. For us, the asymmetry of the comparative sets in motion the same reasoning as for (301). But recall where that reasoning ends up. An intermediate cover is chosen and this leads to a collective-reciprocal interpretation. In the case of (301), this leads, somehow, to imagining a single stack of trays. To see what happens with (303), let's imagine that the default happens to contain, for example, two relatives-cells, one maternal and the other paternal. In that case, (303) would have an interpretation equivalent to the conjunction of a. and b. below:

(304) a. My mother's relatives are taller than my father's relatives.
b. My father's relatives are taller than my mother's relatives.

Intuitively, (304a) and (304b) could not both be true and this explains why this choice for a cover will not work. Other intermediate covers will not work as well, hence (303) has no non-contradictory interpretation. The difference between (301) and (303) has in effect been reduced to the difference between (296) and (304), a difference that has to do with collective interpretations and not with reciprocals per se.[38]

The interpretation strategy outlined here is by no means a complete account. One intuition concerning reciprocals that is left out is the presence of a Strong Reciprocity interpretation for examples such as:

(305) My friends know each other.

The cover that includes a cell for each of my friends is salient, so I will assume for now that that is the value for Cov in a case where (305) is used to start a conversation. The interpretation now depends on what eo is. According to my intuitions, (305) could be uttered truthfully just in case there was at least one value for EachOther that made it true. But others do not agree. They take (305) to be an example that requires Strong Reciprocity: every friend must know every other friend. One explanation for this effect comes from a process of supervaluation of the kind posited by Kadmon (1990) to handle other cases of Cooper pronouns. The charitable hearer reasons herself into a position where she is faced with several alternative values for EachOther that result in different but compatible truth conditions. She assumes that the specific value for EachOther has not been made explicit because it doesn't need to, since the facts are such that any value will make the sentence true. This would be the case on the Strong Reciprocity meaning.

The above explanation for the source of Strong Reciprocity runs counter to that of Dalrymple et al. (1994:§7). They claim that there is a meaning for (305) involving Strong Reciprocity and since it is the strongest

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[38]The idea to relate properties of reciprocals to properties of the related non-reciprocal transitives is not new here. A difference with earlier approaches however, is that while Langendoen (1978:186), for example, would relate (i) to (ii) (schematically, (i) = (ii) + distinctness), the approach taken here would relate (i) to (iii), where the sum total of the plates referred to by the arguments of (iii) are the same as those referred to by the subject of (i), the subject of (ii) or the object in (ii).

(i) The plates were stacked on top of each other.
(ii) The plates were stacked on top of the plates.
(iii) These plates were stacked on top of those plates.

meaning that could be true given the meaning of the predicate containing the reciprocal and the subject of that predicate, it is the one that is chosen. This account differs from the supervaluation idea, for it is meant to be applied in all speech contexts, not just ones where eo is unspecified. Since the predicate and subject of (299a) repeated here:

(299) a. The books in the chart below complement each other.

have the same properties as those of (305), this account predicts that the reading of the sentence discussed earlier should be unavailable since it doesn't involve Strong Reciprocity.

I would like to end this section with what I take to be a serious problem for the analysis here proposed. Consider the following example:

(306) The monkeys were talking to each other in American English.

According to my intuition, (306) is true if some monkeys, I'm not sure how many or what fraction of them, are talking to some other monkeys. It does not require that every monkey be talking so the assignment to Cov in this example could not be a set that contained all the individual monkeys. Rather, it would have to be an intermediate cover, containing simian pluralities. The vagueness in the exact number of loquacious monkeys would then be of a kind with the vagueness present in:

(307) a. The red monkeys were talking to the green monkeys.
b. The monkeys were talking to Curious George.

The problem with this story is that it assumes that an intermediate cover could be assigned by some default mechanism. But such a default mechanism is not generally available. This was precisely the point of Lasersohn's (1989) example repeated here from the previous chapter (section 5.2.3):

(308) The TAs were paid exactly $14,000 last year.

Nothing we have said about the reciprocal should lead us to think that the assignment posited for (306) is any more available than in simple distributive cases.

6.8 On the Binding of Reciprocals

Up to this point, the examples used have been restricted to those in which the sentential subject was the antecedent of the reciprocal. As is well known, the grammar of English allows other possibilities, as can be seen in the following example:

(309) The shoppers parked the cars near each other.

(309) has a reading in which each car was parked near other cars. This is not the reading one gets from the intermediate representation below:

(310) The shoppers_4 Part_3[parked the cars near $\text{EachOther}(x_4)(x_3)$]

According to (310), each shopper parked the cars near other shoppers. This is a possible reading of (309) but not the one we want. We are looking for distribution among the cars, not among the shoppers. This means that we need the PPart operator, not the Part-operator. In (311), I have used the PPart operator and I have altered the syntax, undoing an operation of the kind dubbed "Right-Wrap" in Bach (1979):

(311) The shoppers_4 $\text{PPart}_{2,3}$[parked near $\text{EachOther}(x_1)(x_3)$] the cars_1.

The representation in (311) yields an interpretation along the following lines:

(312) $\forall x \forall y[(<x,y> \in g(PCov)$, x is a shopper, y is a car) $\rightarrow$ x parked y near a car that is different from y.]

To make this more transparent, we assume that g(PCov) pairs an individual shopper with the car he owns. In that case, we get the following paraphrase for (309):

(313) Each shopper parked his car near another car.

This is the reading we are after.

In addition to the readings in (310) and (311), there is a third reading, roughly paraphrased below:

(314) Each shopper parked his car near another shopper.

On this reading (309) would be true in a situation in which John and Mary are the two shoppers, John parked his car near Mary and Mary parked her car near John, and John and Mary are not near each other. Neither (310) nor (311) would be true in this situation. As Sauerland (1994b) has shown, this kind of reading arises with the following intermediate representation, which differs from (311) only in the indexation of the reciprocal:

(315) The shoppers$_4$ PPart$_{2,3}$[parked near EachOther(x_4)(x_2)] the cars$_1$.

The representation in (315) yields an interpretation along the following lines:

(316) $\forall x \forall y[(<x,y> \in g(PCov)$, x is a shopper, y is a car$) \rightarrow$ x parked y near a shopper that is different from x.]

Below are examples whose most natural reading requires the same kind of indexing:

(317) a. They dropped these pamphlets on each other's cities.
b. Tomorrow, they will give these gifts to each other.

The possibility of rearranging the indices on (311) leads to the question of what indexations are allowed and which are banned. This topic is discussed in detail in Heim, Lasnik and May (1991a,b). For the most part, the rules governing indexation in those papers are syntactic rules, which means that the indices on the Part operators invoked here would have to be reflected in the syntactic structure, something we haven't done here. I will consider one type of invalid indexation which seems to be ruled out on semantic grounds. Consider the following permutation of (311):

(318) The shoppers$_4$ PPart$_{2,3}$[parked near EachOther(x_4)(x_3)] the cars$_1$.

This leads to a reading along the following lines:

(319) $\forall x \forall y[(<x,y> \in g(PCov)$, x is a shopper, y is a car$) \rightarrow$ x parked y near a shopper that is different from y.]

Assuming the set of shoppers and the set of cars are disjoint, this formula is equivalent to:

(320) $\forall x \forall y[(<x,y> \in g(PCov)$, x is a shopper, y is a car$) \rightarrow$ x parked y near a shopper]

This would allow that each shopper parked his car near himself and away from all other shoppers, contrary to what (309) actually says. This indicates that in addition to the other constraints on EachOther in a. and b. below, we need c. as well:

(321) for all M,g:
a. $\forall u \forall v\ [\ \|\text{EachOther}\|^{M,g}(u)(v) \subset u]$.
b. $\forall u \forall v\ [\ \|\text{EachOther}\|^{M,g}(u)(v) \neq v]$.
c. $\forall u \forall v\ [\ \|\text{EachOther}\|^{M,g}(u)(v)]$ is undefined if $v \not\subset u$

Finally, I would point out that this reliance on Part operators for the interpretation of reciprocals implies that any predicate that has a reciprocal argument must contain a Part operator. For example, the translation of the following expression:

(322) their gossip about each other

would have to contain a Part operator. This fact is neither surprising nor undesirable given that we can discern distributive understandings for any predicate with a plural argument.

6.9 Concluding Remarks: Sets versus Union

In chapter 4, we considered examples used to argue that the conjunction *and* could not be interpreted as a union operation. The argument rested on demonstrating that truth conditional differences can arise by the replacement of an NP with another that would be coreferent on the union approach. In that chapter it was shown that certain other valid inferences fail to be predicted on the assumption that the source of the truth conditional differences was purely semantic - a matter of the referents of the NPs in question and the extensions of the VPs predicated of them. In the first part of this chapter, more evidence was given that the VPs used in chapter 4 have a discourse sensitive element to them and therefore the effects of substituting one NP for another could very well derive from differences in context change potential as opposed to reference. In the second part of this chapter, a specific analysis of reciprocals was proposed to explain the discourse effects discussed in the first part. In that analysis, there are two points of contact between the semantics and the pragmatics: the Cov variable, which is part of our account of distributivity, and the EachOther variable which is peculiar to the reciprocal.

Judging from the examples discussed here and in chapter 5, it would appear that arguments against the union theory all turn on the issue of distributivity. Forthcoming chapters will dispel this impression, but even within the current discussion we can find counterexamples. To do so, we need to find a potential argument against the union theory that is explained on our account in terms of different values of the EachOther variable. Paralleling the data from chapter 4, such an example would involve a pair of sentences that differed in interpretation but that had identical main verb phrases as well as subjects which in other contexts would appear to be coreferent. The following story contains one such a pair.

A team of sociologists was interested in comparing relationships people have at work with those they have at home. They decided to study a group of married people, where the men worked in several groups in different factories and the women worked together in various restaurants in the city. Each person was asked to describe his or her spouse and his or her work mates. The sociologists noticed that political views were determined by the work place. In their report, they wrote that:

(323) The people who work together are similar to each other with respect to political viewpoint.

the author of this line would clearly not feel committed to the following:

(324) The husbands and wives are similar to each other with respect to political viewpoint.

One might therefore conclude that the subjects of (323-324) are non-coreferent, whereas we would say they are coreferent but that they affect the discourse differently and this has effects in the choice of value for EachOther (cf. example (299b) above).

Now imagine further that the sociologists are simultaneously studying a group of single unemployed people. One sociologist says to the other:

(325) I've already interviewed the people who work together and I'm waiting to meet the unemployed group.

Here the speaker would be committed to:

(326) I've already interviewed the husbands and wives and I'm waiting to meet the singles group.

(323-324) differ from (325-326) in that only the former contain a variable that is susceptible to the discourse differences between the coreferent, subject NPs.

Chapter 7
Notes on Floated Quantifiers

7.0 Introduction

Traditionally, the occurrence of *each* in (327a), was thought to be derived transformationally, 'floated' rightward, from a position preceding the subject NP as in (327b)

(327) a. The frogs each leapt off a lily pad.
b. Each of the frogs leapt off a lily pad.

In addition to *each*, *both* and *all* are common examples of floated quantifiers. This chapter is meant to be a small collection of notes connected with these quantifiers. In section 7.1, Part operators are compared with the floated quantifiers, on which they were modelled. In section 7.2, we turn our attention to *both* in its non-floated incarnations. That section is a response to Peter Lasersohn's claim that the semantics of *both* demands that the sets theory be preferred over the union theory. The results of that section will be used in section 7.3 to explore the claim that floated and non-floated *both* are syntactically related.

7.1 Part Operators versus Floated Quantifiers

The theory of distributivity outlined in chapter 5 was based on a generalization of Dowty and Brodie's (1984) account of floated quantifiers as verb phrase modifiers. This history is likely to lead to the assumption expressed in chapter 5 that covert distributivity operators are simply covert instances of the overt operators. The purpose of this section is to cast doubt on that assumption. It is entirely possible that floated quantifiers are not VP modifiers at all (cf. Sportiche 1988, discussed below) in which case the Part operators might be the only operators of this kind in the language. If this is case, one might want to reanalyze them as interpretations of the plural marking itself. In any case, the analysis of distributivity and the grammar of floated quantifiers are separate questions, theoretically, even if not historically.

The need to distinguish Part operators from floated quantifiers is nowhere more apparent than in the analysis of the reciprocals. Recall in chapter 6 we said that a reciprocal is uninterpretable unless bound by a Part operator, yielding intermediate representations of the following kind:

(328) They$_j$ Part$_i$[saw each other$_{j,i}$].

Taking floated *each* to be an overt incarnation of the Part operator, leads to the false prediction that (329) below should be grammatical.

(329) *They$_j$ each$_i$ saw each other$_{j,i}$.

The ungrammaticality of (329) shows that as long as we preserve our analysis of reciprocals, we need to adopt a different analysis for *each* than was presented when the Part operators were first motivated. We will leave this as an open problem. The interested reader is referred to the remarks and replies of Williams (1991) and Heim, Lasnik and May (1991b) in which the ungrammaticality of (329) is explained partially on syntactic grounds.

Turning to the semantics of the floated quantifiers, we note differences between them and the Part operators with respect to both quantificational force and domain of quantification. Part operators always have universal force and they quantify over singularities and pluralities, depending on the context. While the force of *each*, *all* and *both* is also universal, in some dialects there are floated quantifiers with other than universal force. Quirk et. al (1985:1399) cite the following examples:

(330) They are none of them very enthusiastic. <Informal>
My sisters don't either of them eat enough. <Informal>

The example in (331) below is taken from the OED (OED, *many* §A,3,a.: from 1567 John Maplet) while the one in (332) is from a story by Graham Greene (Greene 1973:395):

(331) We be *many of us* cut off before we come to olde age.

(332) His ambition had been to be a playwright and now that the London theatres were *most of them* closed, he was no longer taunted by the sight of other men's success.

One might argue that these are not true floated quantifiers because of the pronominal complements, but it should be pointed out that the 'true' floated quantifiers all have uses in which they behave as if they had a missing pronoun complement or were themselves pronominal. *each* is used that way in (333):

(333) The frogs leapt off the lily pad. **Each** left a ring of wavelets on the surface of the lake.

With respect to domain of quantification, even the universal floated quantifiers differ from Part operators. The domain of quantification for *each* includes only singularities, as noted in chapter 5, while *all* can quantify over subparts of singularities, as in the following example:

(334) The room was all cleaned up.

In chapter 9, we return to some of these uses of *all*. *Both* is peculiar in that it's domain is restricted in size. The subject of a verb phrase commencing with *both* is presupposed to refer to a two-membered plurality. *The frogs both leapt into the lake* is not felicitous in a conversation about several frogs. We will refer to this property as the "duality presupposition" of *both*.

7.2 *Both* in the Sets and the Union Theories

Floated *both* shares the duality presupposition with at least some of its non-floated counterparts. It is this presupposition that forms the basis of the following argument for the sets theory found in Lasersohn (1988:132, 1995:§9.4). First, consider the evidence for the presence of the duality presupposition:

(335) a. Both children are asleep.
b. Both the children are asleep.
c. Both John and Mary are asleep.

a. and b. are infelicitous in a context in which it is presupposed that there are more or less than two children. The duality presupposition is never violated in example (335c), in which the noun phrase that *both* is combined with denotes a plurality of two. Next, consider the following example, which occurred in a discussion of two grammars of Welsh, one written by Jones and Thomas and the other written by Awbery:

(336) In contrast, both Awbery and Jones and Thomas need extra statements in their grammars to make the distinction.

this example should be infelicitous since the phrase *Awbery and Jones and Thomas* denotes a plurality of cardinality greater than two. But (336) is not infelicitous and the reason, according to Lasersohn, is that the noun phrase *Awbery and Jones and Thomas* in fact does denote a plurality of cardinality two, one of whose members happens to be a plurality itself. This may be impossible according to the union theory, but not according to the sets-theory, hence we have an argument in favor of the latter.

The basis of this account of the felicity of (336) lies in the semantics of the complement of *both*, not in its syntax. This means that any definite noun phrase that denotes a set of two pluralities should be able to serve as the complement of *both*. In chapter 4, we discussed some examples that didn't involve conjunctions of plural noun phrases but that looked like they would have to denote higher order pluralities on the sets theorist's account of things. The subject of (337b) is an example of this kind:

(337) a. The children from Mexico and the children from Venezuela attended different summer camps.
b. The children from Mexico and from Venezuela attended different summer camps.

In the absence of any other context, the most salient interpretation of (337a) is one in which the children from Mexico attended different camps than did the Venezuelans. On the sets view, this interpretation arises because the subject of (337a) denotes a set of two pluralities. This division is 'encoded' in the verb phrase extension. (337b) has the same interpretation as (337a) hence its subject must also denote a two-membered set. In chapter 4, no rules of interpretation leading to this result were proposed, rather these examples were simply left as a challenge to the sets theorist. But no matter what solution is arrived at, unless there is a reanalysis of the verb phrase of (337a), it would seem to me that the subjects of (337a-b) are co-denoting. Given this conclusion, we now predict, contrary to intuition, that the subject of (337b) is a potential complement of *both*:

(338) ?Both (of) the children from Mexico and from Venezuela attended the summer camp.

By similar reasoning based on (339a) below, (339b) is counterfactually predicted to be good (assume that there are several children from each of the communities):

(339) a. The children from the two communities attended different summer camps.
b. #Both (of) the children from the two communities attended the summer camp.

In (340) below, we have another kind example of a noun phrase that would denote a higher order plurality on the sets account but which doesn't involve a conjunction of plurals:

(340) The women and the men disagreed about the morning's activities. That was why the guide put *them* in separate busses.

The pronominal object of *put* has a higher order antecedent, hence it denotes a higher order plurality. This is how the second sentence comes to mean that the women's bus was separate from the men's. Given that such pronouns denote higher order pluralities, again it is expected that they should function as complements of *both*. But this prediction is not borne out either:

(341) #The women and the men disagreed about the morning's activities. To avoid any conflicts in the afternoon, the guide put both of them on a bus to the city center for a free shopping day.

The examples in (338), (339b) and (341) suggest that the sets-based explanation for why (336) is felicitous is mistaken. However, if we reject Lasersohn's account of (336), then we are left with no account of why it is felicitous, not according to the sets theorist nor the union theorist.

The solution to this dilemma seems to me to lie not in the semantics of plurals, but rather in the grammar of *both*. The basis for examining the subject of (336) in connection with those of (335) repeated below:

(335) a. Both children are asleep.
b. Both the children are asleep.
c. Both John and Mary are asleep.

is that they all appear to be noun phrases formed by combining *both* with a nominal complement. But there is another possible source for the occurrence of *both* in (335c) and in (336). *Both* introduces conjunctions of categories other than nominal ones, as in the following examples:

(342) a. John both opened the door and turned up the music.
b. The chicken is both cold and sour.
c. He invented both a talking cup and a singing saucer.

One reason to recognize the occurrences of *both* in (342) as syntactically distinct from those in (335a-b) is the fact that in the latter cases *both* is a determiner and the uses in (342) are not standard cross-categorial generalizations of determiners. Even *both*'s near relative *all* doesn't generalize this way:

(343) a. * all John and Mary and Bill were asleep.
b. * John all walked and talked and sang.

Moreover, if the occurrences of *both* in (342) were the result of a generalization of determiner *both* then we would have to say that the complements of *both* denote two-membered pluralities. This by itself is not impossible and in fact Lasersohn (1995) provides just such an analysis for conjunctions in non-nominal categories. Strong evidence in favor of this view of *both* would come from combining it with non-nominal expressions other than conjunctions that are otherwise thought to denote two membered pluralities. As far as I know, such evidence is not available. Lasersohn (1995:§14.1), citing Cusic (1981), briefly mentions constructions that are supposedly used to refer to groups of events. None of them licence *both*:[39]

(344) a. #John both kept (on) swimming.
b. ?John both swam and swam.
c. #John both swam again and again.

The inability of *both* to combine with non-nominal non-conjunctions casts doubt on the hypothesis that *both* in (342) is of a kind with *both* in (335a,b). This would suggest that there are at least two *both*s in English. The first, $both_{\text{det}}$, is a determiner which requires that its

[39]The discussions of the semantics of *alternately* in Lasersohn (1992:§6, 1995:§14) suggest that "murder one's parent's" might denote a group of two events. One could imagine a use of *both* here to mean something like "he murdered both of his parents." But this is impossible:
i. a. *He both murdered each of his parents.
b. *He both murdered his parents / a parent.

complement denote a plurality with two singular parts. The second, *both*$_{[\_Conj]}$, introduces conjunctions crosscategorially. The comparison with *all* in (343) would suggest that *both* in (335c) and in (336) is not *both*$_{det}$ but rather *both*$_{[\_Conj]}$. This ambiguity hypothesis is by no means new. One finds the distinction made in early work in generative grammar. In Stockwell, Schachter and Partee (1973), for example, *both* is included in the category QUANTifier in the section on determiners, and in the section on conjunction there is a transformation called *Both* Insertion which produces among other things *both John and Mary.*

If one accepts the ambiguity hypothesis, then the problem of (336) is resolved. The subject is formed with *both*$_{[\_Conj]}$ which has no semantic duality requirement. The semantics of the expression *Awbery and Jones and Thomas* is not an issue here, hence the choice between the sets and the union theories is not at stake.

Further evidence for the ambiguity hypothesis comes from the syntactic difference between the two *both*'s brought out by the following paradigm:

(345) a. both the boys
b. both of the boys.
c. both John and Mary.
d. *both of John and Mary.

(346) a. all the boys
b. all of the boys.
c. *all John and Mary and Sue.
d. *all of John and Mary and Sue

On the assumption that *all* and *both*$_{det}$ are members of the same category we can explain (345). *both*$_{det}$ is impossible in (345c,d) just as *all* is in (346c,d). (345c) is grammatical because *both*$_{[\_Conj]}$ is used. But, by definition, *both*$_{[\_Conj]}$ cannot combine with a non-conjunction, so (345d) is out because of the intervening *of.* Lists apparently do not count as conjunctions either, as the following shows:

(347) *The chicken was both cold, sour and expensive.

and this would explain the anomaly of Lasersohn's (1988,1995) example below:

(348) *both John, Mary and Bill are asleep.

Summarizing now, according to the ambiguity hypothesis *both* in (349a) is not the same word as *both* in (349b), despite superficial appearances.

(349) a. both John and Mary
b. both (of) the boys

In (349a), we have an item that introduces conjunctions. In (349b), we have a determiner similar in character to *all* but with a duality presupposition. Since *John and Mary* happens to denote a two-membered plurality, one is lead to misanalyze *both*$_{[\_\mathrm{Conj}]}$ in (349a) as an instance of *both*$_{\mathrm{det}}$.

Circumstantial evidence for the ambiguity proposal comes from a comparison with *either*, the counterpart of *both* with respect to disjunction. Consider the paradigm below:

(350) a. either boy
b. either of the boys.
c. either sour or cold.
d. either John or Mary.

In (350a,b), *either* is a determiner. In a context where it is known that there are more than two boys, both (350a) and (350b) are infelicitous indicating that *either* introduces a duality presupposition like that of *both*$_{\mathrm{det}}$. Comparing (350a,b) to (350c), we are lead to posit a second *either* which can introduce disjunctions. So far this story is parallel to what was said above concerning *both*. The difference comes with (350d). Here there is no chance for misanalysis, since the disjunction, *John or Mary*, does not denote a two-membered plurality, hence the presupposition associated with *either* in (350a,b) could not be met here, hence this is clearly a case of the second, cross-categorial, pre-disjunction, *either*.

Returning again to Lasersohn's (336):

(336) In contrast, both Awbery and Jones and Thomas need extra statements in their grammars to make the distinction.

On the present theory, *both* in this example carries no presupposition of duality, hence this example doesn't count as evidence against the union theory. On the other hand, the problems raised for the chapter 4 proponents of the sets-theory, in connection with (339b) and (341):

(339) b. ?Both (of) the children from the two communities attended the summer camp.

(341) #The women and the men disagreed about the morning's activities. To avoid any conflicts in the afternoon, the guide put *both of them* on a bus to the city center for a free shopping day.

still remain, since they relied on a comparison of the above examples with example (335b):

(335) b. Both the children are asleep.

All of these examples, on the proposed account, involve the duality presupposing variant, *both*$_{det}$. According to the union theory, this presupposition is not met in (339b) or (341) which is why they are infelicitous as compared with (335b).

7.3 Floated *both*: A Sometime Distributivity Marker

The proposal concerning the ambiguity of pre-nominal *both* turns out to have consequences for syntactic analyses of the floated quantifier. Floated occurrences of *both* have often been viewed as related to their non-floated counterparts via a syntactic operation, unlike in the Dowty and Brodie (1984) analysis mentioned above. Traditionally, *both* was thought to float out of an NP into a verb phrase. Somewhat more recently, Sportiche (1988) has pursued that idea 'in reverse'. According to his analysis of floated quantifiers, the *both* phrase would be base generated as the sister of VP and the NP complement of *both* would be moved leftward stranding the quantifier. An examination of data below in terms of our ambiguity hypothesis will lead to the rejection of this analysis, at least for some speakers. Before turning to the data, I would like to note that the degree of disagreement that I encountered in speaker intuitions has led me to suspect that the movement analysis might be correct for a subset of speakers and perhaps is accurate as an account of the history of floated *both*. I should also note that Sportiche's analysis was for floated quantifiers in general so it is possible that the analysis is wrong for *both* but not for the others.

Turning to the data, if one assumes that the movement posited by Sportiche occurs regardless of which *both* is involved, then the grammaticality judgements for the examples in (351) entails those for the examples in (352):

(351) a. Both$_{det}$ the children are asleep.
b. Both$_{[_Conj]}$ [John and Mary] are asleep.
c. Both$_{[_Conj]}$ [Awbery and [Jones and Thomas]] need extra

statements.
d. *Both Awbery, Jones and Thomas need extra statements.

(352) a. The children are both asleep.
b. John and Mary are both asleep.
c. Awbery and Jones and Thomas both need extra statements.
d. *Awbery, Jones and Thomas both need extra statements.

Some speakers do not accept (352c). At first sight, it looks as if this intuition could be explained by assuming that for these speakers there is no movement away from *both*$_{[\_conj]}$. The problem is that they do accept (352b), which would be derived through movement away from *both*$_{[\_conj]}$ (compare (351b)). For these speakers then, a simple movement analysis is incompatible with the ambiguity hypothesis argued for above.

We turn now to those speakers who do accept (352c). Among these speakers there are some for whom the examples below are acceptable despite the predictions of the movement analysis. In (353-355) below, the NP that has moved away from *both* into a VP external position isn't formed with a conjunction. This means that it was the complement of *both*$_{det}$ and hence it should, contrary to fact, denote a pair of singularities in order to satisfy the duality presupposition.

(353) a. The lawyers and the physicians disagreed about the morning's activities. But in the afternoon, they will both go downtown to the museum.

b. Initially, neither the bankers nor the city councilors showed any interest in the plan. But now that the water rights have been clarified, they've suddenly both claimed it as their own.

(354) After the Civil War, the draft age was changed when it was discovered that those men who were either too young to fight or were too old to be drafted had both far outnumbered the fighting men.

(355) The administration thinks that the physics instructors and the math instructors cover five courses. In fact, *those instructors both cover only two courses.* Only the English teachers cover five courses.

In the examples in (353), the putatively moved NP is a pronoun, which on its salient interpretation might be said to denote a pair according to the sets theory. This would constitute an argument for the sets theory, were it not for the fact that the unfloated variants don't sound good:

(356) ??Initially, neither the bankers nor the city councilors showed any interest in the plan. But now that the water rights have been clarified, both of them have suddenly claimed it as their own.

Given this discrepancy, the examples in (353) along with those in (354-355) are unpredicted by the movement analysis, on both the sets theory and the union theory.

To this point, we have isolated at least two groups of speakers for whom the movement analysis makes wrong predictions. For these speakers, we have excluded the possibility of deriving floated *both* from $both_{det}$ or from $both_{[\_Conj]}$. Before returning to the alternatives to movement mentioned earlier, I would like to address a possible response to the conclusions drawn so far.

The arguments provided above are arguments against an analysis in which there is truly movement of an NP out of a construction commencing with *both*. Arguments similar to the one mentioned above concerning (351-352) have been made with other quantifiers. Compare the grammaticality of (357a) below with the ungrammaticality of (357b), its putative source on the movement theory:

(357) a. A, B and C all have knotted ends.
b. * All of A, B and C have knotted ends

Sportiche (1988:440-441) claims that his theory is immune to this type of argument, since strictly speaking he doesn't require actual movement of the subject in (357a), allowing in fact for base generation of a structure like the one in (358) below, where $[e]_{NP}$ is an NP-trace which is anaphoric to the subject NP:

(358) $[A, B \text{ and } C]_{NP}$ ... [[all $[e]_{NP}$] [have knotted ends]].

Given this structure for (357a), one can say about (357b) that conjoined NPs cannot be the object of a partitive quantifier, and (357a) is grammatical because the object of the quantifier, $[e]_{NP}$, is not a conjoined NP. This type of reply applies equally well to our discussion above of (351-352). But Sportiche's theory is not similarly immune to the second argument made here. Compare the following two examples, repeated from above embellished with markers to indicate the position of trace in Sportiche's analysis:

(359) Initially, neither the bankers nor the city councilors showed any interest in the plan. But now that the water rights have been clarified,
a. they_i have suddenly [[both [e_i $]_{NP}$] [claimed it as their own]].
b. both of them_i have suddenly claimed it as their own.

On the theory proposed in the previous section, (359b) is ungrammatical because of a property of the referent of the pronoun, namely it is a plurality with more than two members. The referent of the subject NP of (359a) shares this property. But if the referent of the subject NP of (359a) has this property then so does the referent of the trace which is anaphoric to that NP. So even if there isn't actual movement, there is coreference even on Sportiche's theory and so the second argument stands.

It appears then that for the speakers whose judgements are reflected in (353-355), we must posit a third *both*, this one a VP modifier. Given the apparent similarity with the Part operators, one is tempted to view floated *both* simply as a Part operator with a special proviso that there are exactly two cells in the cover containing elements of the referent of the subject of the *both* VP and these cells contain all and only elements of that entity. Adopting the notation of Beaver (1992) to handle the presupposition, this idea could be spelled out as follows:

(360) $\text{both}_{\text{float}} \approx\approx> \lambda P \lambda y\ [\forall x[(Cov(x) \wedge (x \subset y)) \rightarrow P(x)] \wedge Presup(\ |\ Cov/y\ |\ = 2)]$

Definition: For any X, a set of sets of individuals, and any y, a set of individuals, X/y is the largest subset of X that covers y, if there is one, otherwise it is undefined.

This analysis treats *both* as a special kind of Part operator. A possible argument for this analysis is that unlike floated *each*, *both* can introduce a reciprocal verb phrase (compare (329) above):

(361) They both saw each other.

Unfortunately, this analysis is precluded by other differences between floated *both* and the Part operators. Even though floated *both* is often used to indicate a distributive reading, it does not force one, as the following shows:

(362) John made the soup, I made the eggplant and we both made the

pot roast.

As it happens, floated *both* shares this semantic property with its non-floated counterparts. The following quote shows that $both_{det}$, while often associated with a distributive reading, does not force one[40]:

(363) "Napoleon and Squealer sold Boxer to the knacker" does not imply that Napoleon sold Boxer to the knacker, nor does it imply that Squealer did so. It entails that both of them sold Boxer to the knacker. (von Stechow, 1980:91)

Since *both* does not force a distributive reading, it cannot be analyzed like the Part operator with a universal quantifier, as in (360). As can be seen from (364) below, *both* shares this behavior as a sometime distributivity operator with *all*:

(364) Each of the boys made a cupcake, Ted made the chocolate pudding, Rita made the candied apples, and we *all* made the popcorn.

What exactly determines when a distributive reading is forced by *all* and when not is the subject of Dowty (1987).

7.4 Conclusion

As advertised in the introduction, this chapter has the character of a collection of notes related to quantifiers that float. We have conjectured that floated quantifiers are at least some of them not VP modifiers, hence they differ from the Part operator even though the inspiration for the Part

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[40]Does $both_{[\_Conj]}$ also allow for a non-distributive reading? My intuition is that (i) below makes no sense:

(i) "Napoleon and Squealer sold Boxer to the knacker" does not imply that Napoleon sold Boxer to the knacker, nor does it imply that Squealer did so. It entails that both Napoleon and Squealer sold Boxer to the knacker.

If $both_{[\_Conj]}$, unlike $both_{det}$, is always a distributive marker, then a) we have more support for the ambiguity hypothesis and b) as suggested in chapter 2, *both...and* would be a candidate expression to be translated as Hoeksema's (1983,7a) intersective conjunction.

operator was a VP modifier analysis of floated quantifiers. Concerning *both*, we argued following earlier work in generative grammar that this quantifier occurs in various categories. There is a pre-NP *both* which is a determiner that can occur alongside *the* just like *all*. There is another pre-NP *both* which is part of a complex cross-categorial conjunction. In addition, there is a floated quantifier *both*. What is common to all uses of *both* (including some we have not mentioned, cf. *the both of them*) is the notion of duality. In the case of determiner *both*, there is a duality presupposition and this was used here to argue against the sets theory. In the case of $both_{Conj}$, duality arises in the syntax. If the analysis here is correct, then the notion of duality is very general, including both syntactic and semantic instantiations. This raises interesting questions about the nature of lexical ambiguity and relatedness of words.

Chapter 8
Sorting the Domain

8.1 Types of Pluralities

Our focus in this section will be on the difference in the **variety** of entities that the sets and the union approaches are committed to. In order to study this question, we need to have a way of characterizing variety and of testing for its activity in the grammar. We will start with the idea that the variety of a set of objects is established by dividing that set into different categories. If a semantic theory posits a domain of entities having a wide variety of entities in it, and if this variety is really relevant to the grammar, then it should make reference to the categories into which the domain is divisible. For example, a predicate may apply felicitously only to entities of a certain category.

There are many ways that a domain of individuals comprising singularities and pluralities can be organized. For example, individuals might be sorted into those that are animate, inanimate or mixed (e.g. the individual consisting of you and your coat). However, not all ways of dividing up the domain are relevant to the differences between our two approaches to plurals or to the semantics of plurals in general. We will focus on mathematical or logical ways of dividing the domain. In particular, the subjects of our interest will be the classification of entities in the domain by their cardinality and the classification of entities by position in a set-theoretical hierarchy, that is, by some logical typing of the domain.

To see why these classifications are relevant, I will explain how I come to call them logical. Following the logician's use of the term "logical" in describing quantifiers, a sorting or classification is considered logical if it is "permutation invariant," as follows:

Let perm be a one-one mapping of D onto a set D'. A set D'^* is constructed from D' by the same method that D^* is constructed from D (what that method is depends on the particular theory of plurals). PERM is a one-one function from D^* to D'^* defined as follows:

1. for $x \in D$, $PERM[x] = perm[x]$
2. for elements X,Y in D^*, D'^* respectively,

$$PERM[X] = Y \text{ iff } \forall x \in X\ \exists y \in Y\ (PERM[x] = y) \text{ and } \forall y \in Y\ \exists x \in X\ (PERM[x] = y)$$

A classification is **permutation invariant** if for any $X \in D^*$ and any permutation of D, perm, X and PERM[X] are in the same class. Given the way PERM is defined, X and PERM[X] will always be of the same cardinality and of the same logical type, so these are logical classifications. An example of a non-logical sorting would be one that put all individuals having John as member in one category and all others in another category (John could turn out to be a member of D but not of D'). Animacy provides another more natural example of a criterion for sorting that is non-logical (PERM may map all animate elements of D into inanimate elements of D'). The limitation to logical classifications expresses the requirement that the sorting criteria not distinguish between different elements of D (cf. Mostowski 1957 for similar point regarding quantifiers). This guarantees that the categories involved are not simply inherited from characteristics of individuals that are unrelated to pluralization.

In this section then we will contrast the two most obvious logical classifications, cardinality and type-hierarchy, in terms of their activity in the grammar. Looking ahead a bit, notice that a type-hierarchy provides a rather impoverished method for sorting the individuals of the union theory, whereas that is certainly not the case for the sets theory. This should be clear from the relationship between D and D^* on the two approaches:

Union theory: D^* is the set of all non-empty subsets of D.
Sets theory[41]:

$$D_0 = D$$

$$D_{n+1} = D_n \cup POW_{\geq 2}(D_n)$$

$$D^* = \bigcup_{n \leq \omega} D_n$$

[41] $POW_{\geq 2}(X)$ is the set of all the non-empty non-singleton subsets of X.

8.2 Cardinality[42]

By sorting the domain in terms of cardinality we mean quite simply that individuals (pluralities and singularities) are distinguished by the number of members they have. Such a classification of the individuals in the domain does appear to be reflected in the grammar. This criterion can be used to describe the morphology of number. It is fairly accurate to say that morphologically plural predicates are true of entities having two or more members while the singular is true of entities having a single member. Some languages have dual forms. These are true of entities having exactly two members. And in these languages, the plural is sometimes defined only for entities having three or more members. For example, in American Sign Language, a sentence whose main predicate is an "agreement verb" inflected with the "exhaustive" inflection is ungrammatical if the agreeing noun phrase refers to an individual having only one or two members.[43] In short, there is some evidence from morphology that languages presuppose a domain of individuals sorted in terms of cardinality.

In addition to number restrictions imposed by inflection, often lexical items themselves semantically select their arguments in terms of cardinality. A spectrum of verb types, though limited, is perceptible. Thus whereas the verb *stand* can felicitously be applied to a term denoting individuals with one or more members, the predicate *meet* requires two or more people:

(365) #John met.

and the predicate *gather* requires somewhat more than that:

(366) ? John and Mary gathered in the park.

and finally *swarm*, can be true or false only of large groups. Except in jest, we cannot say, referring to three insects, that:

(367) #Pangur and Little One and Chubaka were swarming around the living room when I walked in.

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[42]This section owes much to Dougherty (1970).

[43]This information was provided me by Karen Petronio. The verbal inflection "exhaustive" is discussed in Klima E. and U. Bellugi, 1979, *The Signs of Language*. Harvard University Press, Cambridge MA.

Another example of this type is the German verb *strömen* [to pour/stream in] which Bartsch (1973:77) notes "is not applicable to small groups but rather to masses of individuals."

While it seems that verbs in the *gather* and *swarm* classes do not always have two-place counterparts, the verbs in the *met* class all seem to, for example:

(368) a. #John met.
b. John and Mary met.
c. John met Mary.

(369) a. #Line A intersects.
b. Line A intersects line B.
c. Lines A and B intersect.

These verbs, in their intransitive incarnations, are sometimes described as covert reciprocals. I do not know why these should be the only members of the *met* class, if in fact that is the case.

This phenomenon is not limited to verbs. Adverbs and adjectives, for example, impose similar restrictions. Verb phrases formed by combining a verb with *together* are of the *met* type while those containing *en masse* are of the *swarm* type. The adjective *parallel* is of the *met* type while *unanimous* seems to require some larger group:

(370) # John and Bill were unanimous in their disapproval.
My parents were unanimous in their disapproval.

Although a description of this spectrum of predicate types in terms of cardinality seems right, it is not clear exactly how it should be characterized formally. Taking the semantic value of a 1-place predicate to be the characteristic function of a set, one might think to incorporate in the grammar statements such as:

(371) X is in the domain of the function || swarm || iff the cardinality of X is large.

The problem with such a characterization is that many of these predicates combine nicely with singular collectives and bare-plurals, which on some accounts denote singularities. We will not attempt a formalization here. Another question which must remain open is the following. In the morphological domain, we had inflections, singular and dual, which place a maximum on the size of the individuals in the domain of predicates with that inflection, whereas the plural and exhaustive inflections enforce a minimum but no maximum. On the other hand, in the case of selectional restrictions there were no examples of predicates that apply exclusively to groups below a certain size. What then is the status of this asymmetry between maxima and minima?

Our focus so far has been presuppositions introduced by certain predicates concerning the cardinality of their arguments. However, the actual meanings of predicates include reference to cardinality as well. Most obvious examples are the numerals themselves as well as verbs such as *outnumber* and other comparative constructions.

Finally, we note that there is a limited sorting of variables in terms of cardinality. In English this occurs in the difference between bound plural and singular pronouns. If *both* is functioning as a bound pronoun in the next example then we require a more fine grained sorting: one, two, two or more.

(372) Two people who truly like each other are happy only if both are successful.

Probably a better place to look for this type of thing would be in languages, like American Sign Language, which actually have dual (and trial) pronouns.

This completes our survey of cardinality related phenomena. The data here is meant mainly to be suggestive of how a logical sorting of the domain might be reflected in the grammar. Reference by the grammar to the cardinality of individuals is more or less equally expected on either of our two theories, and so we have not delved deeply into this question.

8.3 Set-theoretic Hierarchy

In contrast with cardinality, reference in the grammar to a hierarchical sorting of individuals is to be expected on the sets theory alone. Given the domain D^* as defined for the union theory, a type-theoretic sorting would at most distinguish singularities from pluralities. It could not be used to distinguish pluralities. Thus the one purpose a hierarchical classification of individuals could serve, to distinguish singularities and pluralities, is achieved with reference to cardinality, which is probably needed anyway. On the other hand, position in a set-theoretic hierarchy would provide a meaningful criterion for the sorting of D^* as defined in the sets theory. To clarify this claim further, we will settle on a specific hierarchy that would make sense on the sets approach. To do this we repeat the definition for D^*:

(373) Sets theory:

$$D_0 = D$$

$$D_{n+1} = D_n \cup POW_{\geq 2}(D_n)$$

$$D^* = \bigcup_{n \leq \omega} D_n$$

There are a number of different hierarchies that could be specified. One obvious possibility is a hierarchy in which level n corresponds to D_n in (373). One property of this hierarchy is that the same individuals can occur at various levels. Thus for example elements of D occur at every level. While this may be useful for some purposes, it seems like it would be difficult to find linguistic evidence for such a hierarchy.

Another possibility would be a hierarchy in which each level n+1 individual is **composed** entirely of individuals from level n, for $0 \leq n \leq \omega$. This is a natural candidate for a hierarchy; however, it has a serious defect. "Mixed individuals" are left out. To see this, imagine that $a \in D$ and $\{c,b\} \in D^*$ and that they are from different levels. If this last requirement is not met then we do not even distinguish pluralities and singularities. The problem now is that we have no level at which $\{a,\{c,b\}\}$ occurs since it is not composed solely of individuals from any one level.

If the grammar were indeed sensitive to some hierarchy then, it would have to be one that includes nonoverlapping levels, but levels that together included all elements of the domain. Viewing the construction in (373) dynamically, what we would like is a hierarchy in which at level n of the hierarchy, we find all and only the individuals that are newly created in the formation of D_n. In (373), D_{n+1}, defined as $(D_n \cup POW_{\geq 2}(D_n))$, includes all the new individuals created at D_{n+1} along with old ones. What about $POW_{\geq 2}(D_n)$? This also contains all the new individuals created at D_{n+1}, but it still includes some individuals from D_n. As the following shows this:

(374)	a. $D_n = D_{n-1} \cup POW_{\geq 2}(D_{n-1})$	by (373)
	b. $POW_{\geq 2}(D_n) = POW_{\geq 2}(D_{n-1} \cup POW_{\geq 2}(D_{n-1}))$	line a.
	c. For any A,B, $POW_{\geq 2}(A) \subseteq POW_{\geq 2}(A \cup B)$	def. $POW_{\geq 2}$
	d. $POW_{\geq 2}(D_{n-1}) \subseteq POW_{\geq 2}(D_n)$.	lines b,c
	e. D_n and $POW_{\geq 2}(D_n)$ overlap.	lines a,d

What we need then is to remove the elements of D_n, from $POW_{\geq 2}(D_n)$. This is the idea behind the following hierarchy (for any n, D_n is given by

(373)):

(375) Hierarchy of elements of D^* for the sets-theory.
Level 0 = D
Level 1 = $POW_{\geq 2}(D)$
For any $n \geq 2$, Level n = $POW_{\geq 2}(D_{n-1}) - POW_{\geq 2}(D_{n-2})$.

The appeal of this hierarchy is its correspondence to the syntax and morphology. Noun phrases in which pluralization is nested to depth n denote level n entities, where by "pluralization" we mean an instance of plural marking or term conjunction. Thus, for example, *John* involves no pluralization and it denotes a level 0 individual. *The boys* contains one pluralization and it denotes level 1 entities. Finally, *the boys and the girls* and *John and the girls* both contain a pluralization within a pluralization and they both denote level 2 entities.

Assuming now that the sets theory is correct, and therefore that the hierarchical sorting of the domain given in (375) is available to the grammar, we set about to see if in fact the grammar makes any reference to it. The kind of thing we are looking for is a predicate that can be felicitously applied only to certain noun phrases depending on their level and therefore on the depth of embedding of pluralization in the noun phrase. In fact, as far as I could tell, there is no evidence either from morphology or from semantic selection of the essential use of a hierarchical sorting of the individuals in the domain.[44] Furthermore, in ordinary

[44]Link(to appear:20) makes a similar point.

J. Hoeksema suggested to me in public that the predicate *be equally numerous* may not fit this characterization, that is, it may apply only to (some) noun phrases denoting at level 2 and higher. However, I think the following piece of discourse is well-formed:

i. After the earthquake the community was divided into two independent groups, one in the west and the other in the east. Each developed its own culinary style and music tradition. A recent study of population statistics revealed a strange development. After about 100 years of separation, the women from the western community far outnumbered the women from the eastern community, whereas the men remained just about equally numerous.

In (i) the predicate *remain equally numerous* applies to *the men* which

English, there do not seem to be predicates whose meaning makes essential reference to our hierarchy. Nor is there any evidence that the language makes essential use of a range of variable types in quantifying over pluralities. Thus the variety characteristic of the sets-domain seems largely to be ignored by the grammar.

8.4 Conclusion

The motivation behind the discussion here is as follows. Our theories differ in the variety of entities found in D^*. If entities are characterized hierarchically, then the union theory assumes there to be at most two kinds of entities, singularities and pluralities, whereas the sets theory assumes there to be an infinite range of entities. If there was a link between the variety manifested in the domain of individuals and grammatical phenomena, then this difference could be exploited to compare the theories. A look at reference to cardinality in the grammar suggested a plausible link. Our conclusion was that there doesn't seem to be similar reference to a set-theoretic hierarchy in the grammar. This in turn is taken as a challenge to the sets approach. Why is it that the semantics requires distinctions among entities concerning which the grammar is silent? One might even try to phrase this question in terms of learnability.

Of course this is not a decisive argument against the sets approach. That approach is not committed to the specific sort of hierarchy that I have considered here. Furthermore, just because the individuals in the domain can be sorted in certain way, doesn't mean that the grammar will necessarily make reference to that criterion of sorting.

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denotes a level 1 type entity.

Chapter 9
Collective Nouns[45]

9.1 Bunches

The purpose of this chapter is to consider collective nouns such as *group* or *deck* (of cards). In chapter 3 (page 36), these nouns were characterized as "substantives which (in the singular) denote a collection or number of individuals". These nouns optionally appear with an *of* complement containing a bare plural noun or noun phrased which describes the members of the collection. We will refer to a noun phrase headed by a collective noun as "a collective noun phrase." Noun phrases not so headed will be called individual noun phrases. The term "bunch" will be used to characterize the kind of thing a singular definite collective noun phrase refers to. The central question to be asked in this chapter is whether a bunch is a singularity or a plurality. A related question will be whether a plural individual noun phrase has a reading in which it denotes a bunch. For example, *the deck*, by definition, denotes a bunch. If *the cards* is assigned the same denotation as *the deck* in some or all contexts, then it too denotes or can denote a bunch. I think it is fair to say that Bennett (1974), Link (1984), and Landman (1989)[46] believe that plural individual noun phrases can denote bunches, while Lasersohn (1988) and Lønning

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[45]Working independently, Chris Barker and I arrived at similar conclusions concerning collective terms and we discovered some of the same evidence. His research is reported in Barker (1992).

[46]In the theories of Link and Landman, the denotations of collective noun phrases are called groups. However, since even plural individual noun phrases can denote groups in those theories I have avoided that term.

(1989) do not.[47]

The answers to these questions about bunches have consequences for the sets versus union debate. To see this, consider the following scenario. Assume that bunches are singularities. Next assume, on the basis of predicate sharing (see section 3.2 for this term) as in the following pair:

(376) The committee voted.
(377) The committee members voted.

that plural individual noun phrases can denote bunches. If two such noun phrases are conjoined with a union *and* (e.g. *the members of committee A and the members of committee B*) we end up with a plural individual noun phrase that denotes a plurality having two members, each of which is a bunch. If this were the case, the differences between the union approach and the sets approach become much less substantial. Matters are even worse if we follow Landman (1989a) and take a bunch to be a singleton set whose sole member is a plurality. Allowing *and* to denote union and allowing that a plural individual noun phrase can denote a bunch, as is the case on Landman's theory, we end up with the conjunction of two plural individual noun phrases again able to denote a two membered plurality. In particular, the conjunction of two bunch denoting plural individual noun phrases would denote exactly what was originally proposed in the sets approach without the introduction of bunches, namely a plurality of pluralities (for details see section 2.4). This is clearly not in the spirit of a pure union approach. It would favor a sets approach or at least a mixed approach. For recall, the two approaches disagreed about whether a noun phrase such as *the boys and the girls* denotes a plurality with as many members as there are children (union approach) or just two members, one female and one male (sets approach). Sticking to a union *and* but allowing that *the boys* and *the girls* can denote singletons containing a plurality, we end up with the latter denotation for *the boys and the girls*.

To this point, we have been assuming that bunches are singularities, and then trouble arises for the union approach with the possibility that plural individual noun phrases can denote bunches. Arguments against the union approach are possible as well, even if one starts with the assumption that bunches are pluralities. For it is natural to assume that a plural

[47]Lønning (1989:155) distinguishes between *the group* and *the group of boys*. Building on Selkirk (1977), he proposes a syntactic analysis of *the group of boys* in which the head of the noun phrase is *boy*. In this case, it would have the same denotation as *the boys* and would not denote a bunch.

collective noun phrase such as *the congregations* denotes a set or plurality of bunches. *The two congregations* would denote a plurality with two member bunches. If bunches are pluralities, then a plural collective noun phrase denotes a set of sets or plurality of pluralities. This already requires a modification of the domain for the union theorist. The next step is to discover a plural collective noun phrase that is apparently coextensive with a conjunction of plural individual noun phrases. For example, based on the following pair and a context in which they are seemingly synonymous:

(378) The congregations prayed together.
(379) The Methodist congregants and the Presbyterian congregants prayed together.

one might argue that $\|$ the congregations $\|$ = $\|$ the Methodist congregants and the Presbyterian congregants $\|$. It would follow then that a conjunction of plural individual noun phrases denotes a set of sets, a result that is incompatible with the union approach.

I have just sketched two lines of reasoning by which collective noun phrases are used to attack the union theory. This does not mean that these noun phrases per se are problematic for the union approach. Discussion of the evidence below will probably make more sense if we first outline an approach to collective noun phrases that is compatible with the union theory. On this approach, singular collective noun phrases denote bunches and a bunch is just a certain kind of singularity while plural individual noun phrases are purely plurality denoting. Problems arise when either of these two assumptions are contradicted. One argues either that a) singular collective noun phrases denote pluralities or b) plural individual noun phrases are singularity denoting. It is important to point out that both of these arguments are based on predicate sharing between collective and plural individual noun phrases, which leads to the hypothesis that they co-denote. This means that again we need to ask: what predicates are shared, what predicates are not shared and crucially, how is the non-sharing explained. To facilitate discussion, I will neutrally speak about a plural individual noun phrase *associated* with a collective noun phrase. By this I mean a plural individual noun phrase which denotes a plurality whose members are all and only those individuals that make up the bunch denoted by the collective noun phrase. Also, I will occasionally follow Jespersen in referring to collective noun phrases simply as collectives.

In the following section, the data on predicate sharing will be laid out. I have divided this data up into the following categories. First, we will look at cases in which the 'predicate' that applies to the noun phrases in question is a quantifier. This would seem to be relevant to the question at hand. These constructions tell us something about whether the language treats the denotation of a noun phrase as a set that can be quantified over and whether the two types of noun phrases compared here are treated the same. Next, we will look at verbal predicates that seem to semantically select for plural entities. Following that, we take up predicates that are morphologically marked as plural. In this section we also consider phrases that contain a pronoun that is anaphoric to the noun phrases under investigation. Following Jespersen, we look at how the number of a pronoun relates to the kind of antecedent it can have. The last piece of evidence we consider is copular constructions in which a collective is used predicatively with a plural individual noun phrase subject. This is not strictly a case of predicate sharing.

As we shall see, there is far from total predicate sharing between associated collective and plural individual noun phrases. In order for the argument against the union theory to go through some account must be given for this non-sharing. In the final section, we will consider such an account, found in Landman (1989b).

9.2 Noun Phrases as Restrictors of Quantifiers

Before attending to the data of this section, I would like to redefine the term "singularity." Originally, a singularity was defined linguistically as any object that is the denotation of a singular (count) noun phrase. Now however, we have singular collective noun phrases which denote bunches and we don't yet know if bunches are singularities. So "singularity" is redefined semantically as follows (cf. Quine's demarcation of "individual" in the Appendix):

(380) $\forall x[\text{singularity}(x) \Leftrightarrow \forall y[y \in x \Leftrightarrow y=x]]$

and we still have D as the set of all singularities in the domain. Another thing that needs to be made clear is the use of the symbol "$\in$." This symbol is a part of the metalanguage. The object language *member* does not (always) denote this relation, hence the illformedness of the following:

(381) a. #The boys have three members.
b. #John is a member of the boys.

Talk of members of a plurality is to be understood in the metalanguage sense of membership.

With those preliminaries aside we now turn to quantificational structures that include definite noun phrases as restrictive terms. Such structures will, it is hoped, provide a diagnostic for determining the type of entity denoted by the definite noun phrase. This diagnostic can then be used to investigate bunches.

As was pointed out in chapter 7, partitive phrases with *all* involve different kinds of quantification. Consider the following examples:

(382) All of the cars were painted.
(383) All of the car was painted.

In (382) we have quantification over members of an automotive plurality. In (383), on the other hand, we have quantification over parts or pieces of a singularity. Let us provide two denotations for *all* reflecting this difference:

(384) $\| \text{all}_{\text{pl}} \| = \{ \langle A,B \rangle \in (D^*\text{-}D) \times D^* \mid A \subseteq B \}$
$\| \text{all}_{\text{sing}} \| = \{ \langle A,B \rangle \in D \times D^* \mid \mathbf{piece}(A) \subseteq B \}$
piece is a contextually specified partial function from D to D^*. Intuitively, it gives for every element in its domain the set of parts of that element. John's arm in some contexts will be a member of **piece**(|| John ||).

all$_{\text{pl}}$ is employed in (382) and *all*$_{\text{sing}}$ in (383). We might have combined these two meanings into one, since they are differentiated semantically in terms of whether their first argument is a singularity or not. One reason to keep them separate is that only the plural form shows the pronominal behavior characteristic of quantifiers such as *all*, *each*, and *most*. Thus while *all* is interpretable as *all of the cars* in the final part of (385) below, *all* is simply uninterpretable in the final part of (386):

(385) The officers were concerned that their cars would not be seen at night. The manufacturer, seeking to allay their fears, informed them that most of the cars were adorned with reflective strips, and in any case, all were painted with glow in the dark paint.
(386) The officers were concerned that their car would not be seen at night. The manufacturer, seeking to allay their fears, informed them that most of the car was adorned with reflective strips, and in any case, all was painted with glow in the dark paint.

In the analysis of *all* in (384), no role is played by the partitive *of*. An alternative along the lines of Barwise and Cooper (1981) might be to let *all* have a standard universal quantifier meaning and have *of* deliver, in the case of (382), the set of members of the plural noun phrase's denotation and in the case of (383) a set of pieces of the singular noun phrase denotation. One reason not to do this is that the dual meaning of *all* is preserved in its floated incarnations[48]:

(387) The cars were all painted.
(388) The car was all painted.

So *of* is not made essential in our analysis.

We now have the beginnings of a diagnostic for the denotations of definite noun phrases which we apply to collectives:

(389) a. All of the group was silent.
b. All of the boys were silent.

In (389b), we have quantification over members of a plurality. What does this tell us about the potentially synonymous (389a)? In fact, not very much. Since *all* can quantify over parts of a singularity as well as over members of a plurality, we don't really know what we have in (389a). What we need is a quantifier that has only one of these meanings. One candidate is *each*, as the following shows:

(390) Each of the cars was painted.
(391) *Each of the car was painted.

The meaning of *each (of)* is just the meaning of all_{pl} given in (384). In fact, in light of Dowty (1987), this meaning is more appropriate to *each* than to *all*. In any case, crucially, *each* has no meaning corresponding to all_{sing}. By the way, this is yet another reason not to pin the different meanings of *all (of)* on the *of*. If this were the case then we could not have a quantifier, *each*, that had only one of the meanings, unless we posited two *of*'s only one of which was selected by *each*. Back to the main point, we now have a quantifier that semantically selects for a plurality denoting term in its first argument. Before using this to test collectives, let me dispel a possible worry. One might imagine that *each (of)* selects its first argument on the basis of syntactic plurality. Evidence against this view comes from the fact

[48]Incidentally, a comparison of floated *all* in (388) with pronominal *all* in (386), casts doubt on a hypothesis, raised in section 7.1, according to which floated quantifiers are actually instances of pronouns 'derived' from homophonous determiners. Were this the case, then a floated singular *all* would derive from a nonoccurring pronominal singular *all*.

that it will not combine with non-count plural noun phrases:

(392) a. The funds were ill-gotten.
b. # Each of the funds was ill-gotten.
c. All of the funds were ill-gotten.

(393) a. His guts were spilling out.
b. # Each of his guts was in a different place.
c. All of his guts were oozing out.

each (of) combines with noun phrases that denote pluralities and those in (392)-(393), though syntactically plural, do not denote pluralities. Armed with *each* as a fairly safe diagnostic for semantic plurality, we apply it to collectives:

(394) a. ?Each of the group left a flower.
b. *Each of the deck had a red mark on it.
c. ?Each of his family ordered a different dish.

each (of) does not combine with singular collective noun phrases. Floated *each* displays the same behavior:

(395) a. ?The group each left a flower.
b. *The deck each had a red mark on it.
c. ?His family each ordered a different dish.

If the line pursued here is correct, it follows that bunches are not pluralities. This means that if plural individual noun phrases are found to denote bunches, then they are ambiguous between a bunch and a plurality denotation, as is the case in the theories of Link and Landman. But we don't yet know if they can denote bunches and *each* cannot help us here. According to the ambiguity theorist plural individual noun phrases occur after *each* in their non-bunch denoting forms.

What is needed now is a quantifier that is the reverse of *each*. That is, a quantifier that has only the singular or "pieces" interpretation we saw above with *all*. It is a little tricky to find a universal quantifier that fits the bill. However, I would argue that the word *part* in the following construction is to be analyzed as an existential "pieces" quantifier with the denotation assigned in (397):

(396) a. Part of the car was painted.
b. Part of the funds were ill-gotten. (compare (392))
c. #Part of the boys were in Texas.

(397) $\| \text{part} \| = \{ <A,B> \in D \times D^* \mid \textbf{piece}(A) \cap B \neq \varnothing \}$

Applying this quantifier to collectives we arrive at a well-formed construction:

(398) Part of the group was in Texas.

Ultimately, what is important here is the comparison between (398) and (396c). This contrast directly contradicts the ambiguity theory. If plural individual noun phrases such as *the boys* had readings on which they denoted a bunch, (396c) would be well-formed on that reading. But in fact, plural individual noun phrases cannot denote bunches. Putting our two results together, we have that plural individual noun phrases do not denote bunches and collective noun phrases do not denote first order pluralities, hence associated noun phrases such as *the committee* and *the committee members* should not be analyzed as co-extensional.

The remainder of this section will be taken up with notes and observations related to the argument made thus far.

We said that there is no obvious candidate for a unambiguous universal pieces quantifier. The closest I could come was the ad-noun *whole*. As Jespersen(§4.86) noted, collective noun phrases can be modified with *whole*:

(399) a. The whole family was in an uproar.
b. Reagan's whole library was moved to California.

As in the case of *part (of)*, collectives pattern differently from plural individual noun phrases:

(400) a. #The whole boys were in an uproar.
b. #The whole books were moved. (with the meaning of 399b.)

Other prenominal quantificational words include the word *individual* and the numerals. These combine with plurals but not with singular collectives:

(401) a. The individual members had a chance to view the proposal.
b. * The individual committee had a chance to view the proposal. (on a reading synonymous with a.)

(402) a. The five members voted.
b. #The five committee voted.

Just as there are floated adverbial versions of *all* and *each*, *part (of)* has an adverbial counterpart in *partly*. The adverbial versions of (396c) and (398) above are:

(403) a. ?The boys were partly in Texas at the time.
b. The group was partly in Texas at the time.

In fact, a verb phrase containing one of these adverbs **can** be used with a plural individual noun phrase, as in:

(404) The bricks were partly covered with paint.

In this case, we have a distributive reading of the verb phrase. (404) would probably not be judged true in a situation where there was a pile of bricks a few of which were totally covered with paint but most of which had no paint on them. On the other hand, if a mason built a wall out of the bricks and then painted a few of them it would be true that:

(405) The wall was partly covered with paint.

The contrast is highlighted with the use of an overt element to mark the distributivity of (404):

(406) a. The bricks were all partly covered with paint.
b. ?The wall was all partly covered with paint.

The anomaly of (406b) suggests an answer to a question raised in connection with (389) regarding *all* and collectives. Since *all (of)* quantifies over members and over pieces, we couldn't tell what was happening with collectives. However, if *all* could in fact quantify over members (not pieces) of a bunch, then (406b) wouldn't be anomalous; it would have the meaning of (406a).

The following examples inspired by Dougherty (1970:853fn8) involve other contexts that distinguish bunch denoting from plurality denoting phrases:

(407) Many in the group are from New York.
(408) Much of the group is from New York.
(409) Some in the group are from New York.
(410) Some of the group is from New York.

Dougherty demonstrates with these examples that collectives can be quantified with both count and non-count quantifiers. In the latter case the resulting noun phrase is singular, as in (408) and (410). As for the issues addressed here, note that replacing *the group* with *the boys* in these examples results in ungrammaticality.

Going the other way, reciprocals provide for a context that has been analyzed as quantificational but which disallows bunches. Contrast:

(411) The rocks in that pile are touching each other.

with:

(412) #That pile is touching each other.

For analyses of the reciprocal which involve *each*-quantification of the subjects of (411) and (412), the contrast here is unsurprising, given that we already know the first argument of *each* is not defined for bunches. Given the theory of reciprocals in chapter 6, the contrast here derives from the Part operator.

Interestingly, this contrast is maintained even in cases where the reciprocal is not overt. Here is a sample:

(413) a. #The trio collided. (from Dougherty 1970)
b. John, Bill and Tom collided.

(414) a. The members of group A live in different cities.
b. #Group A lives in different cities.
c. The members of groups A and B have the same last name.
d. Groups A and B have the same last name. ($\neq$ c).
e. These texts were discovered independently.
f. This set of texts was discovered independently.($\neq$ e)

(415) a. These conditions are mutually exclusive.
b. #This set/list/group is mutually exclusive.

I will end this catalogue with a puzzle that arose in thinking about the diagnostics used here. In the literature on generics there is some discussion about the differences between the singular generic as in (416a) and the bare plural as in (416b):

(416) a. The telephone became affordable to the average American around the turn of the century.
b. Telephones became affordable to the average American around the turn of the century.

Carlson (1977:440) concludes, somewhat unhappily, that both types of generics denote a property set of a kind (for Carlson a "kind" is an individual in its own right). The set denoted by the definite generic is a subset of the set of properties denoted by the bare plural. Differences between the two noun phrase depend on which properties are in the former set, but not in the latter.

Though it may not follow necessarily, one would expect our quantificational diagnostics not to differentiate between these two types of generics since they both refer to kinds. Furthermore, since Carlson (1977:§4.1) argues that kinds are not sets, we would expect kind-denoting terms to pattern with singularity denoting terms.

Applying our diagnostics in (417)-(420) below, we find some contexts in which the definite generic patterns with singularity denoting terms while the bare plural patterns with plurality denoting terms.

(417) a. The white blood cell is responsible for producing aminosalicylic acid.
b. White blood cells are responsible for producing aminosalicylic acid.
c. # Part of the white blood cell is responsible for producing aminosalicylic acid. (meaning 'some white blood cells')
d. # Part of white blood cells is/are responsible for producing aminosalicylic acid.

(418) a. Dogs attack themselves, when they get irritated.
b. The dog attacks itself, when it gets irritated.
c. Dogs attack each other, when they get irritated.
d. # The dog attacks each other, when it gets irritated.

(419) a. 1989 Fords each come with a different serial number.
b. *The 1989 Ford each come(s) with a different serial number.
c. 1989 Fords come with one gasline each.
d. ?The 1989 Ford comes with one gasline each.

(420) a. #Each of 1989 Fords comes with a catalytic converter.
b. #Each of the Ford comes with a catalytic converter.

Some of these data are discussed in the literature on generics. Wilkinson (to appear) discusses pairs like the one in (420) within the context of a theory that in contrast to Carlson (1977) views bare plurals as potentially not kind denoting. Also relevant is Dayal's (1992) discussion of the significance of number in distinguishing the bare plural and the definite generic.

At the heart of this subsection was a distinction in the semantics of certain English quantifiers between quantification restricted to members of a plurality or set and quantification restricted to pieces or parts of an entity. *all* was claimed to exemplify both types of quantification depending upon the entity providing the restriction. By isolating quantifiers that display only one of these types of quantification, we were able to probe the type of entity that collective noun phrases denote. We concluded that plural individual noun phrases and singular collective noun phrases do not denote the same type of object. This result is pleasing to the union theorist. On that theory, pluralization can never raise the order of the plurality denoted past first order. If plural noun phrases could denote bunches this cap on the order of pluralities would be threatened.

What we have shown here is that many quantificational predicates are not shared by collective and plural individual noun phrases. The argument based on this evidence involves the assumption that the non-sharing is the result of a difference in extension. In order to challenge this assumption, one would have to point to some other aspect of the syntax or semantics of the noun phrases in question that would explain the non-sharing.

9.3 Verbal Predicates and Anaphora

9.3.1 Introduction

In this section we attempt to deduce from the kinds of verbal predicates that apply to collective and plural individual noun phrases something about the relative nature of bunches and pluralities. We will look at predicates that have been classified as semantically plural as well as syntactically or morphologically plural predicates. In addition, we consider the class of noun phrases that may serve as non-quantificational linguistic antecedents to plural pronouns.

9.3.2 Evidence That Associated Collective and Plural Individual Noun Phrases Co-refer

In the introduction to this chapter we discussed the following example which suggests equating the reference of *the committee* with that of the plural individual noun phrase *the committee members*:

(376) The committee voted.
(377) The committee members voted.

Examples with inanimate collective noun phrases are also used to support coreference claims, for example:

(421) The deck was shuffled.
(422) The cards were shuffled.

This example has the added feature that the predicate *shuffled* is not normally appropriate with a non-collective singular subject, for example:

(423) ?The card was shuffled.

Facts of this type are used as the basis for the following argument. The contrast in (422)-(423) indicates that *shuffled* refers to a property that pluralities but not singularities can have. (421) shows that bunches can have this property. Hence, bunches must be pluralities and not singularities. It is easy then to claim that the subjects of (421) and (422) both denote the same plurality. Other examples supporting this line of reasoning are:

(424) a. The nomads were scattered across the continent.
b. The community was scattered across the continent.
c. ?The nomad was scattered across the continent.
(425) a. The chairs were rearranged before the guests arrived.
b. The kitchen set was rearranged before the guests arrived.
c. ?The chair was rearranged before the guests arrived.
(426) a. The tourists were assembled in the parking lot.
b. The group was assembled in the parking lot.
c. ?The tourist was assembled in the parking lot.

Up to now we have been looking at predicates that might be called 'semantically plural' as they appear to sort for plurality denoting terms. In Jespersen (1914:§4.8) and elsewhere similar kinds of effects are discussed with respect to predicates that are morphologically plural. Plural predicates are so identified because they generally do not combine with singular subjects. However, a singular collective noun phrase[49] may serve as the

[49]A collective noun phrase such as *the committee* is considered syntactically singular for the following reasons:

1. there is a contrast between *the committee* and *the committees*
2. *the committees* cannot serve as the subject of a singular predicate.
3. **these committee* is ungrammatical.
4. It won't do to say that what I am calling a singular collective

subject of a syntactically plural predicate, as in the following British English example:

(427) The committee are tall.

The argument made above with predicates such as *shuffle* obtains here as well. Syntactically plural predicates apply felicitously to plurality denoting terms but not to singularity denoting terms. The fact that they apply to bunch denoting terms indicates that bunches are pluralities.

Jespersen also observed that predicates containing plural pronouns of various types combine with singular collective noun phrases which serve as antecedents for the pronouns. Here are five of the examples cited by Jespersen:

(428) The *choir* knelt and covered *their* faces.
(429) The *committee* congratulated *themselves*.
(430) when the *legislature* abolished the laws against witchcraft, *they* had no hope of destroying the superstitious feelings of humanity.
(431) desiring I would take some care of their poor *town*, *who*, he says, will lose *their* liberties...the *town* had behaved *themselves* so ill to me, so little regarded the advice I gave *them*, and disagreed so much among *themselves*, that I was resolved never to have more to do with *them*.
(432) there *was a* grand *band* hired from Rosseter, *who*, with *their* wonderful wind-instruments and puffed-out cheeks, *were themselves* a delightful show to the small boys.

Jespersen pointed out that distance plays some part, "the plural construction occurring more easily at some distance from the singular substantive than in immediate contact with it." Perhaps this is the reason why (429) sounds strange to some speakers. These examples involve what may be analyzed as pragmatic cases of anaphora. But one might also inquire about bound variable anaphora. The question is can a plural pronoun be bound by a singular quantifier headed by a collective noun. Following are two examples whose status I am unsure of:

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noun phrase such as *the committee* is really syntactically ambiguous with respect to number since, as Jespersen points out, often a single instance of such a noun phrase will display both singular and plural agreement within the same sentence.

(433) Every debate team that Bill coaches eventually gets disqualified because they attack each other instead of attacking their opponents.
(434) Usually, if a debate team is coached by Bill, they end up attacking each other.

Regardless of the extent of this phenomenon, we are left with a range of plural predicates that apply to singular collective noun phrases thus lending support to coreference claims concerning collective noun phrases and their associated plural individual noun phrases.

9.3.3 *Evidence That Collective and Plural Individual Noun Phrases Do Not Co-refer*

In the previous subsection the evidence supporting coreference between singular collective and associated plural individual noun phrases came in two varieties. To begin with, we saw simple examples of predicate sharing. This was meant to show that specific noun phrases were coreferent. The other kind of data was of a more general type having to do with the nature of bunches. We saw that semantically plural predicates such as *shuffle* or *scatter* apply to singular collectives, implying that bunches may be pluralities. Also, plural pronouns seemed to take singular collectives as antecedents and syntactically plural predicates combined felicitously with singular collective subjects. The negative evidence in the present section will follow a similar pattern. To start with, some examples of predicate non-sharing will be presented, thus challenging the hypothesized coreference of collectives and plural individual noun phrases. After that there will be a number of general arguments against identifying bunches and pluralities.

The following list consists of contrasting sentence pairs with the one sentence having a singular collective as subject and the other a plural individual subject with the same predicate. Each pair is meant to be a case of predicate non-sharing, as the judgments marked with a "?" indicate.

(435) a. The committee has five members.[50]
b. ?The men have five members.
(436) a. The committee is composed of two judges and a fireman.
b. ?The members are composed of two judges and a fireman.
(437) a. The list had too many entries.

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[50]This contrast is from Lønning (1987:153). Bennett (1974:237) similarly noticed the ungrammaticality of **members of the gods*.

b. ?The names had too many entries.
(438) a. These players have foreign sounding last names.
b. ?This team has foreign sounding last names.
(439) a. The deck has two aces in it.
b. ?The cards have two aces in them/it.
(440) a. #The deck has two aces among it/them.
b. The cards have two aces among them.
(441) a. These cigarettes can be smoked in under two minutes.
b. This pack can be smoked in under two minutes.

For (441a), the distributive reading of the predicate is intended. (441b) appears to disallow this reading. If distributivity is in fact analyzed as in chapter 5 with a quantificational operator, then this data falls in with what we saw in our earlier quantification section in general, and the data on reciprocals in particular (411-415).

As (435-441) show, there is some degree of predicate non-sharing between collectives and associated plural individual noun phrases which is unaccounted for on a coreference hypothesis. Moreover, this data is troublesome even for theories that fall a bit short of claiming coreference. For example in the theory of Landman (1989a) pluralities and bunches are distinct, but predicates can systematically shift from applying truthfully to a plural individual noun phrase to applying truthfully to an associated collective. Such a theory would have trouble with (440). And a theory such as Landman's or Link's (1984) in which a plural individual noun phrase can denote either a bunch or a plurality would have trouble explaining why (435b) is ill-formed. Unless some theory is presented which can explain why the predicates examined here should be ignored, we should be skeptical of the coreference hypothesis. Before moving on to other types of evidence, I should note that the examples in (435-441) are all of a general nature, that is they involve predicates that by their very nature select exclusively for either the collective or the plural individual member of the pair in question. But there are also predicates that could apply to both, but in a specific situation may not. For example, if John, Betty and Sue are all and only the members of the Math Department and they all own cars, the following may both be true:

(442) a. John, Betty and Sue own several cars.
b. The Math Department doesn't own any cars.

In this situation then, the predicate *own cars* is not shared by the associated subject noun phrases in (442).

In the previous subsection, it was noted that semantically plural predicates have been used to show that bunches are pluralities. The argument made there however is not very strong. The problem is that many predicates that are classified as semantically plural apply to mass nouns as well, as noted in the generative literature by Dougherty. Thus while *the chair was rearranged* (425c) may be strange, *the furniture was rearranged* is not. Furthermore, the following examples which employ the predicates used earlier cast a layer of doubt on the usefulness of so-called "semantically plural predicates" in identifying bunches and pluralities:

(443) a. The pieces of the puzzle were scattered around the room.
b. The puzzle was scattered around the room.
c. #A piece of the puzzle was scattered around the room.
(444) a. The parts of the computer have to be assembled.
b. The computer has to be assembled.
c. #The screw has to be assembled.

This data suggests that the domain of application of these predicates includes things with a salient part-whole structure, which includes, but is not limited to bunches.[51] It would seem then that the relevant semantic feature of these predicates cross-cuts the singularity-plurality distinction so they do not tell us that much about the possible plural nature of bunches.

So-called semantically plural predicates were of course not the only types of predicates whose application to collectives argues for the identification of bunches and pluralities. There were also examples, noted by Jespersen among others, in which singular collectives either combine with syntactically plural predicates or antecede plural pronouns. These seem to make a clearer case for the proposed identification. And yet, it should be noted that these arguments rely on the assumption that syntactically plural predicates denote functions that are defined for pluralities only and the assumption that if the reference of a plural pronoun is determined on the basis of a single non-quantificational linguistic antecedent, that antecedent must denote a plurality. There is room to dispute both of these assumptions. Perhaps, syntactically plural predicates denote functions defined for pluralities and bunches. Perhaps a plural

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[51]I assume the subjects of the b. sentences are not collectives. The anomaly of the phrases in (i.-ii.) suggest that the head nouns of the noun phrases in question are not collective:

i. #a puzzle of wooden pieces
ii. #a computer of imported parts

pronoun is interpretable as denoting that plurality whose members are those individuals composing the bunch denoted by a collective antecedent. There is a consideration that seems to me to favor the latter proposal. Jespersen noted that "it is only with collectives denoting living beings that the plural construction is found." Compare the following discourses in which I indicate the intended reference of the pronouns in square brackets:

(445) The committee finally decided to vote. They[=the members of the committee] had deliberated long enough.

(446) a. The mover refused to take Jack's library. #They[=the books in the library] had not been tied properly.
b. ?When John shuffled the deck he discovered they[=the cards] were tattered.

The infelicity in (446) is unexplained if all we say about (445) is: a) bunches are in fact pluralities, b) plural pronouns denote pluralities and c) semantic or pragmatic rules assign to the plural pronoun of (445) the referent of its antecedent. It will not help to modify (b) and say that plural pronouns denote only animate pluralities. That is simply false, since *the books* may serve as the antecedent for a plural pronoun. It will also not help to modify (a) and (b) and say that bunches are singularities and that plural pronouns may admit animate singularities as antecedents. That is also false: *John* cannot serve as the antecedent for a plural pronoun. Rather we need to say something like the following. In contrast to pluralities, a bunch can be the referent of the antecedent of a plural pronoun only if it is composed of animate (or human) beings. The crucial point for us is that the data in (445) when considered in light of (446) cannot be used to argue that bunches are pluralities. Furthermore, once we have entertained the possibility that pronominal anaphora is an indicator for the semantic status of a noun phrase antecedent, we can use it to learn about plural individual noun phrases. Collectives, especially inanimate ones, allow for singular pronominal anaphora:

(447) a. The deck is on the scale. It weighs too much.
b. The Supreme Court is in session. It's members are all busy.

It seems reasonable to assume then, that singular pronouns may denote bunches. If it were the case that plural individual noun phrases were sometimes bunch denoting, one might expect, counterfactually, that they would allow for singular pronominal anaphora:

(448) The cards were shuffled. # It[=the cards] was put on the table.

In the theory of Landman (1989a) the plural individual subject of *shuffle* is bunch denoting and so its inability to serve as the antecedent of a singular pronoun demands explanation. Putting the results together, if pronominal anaphora teaches us anything, it is that collectives do not denote pluralities and plural individual noun phrases do not denote bunches.

The arguments put forward here can be made as well for the case of number agreement in verbal predicates. Jespersen's observation obtains here as well. That is, while an animate singular collective might, in some contexts and dialects, combine with a plural verb phrase, inanimate ones don't. Furthermore, plural individual noun phrases, whether animate or inanimate, do not in general combine with singular verb phrases, while singular collectives do. The fact that the rules for number agreement are sensitive to animacy lends support to a semantic or partially semantic theory of agreement. Following the approach outlined in chapter 2, section 2.3, we would like to capture the animacy facts in terms of the relative domains of the functions denoted by singular and plural predicates. However, if we identify bunches with pluralities, there is no easy way to implement this idea. We can't say that only animate pluralities are in the domain of the denotations of plural predicates[52], since inanimate plural individual noun phrases combine with plural predicates. Rather what needs to be said is that bunches are not pluralities and the only bunches in the domain of plural predicate denotations are those composed of animate entities.[53] Actually, there is another possibility. We might say that

[52]Interestingly, such may be the case in some dialects of Arabic. There, verbal predicates are marked as plural only when preceded by a subject noun phrase denoting a plurality of humans. This is true despite the fact that there is no morphological marking for animacy and there is plural marking on inanimate noun phrases. (The facts reported here come from Landau, 1973:67-68)

[53]Note further that this formulation requires that bunches be distinguishable from run of the mill singularities. John is a singularity composed of an animate entity, yet *John* doesn't take plural agreement.

One might think to adopt Landman's (1989a) construction of bunches here. Unfortunately, although Landman does distinguish bunches (what he calls groups) from pluralities (what he calls sums) and run of the mill singularities, he does not go far enough to avoid the problems raised here. For Landman, bunches are singleton sets whose only member is a animate collectives may denote pluralities but inanimate ones may not (or that animate bunches are pluralities) and that plural predicate denotations are defined exclusively for pluralities. The problem with this solution is that it seriously weakens all other arguments for saying bunches are pluralities because those arguments fail to discriminate between animate and inanimate collectives.

Finally, assuming a semantic theory of agreement as envisioned here, we cannot allow plural individual noun phrases to denote bunches, since bunches are in the domain of singular predicates while plural noun phrases do not combine with singular predicates.

Summarizing then, at best no argument can be made about the nature of bunches based on the types of predicates that may apply to collectives. At worst, it appears difficult if not impossible to give a semantic account of the types of predicates that apply to collectives without clearly distinguishing between bunches and pluralities.

9.4 Predicative Noun Phrases

There is one final bit of evidence that has been adduced in favor of identifying bunches and pluralities. It consists of examples in which a collective noun phrase is used predicatively:

(449) John and Mary are a happy couple.

One assumes that the predicate *be a happy couple* is true of any entity in the denotation of *happy couple* and hence that the entities it is true of are bunches. If (449) is true, then *John and Mary* denote a bunch and so we have a plural individual noun phrase denoting a bunch. Recall that this result is problematic, once we start considering plural collectives like *the two couples* and their associated plural noun phrases, like *the Smiths and the Joneses*.

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plurality. For example, the bunch denoted by *the deck* is a singleton whose only member is the plurality whose members are the cards. Being inanimate, this bunch will not be in the denotation of the plural *were shuffled*, while the plurality denoted by *the cards* will. The problem is that Landman's theory includes type-shifting operations of the kind discussed in chapter 4. Thus, the predicate *were shuffled* could be lifted so as to apply truthfully to any term denoting a bunch whose sole member is a plurality in the extension of the non-lifted *were shuffled*. Lifting should lead to a grammatical reading of **the deck were shuffled*.

One could also use (449) to argue in the opposite direction by first assuming that the subject of (449) is plurality denoting and then arguing, based on the fact that the collective can be predicated of the subject, that collective nouns have pluralities in their extension. I will begin by responding to the first argument, that plural noun phrases are potentially bunch denoting and then afterwards consider the second type of argument.

To repeat then, it was just argued that since *be a happy couple* denotes a set of bunches, its truthful application to a plural individual noun phrase implies that such noun phrases are potentially bunch denoting. This argument relies crucially on following Partee (1987:§5) and references cited therein in taking *be* to be a logical type-shifter (from $<<e,t>,t>$ to $<e,t>$) or simply taking it to mean simply "apply predicate." These interpretations account in part for the co-extensionality of common noun and "*be a* common noun" pairs such as *man* and *be a man*. This is a feature common to many analyses of *be*, according to Partee (1987:137), though she cites Stump (1985) as an exception. One of the meanings that Stump assigns *be* is that of a sort-shifter turning predicates of stages into predicates of individuals (in the sense of Carlson 1977). We might want to propose a similar meaning here. That is, perhaps *be* takes predicates of bunches into predicates of (associated) pluralities.[54] In other words, *couple* is a predicate of bunches but *be a happy couple* is true of a plurality just in case a bunch associated with it is in the extension of *happy couple*. Were this the meaning of *be*, we could maintain, even in the face of (449) above, that bunches and pluralities are distinct and that plural individual noun phrases

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[54]I.e. something like the following holds:

$$x \in \| \text{be} \| (A) \text{ iff } x \in D^* \wedge \exists z[z \in A \wedge \forall y[y \in x \Leftrightarrow (y \text{ is a part-of}(z) \wedge \text{human}(y))]$$

The restriction to humans is motivated by the strangeness of sentences in which an inanimate collective is used to form a predicate of pluralities:

(i) ?These cards are an expensive deck.

Although, B. Partee likes the following:

(ii) Those stars are a constellation.
(iii) The five of hearts, the ace of spades,...and the ace of clubs are a good hand in poker.

cannot denote bunches. But is there any reason to opt for this more complicated meaning of *be* other than to avoid a consequence unpleasant to the union theorist?

In fact, the simple "apply predicate" meaning of *be* runs into trouble once we consider plural predicative collectives as in:

(450) The guests this evening will be couples from Hungary.

To see the problem let us attempt to describe the truth conditions of the somewhat less informative:

(451) The guests are couples.

If *couple* denotes a set of bunches, then *couples* should, according to rule [8] (section 1.1), denote the set of all non-empty subsets of $\|$ couple $\|$, which is a set of sets of bunches. On the proposal we are entertaining here, *are couples* will denote the same set of sets. (451) is true then if and only if the denotation of *the guests* is in that set. This requires that *the guests* denote a set of bunches. More specifically, it must denote a set of bunches, each of which is a couple. Now even if we concede that somehow plural individual noun phrases may denote bunches, we still would need a way to assign a set of bunches (or plurality of bunches) as the denotation of a noun phrase whose head is not a collective noun. No semantics of plurals that I know of purports to do this. We have shown then that using (449) in the manner spelled out here to argue that plural individual noun phrases are bunch denoting, one runs into trouble with plural predicative collectives.

On the other hand, taking *be* to be a sort-shifter as described above, (451) can be approached as follows. *Couples* denotes the set of all non-empty subsets of $\|$ couple $\|$. In particular, it will contain singletons corresponding to the members of $\|$ couple $\|$. Taking bunches to be singularities, a singleton of a bunch is just the bunch itself (Quine's Innovation, see Appendix). This means that $\|$ couple $\|$ is a subset of $\|$ couples $\|$. Applying our sort-shifting meaning of *be* to $\|$ couples $\|$ we get that *be couples* is true of a plurality of individuals if and only if an associated bunch is a couple and is in $\|$ couples $\|$. In other words, *be couples* is true of any plurality whose members form a couple.[55] Now *be couples* is a plural predicate and hence is subject to a distributive reading.

[55]A reviewer pointed out that this analysis along with a semantic theory of agreement like the one discussed in section 2.3 incorrectly predict **John and Mary are couples* to be grammatical.

Bearing in mind our discussion of distributivity in chapter 5, we ask what value is assigned to the variable in the distributivity operator? By a rule of accommodation of the type discussed in Lewis (1979), a value is assigned which divides the domain in such a way that every individual guest is in a cell with one other guest with whom he/she is married or paired in some significant way. (451) is true if *be couples* is true of each cell in the partition that contains guests. If the guests are all single, there will be no such partition and (451) will come out false. If on the other hand, there is a partition of our guests into couples, (451) will come out true. Notice, this analysis relies on having a plurality denoting term as the subject of (451). We do not as yet have a distributivity operator based on the partitioning of a bunch and we do not want to introduce one. It is a property of collectives that they are generally not amenable to distributive readings, as noted in connection with (441), repeated below:

(441) a. These cigarettes can be smoked in under two minutes.
b. This pack can be smoked in under two minutes.

One question arises here out of Partee's analysis of *be*. She proposes to extract the logical type-shifting function from the meaning originally proposed by Montague for *be*. Should we likewise take the sort-shifting to be a general mechanism that applies to all predicates of the language and leave *be* with its simple "apply predicate" meaning? This would not be a good idea, as a general policy. As observed above in (435-437), predicates such as *have five members* apply successfully to collectives but not to plural individual noun phrases. A better idea would be to limit the sort-shifting mechanism to predicative noun phrases. The following examples furnished by F. R. Higgins would argue in favor of this last proposal:

(452) a. We treat them **as** a couple.
b. We treat them **like** a couple.
c. We consider them a couple.

In each of these cases, there is no *be* but there is predication of a collective to a plural individual noun phrase, hence it might make sense to consider the sort-shifting as part of the predicativization of the collective noun phrase.

Summarizing now, predicative collectives were initially used as evidence that plural individual noun phrases are bunch denoting. In particular, they must denote bunches when acting as the subject of a predicate formed from combining *be* with a predicativized collective noun phrase. But this argument was based on an analysis of *be* and/or predicativization which works only for examples in which the predicative collective is singular. An alternative analysis of *be* and/or predicativization as a bunch/plurality sort-shifter, accounts for the examples with singular as well as plural predicative collectives. And on the sort-shifter approach plural individual subjects of predicative collectives must in fact be plurality denoting.

Finally, recall above that an alternative type of argument was suggested based on (449), repeated here:

(449) John and Mary are a happy couple.

On this alternative, one argues that (449) shows that collectives are plurality denoting since they may apply predicatively to plural individual noun phrases. As explained in the introduction to this chapter, this result is damaging to the union theory, if one takes it one step further to plural collectives, such as *the two couples*. If that noun phrase denotes a plurality having two members, each of which is itself a plurality then the union theory is undermined. So, it is really the plural collectives that we need to focus on. But here (450) enters in again,

(450) The guests this evening will be couples from Hungary.

for if rely on the simple minded view of the predication relation in (449) appealed to in the argument above, then (450) shows that plural collectives in fact do not denote higher than first order pluralities, since they can apply predicatively to noun phrases denoting first order pluralities.

9.5 Notes on Cross Linguistic Variation

In researching the relation between bunches and pluralities, I discovered some cross-linguistic variation in the degree and manner in which these are distinguished.[56] One of these differences has to do with animate collectives in British English (BE) versus American English (AmE). The others have to do with the use of the word meaning 'part' in Hebrew and Italian.

Above, I used the following example which seems to be good in BE

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[56]For native speaker judgments in this section I thank Gennaro Chierchia, Jane Grimshaw, Sigal Uziel Karl, Tanya Reinhart, the poet Aharon Shabtai, Mandy Simons, and Sandro Zucchi.

but not in AmE:

(427) The committee are tall.

It turns out that for some speakers of BE, the use of animate collectives in contexts that would be ungrammatical for AmE speakers is more widespread. Following are some examples:

(453) a. Each of the group left a flower.
b. Each of his family ordered a different dish.
c. The group like each other.

Judgements depended not only on the particular speaker (= dialect?) but also on the particular collective noun used.

What consequences do these facts have for the union versus sets debate? One might be tempted to say that at least in some cases, collectives in BE are in fact plurality denoting, hence we have an argument against the union theory. However, we must be careful here. Recall, that the trouble for the union theory actually starts only when collectives are in the plural. The union theory would be counterexemplified by a plural collective denoting a higher order plurality. Interestingly, to the degree that I tested this question, I found that BE in fact provides evidence for the union theory. The speakers I asked found it impossible to use the example below:

(454) The committees are old.

to mean that the members of the committees are getting on in age. A possible explanation for this would be that in BE *the committee* is ambiguous between bunch denoting and plurality denoting readings and since there is nothing in the domain that would correspond to the plural of a plural, assuming the union theory, only the bunch meaning surfaces when *committee* is pluralized.

Finally, I would note a difference between what was said here about BE as opposed to what was said earlier in section 9.3. There I claimed that the use of a plural verbal predicate with a singular collective has to do with the meaning of the verbal predicate as opposed to an ambiguity in the meaning of the noun phrase. On that story, the predicate simply has animate bunches in its extension. That seemed the right way to go for dialects that do not in general treat these terms as plurality denoting. Perhaps then the difference between the two dialect groups arose from a reanalysis of a 'quirk' in verbal meanings to one in noun phrase meanings or vice-versa.

The second area of cross-linguistic variation that I encountered had to do with modifiers that select for singularity denoting complements. In section 9.2, I claimed that *part* is once such modifier:

(396) a. Part of the car was painted.
b. Part of the funds were ill-gotten.
c. #Part of the boys were in Texas.

The phrase *#part of the boys* should mean approximately *some of the boys*, but it is illformed because, I claimed, *part of* selects for singularity denoting complements. But now consider the following Modern Hebrew translation for *some of the boys*:

(455) xelek me----ha-----baxur-----im.[57]
part from the boy plural

Hebrew apparently lacks a word like *some*, in the singular as well as in the plural. Instead use is made of the word for *part*. The grammatical *part of the group* is translatable with the same idiom:

(456) xelek me----ha---kvuca
part from the group

In other words, for Hebrew, one apparently cannot produce an argument based on (the translation of) *part* to show that plural individual noun phrases do not denote bunches. I am even doubtful about whether one could make the Hebrew parallel of the argument, based on *each* for example, that collective noun phrases do not denote first order pluralities.

There is an interesting twist to this puzzle which points up problems of translation. While (455) would be a natural translation for *some of the boys*, it wouldn't be the natural literal translation for **part of the boys*. I think that would be:

(457) xelek shel ha-----baxur----im.
part of the boy plural

which, in fact, more or less preserves the ill-formedness of the English phrase. But this is of little help to the bunch investigator, for the following is not very well-formed either:

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[57]Dashes are here used to mark off morphemes.

(458) xelek shel ha---kvuca
part of the group

As far as I could determine, *xelek shel* is only appropriate in cases where the object in question has a fairly obvious part structure. For example:

(459) xelek shel ha---mot
part of the rod

would be appropriate if the rod had various connected parts. While the phrase:

(460) xelek shel ha shamayim
part of the sky

is odd. A similar restriction seems to apply in the construction of English compounds with *part*: *car part* vs. *#sky part.*

My first reaction to this data was that since the word *part* has been pressed into service as an existential determiner, there simply may not be any evidence that pluralities and bunches are distinguished in the ontology of the Hebrew language. However, it turns out that other constructions using *part* do provide evidence for the distinction. Recall, some of the evidence used above had to do with adverbials based on the word *part* and this evidence does translate, as follows:

(461) a. hu cava 'et ha---kir be-ofen--xelki
he painted ACC the wall in manner partial

'He partly painted the wall'

b. hu cava 'et ha---lven--im be-ofen--xelki
he painted ACC the brick PL in manner partial

'He partly painted the bricks'

(462) a. Ha--kvuca nifge'a be--ofen---xelki
the group was-injured in manner partial

'the group were partly injured'

b. Ha--yelad---im nifge'u be--ofen---xelki the child PL were-injured in manner partial

'the children were partly injured'

(461b) cannot mean that some of the bricks were painted and some were not, a situation that would make (461a) true, if the bricks were formed into a wall. Likewise, (462a) but not (462b) would be true if some of the children in the group were injured while most were left unharmed.

A similar pattern arose in attempting to translate the *part* argument into Italian. Gennaro Chierchia pointed out to me that in contrast with the English example, the following is fine in Italian:

(463) Parte dei ragazzi erano in Texas.
Part of-the boys were in Texas

Again this might lead one to suspect that Italian doesn't make the same distinctions as English. But again, upon closer inspection I found this not to be the case. Consider what happens when the word *part* is pluralized:

(464) a. parte dei ragazzi
part of-the boys

b. una parte dei ragazzi
a part of-the boys

c. *tre parti dei ragazzi
3 parts of-the boys

d. tre parti del gruppo: la testa, la coda e il centro
3 parts of-the group: the head tail middle

e. tre parti del muro
3 parts of-the wall

f. * tre parti dei mattoni
3 parts of-the bricks

(464c) and (464f) are out on the reading where one is counting parts of a plurality (not body parts or parts of a brick). The argument in Italian must be made using the plural *parti*.

This completes our brief exploration into cross-linguistic semantics. The hypothesis suggested by the comments made here is that languages do not disagree with respect to their ontologies, even if the evidence for the ontology may differ. Of course, these notes were not intended as a serious study of this question.

9.6 Analysis of the Evidence

At this point, we have seen the evidence bearing on the relation between associated collective and plural individual noun phrases. I will now sketch two positions one might take given this evidence. The first is in favor of distinguishing bunches and pluralities and the second is in favor of identifying them.

9.6.1 An Extensional Account.

The majority of the data presented here argues for taking bunches and pluralities to be distinct and for taking the former to be the sole denotation domain for collectives and the latter the sole domain for plural individual noun phrases. The question remains then: how do we explain the predicate sharing that is observed? Modifying Blau's (1981) example slightly, how do we account for the fact that if the deck is shuffled, scattered on the table, bought by Jack or sorted by Frank then so are the cards? The answer is we don't, not formally, at least not in terms of coreference. As noted in chapter 3, it is quite common for two noun phrases to share some predicates without being coextensional. There might even be a systematic explanation for the sharing, even if this explanation is not within the realm of natural language semantics. In the present case, the sharing has to do with the intimate relation between a deck and the cards that make it up, even if that relation is not identity. Compare the entailment from a. to b. in the pairs below:

(465) a. Bill's painting is pornographic.
b. Your reproduction of Bill's painting is pornographic.

(466) a. Bill is in Texas.
b. Bill's brain is in Texas.

(467) a. Bill's father has redheaded ancestors.
b. Bill has redheaded ancestors.

In (467) for example, the entailment has to do with facts about ancestry and not about coreference between Bill and his father.

I think it is important to spell out some details of the position we are taking. There is a membership relation denoted by the metalanguage symbol "$\in$" and there is a different membership relation denoted by the English *member*. Every singularity bears the $\in$-relation to itself and singularities bear the $\in$-relation to pluralities. John bears the $\in$-relation to the men in his support group, but not to his support group. On the other hand, the relation that *member* denotes holds between John and his support group, but not between John and the men in his support group. To drive the point home even further, I would point out that a singular noun phrase whose head noun is *set* does not denote a plurality, it denotes a bunch. The elements of a set do not bear the $\in$-relation to the set (though the set itself might); they bear to the set that relation which the English word *member* denotes. In ordinary English, the relation that *member* denotes seems to be restricted to animate entities: ?This chair is a member of Mary's dining room set. Of course, the $\in$-relation has no such restriction. Of historical interest here is the following passage from Russell (1903:68, §70):

> A class, we have seen, is neither a predicate nor a class-concept, for different predicates and different class-concepts may correspond to the same class. A class also, in one sense at least, is distinct from the whole composed of its terms, for the latter is only and essentially one, while the former, where it has many terms, is, as we shall see later, the very kind of object of which *many* is to be asserted. The distinction of a class as many from a class as a whole is often made by the language: space and points, time and instants, the army and the soldiers, the navy and the sailors, the Cabinet and the Cabinet Ministers, all illustrate the distinction.

Russell's "class as a whole" is a bunch while his "class as many" is a plurality.

Russell distinguishes non-linguistic objects and then claims that different terms in the language map on to these different kinds of objects. This is the view we endorse. Compare it to Jespersen's categorization of collectives mentioned in the introduction according to which collectives are "substantives which (in the singular) denote a collection or number of individuals". On this view, the category of collective arises from a 'mismatch' between the semantics and the syntax, not from a distinction already present in the ontology.

9.6.2 A Non-Extensional Account

An alternative to the account just sketched would start by assuming that associated collective and plural individual noun phrases are in fact coreferent, however, they differ in some way that explains the non-sharing of predicates that we've seen. Discussions of intensionality follow this pattern of explanation and since that phenomenon served as inspiration for the account to be examined here, we start by reviewing an example of non-sharing explained by appeal to the intension-extension distinction. The noun phrases *the President* and *Bill Clinton* are currently co-extensional, but they have different intensions since they are not co-extensional at all times and even at the current time, one can imagine possible situations in which they wouldn't have been co-extensional. The prediction then is that these noun phrases will fail to share predicates that somehow involve different times or possible worlds, predicates such as *will not live in Washington in the year 2000* or *must always open Congress*.

The analysis of intensionality provides a guide for a possible account of the pairs of noun phrases we are interested in, but it is not itself the correct analysis. There are two ways to see this. The first is that the predicates that are non-shared in our cases do not as a rule have anything to do with varying times or worlds (modality or tense). Another way to see that intensionality is not the source of the differences observed is to consider the noun phrases *Committee A* and *the members of Committee A*, a pair of noun phrases for which we found non-sharing. Let's assume, counterfactually, that they differ intensionally but not extensionally. That would mean that in this world and at the current time, both have the same plurality as their extension, but that at other worlds or times they differ. But how could that be? How could an individual be part of the plurality which is **the members** of Committee A without at the same time being part of the plurality which is Committee A?

The conclusion then is that we need to find some way that noun phrase meanings can differ other than in terms of intension or extension. The question can be put in slightly more concrete terms as follows. Under the current alternative, we are taking associated noun phrases to refer to or to be about the same entity, while at the same time claiming that they denote different sets of properties of that entity. This is like the definite generic and the bare plural on Carlson's analysis mentioned above. The puzzle now is to try to say what the source of these two property sets is. One possible answer is suggested by the analysis in Landman (1989b) of a slightly different but closely related problem. That problem concerns pairs of collective noun phrases which refer to bunches that appear to be distinct but which are made up of the same individuals, something that would be impossible if bunches were just pluralities. Landman's idea is that we should think of these noun phrase pairs as just special cases of reference to the same individual under different guises. To give an idea of what reference under a guise is, consider the following example, based on one used by Landman, which does not have to do with collectives. In order to adequately support his family, my high school chemistry teacher, Mr. Caliendo, worked in the evenings as a druggist. When the teachers in our district went on strike, it was true that:

(468) The chemistry teacher is on strike.

but it would have been misleading if not false to say that:

(469) The druggist is on strike.

Mr. Caliendo had different properties as a teacher than he had as a druggist. Nonetheless, we never believed that there were two Mr. Caliendos. Noone would have denied that *the druggist* and *the chemistry teacher* were co-extensional. As Landman shows, the same phenomenon can be reproduced with pluralities as well as with entities composed from pluralities. In (468-469), one and the same individual is first considered under the guise of a chemistry teacher and then under the guise of a druggist. The expression used to name the guise is part of the noun phrase used to pick out the individual himself. But this is not always the case. Landman observes that phrases of the form *as a* $[_{CN}\_\_]$ can be used in English to name the guise. For example, Mr. Caliendo, as a teacher, was on strike while Mr. Caliendo, as a druggist, was not on strike.

Landman's proposal has to do with pairs of collectives, however one might consider extending it to handle collective-plural individual pairs. The idea would then be that *my family* and *the members of my family* refer to the same plurality, but under different guises. Different guises give rise to different sets of properties of that same plurality. This would explain the observed non-sharing of predicates. This idea has some intuitive appeal, especially for those who like to keep the ontology sparse to begin with. To do it real justice, the details should be spelled out (some of which are already in Landman 1989b), especially the compositional semantics which would lead to the different property sets. While this is beyond the scope of the present work, I would like to end with some questions that such an account would have to address.

In Landman's paper, he points out that the more connotative a term is, the more likely it is to produce a disguised individual. Similarly, since "chemistry teacher" and "druggist" are rather different properties, Mr. Caliendo has rather different properties under these guises. But now compare our own case. In order to explain the predicate non-sharing discussed in previous chapters, we would have to say that "my family" and "members of my family" are different guises for the same plurality. But they don't seem so different. It would be hard, for example, to know that the people at the next table fit one of the guises without knowing that they fit the other. Furthermore, what would be the extensions of these two properties (being my family and being the members of my family) if on the one hand they are different properties (hence contribute different guises) and on the other hand, bunches are just pluralities?

Landman (1989b:742) alludes to this problem when he notes that if there is a group consisting of John and Bill, then *John and Bill* should denote roughly the same set of properties as *the group*, because being a group unlike being a druggist is not a very connotative property. However, these two noun phrases show more or less the same degree of non-sharing as other pairs.

The animacy effects noted in the discussion of verbal predicates and agreement also seem to go in the wrong direction. Comments in Landman's article (page 728) would lead one to expect that inanimate collective nouns would be less connotative than animates (compare the concept of a committee or a government to that of a deck) and hence one would expect them to differ less from their associated plural individual noun phrases than do their animate counterparts. In fact, the opposite is true.

Problems also arise when one considers phrases of the form *as a* $[_{CN}\_\_]$ mentioned earlier. First, consider the following example:

(470) Our chemistry teacher made $5 per hour as a druggist.

According to (470), Mr. Caliendo had the property of earning $5 per hour under his druggist guise. This shows that the when it is present, the *as*-phrase provides the guise, regardless of the form of the term picking out the individual. This means that an *as*-phrase of the right kind should cause a plural individual noun phrase to behave like a collective. But as Lasersohn (1988:149) notes, this does not seem to work:

(471) a. ?The boys as a baseball team have 12 members.
b. ?The boys have 12 members, as a team.
c. ??John and Mary were founded in 1925, as Committee A. (= Lasersohn's 25b)

Finally, the concept of a guise seems to be such that one noun phrase could not be taken to denote the same individual under different guises. This seems right. Continuing with our earlier example, after the strike was over Mr. Caliendo, along with other teachers, received a late paycheck, though he was able to get by on the money he had made as a druggist. And yet, it is strange to say:

(472) Mr. Caliendo received his paycheck two weeks late and was paid on time.

If collectives combine with plural predicates on their plural guise and singular predicates on their bunch guise then we have a problem. For as Jespersen (§4.85-6, p.99) points out, one and the same collective noun phrase may combine with a plural and a singular predicate in the same sentence.

Summarizing then, the guise story remains a possible alternative account of the predicate non-sharing observed earlier. The guise story in general needs to be worked out and the nature of the 'bunch guise' itself needs to be elaborated in way that doesn't simply rely on the singularity-plurality distinction, for that would amount to adopting the first alternative of section 9.6.1, just in a more complicated setting.

9.7 Conclusion

The subject of this chapter was the relation between plural individual noun phrases, such as *the Senators* and collective noun phrases, such as *the Senate*. It has been claimed that in some cases this relation is one of coreference. This claim then leads either to the conclusion that plural individual noun phrases can be singularity denoting or that singular collectives are plural denoting. Under either of these assumptions, it looks like one could form noun phrases that are semantically 'plurals of plurals': either by conjoining singularity denoting plural individual noun phrases or by pluralizing collectives. The union theory predicts that there should be no plural of a plural (semantically), hence collectives are relevant to the sets versus union debate.

In sections 9.2-9.4, we cited data arguing against the possibility of a plural individual noun phrase coreferring with a collective. The data included quantificational and verbal contexts that distinguish the two types of noun phrases on semantic grounds, as well as facts about number agreement between subject and predicate and between pronoun and antecedent, facts which resist analysis in a theory where singular collectives denote pluralities.

In the end we concluded that in a purely extensional theory, collectives and plural individual noun phrases could not be coreferent, however we raised the possibility that this conclusion could be avoided by adopting a non-extensional theory to explain the data.

Chapter 10
Conclusion

10.1 What was Discussed

Imagine a pair of florists discussing an arrangement of roses and violets. In the course of the conversation, they might have occasion to use any of the following three noun phrases: *the flowers*, *the roses and the violets*, and *the arrangement*. What is the relation between the referents of these noun phrases? Does the language treat them as referring to objects with the same part-whole structure? Are they coreferent? These kinds of questions have been the focus of the preceding pages. In trying to answer them, we appealed for the most part to four linguistic phenomena. The first was semantic selection, in particular the sortal restrictions imposed by predicates on their noun phrase arguments. The second was distributivity, whereby a speaker names a plurality and attributes a property to parts of that plurality. The third phenomenon was reciprocity whereby a speaker names a plurality and claims that a relation holds between parts of that plurality. The fourth phenomenon had to do with quantification. In natural language, quantification involves a quantifier and a domain over which that quantifier quantifies. We studied cases in which a noun phrase is used to name the domain of quantification. An important theme running through much of the discussion was the difference between an answer to one of the above questions that lies in the realm of pragmatics versus one that is semantic. An example of the former might involve the claim that the part-whole structure enters in as the result of a negotiation between speakers in a conversation, formally represented as a free variable in a semantic representation. An example of the latter would take the part-whole structure to be inherent in the entity referred to.

Most of the discussion involved the phenomena just mentioned and the argument usually took the form of a particular linguistic context that would yield different results when combined in turn with two different but potentially coreferent noun phrases of the kinds used by our florist friends above. There is one final piece of evidence that doesn't fit into the above characterization and that wasn't mentioned so far. This has to do with rules governing understood coreference between noun phrases. It has been observed that a **non-pronominal** noun phrase generally cannot be coreferent with another noun phrase that c-commands it. The following example illustrates this rule (where coindexation is meant to indicate understood coreference):

(473) a. John$_i$ thought that he$_i$ would be allowed in the museum.
b. *John$_i$ thought that John$_i$ would be allowed in the museum.

We can use this rule to test the noun phrase pairs relevant to us. Imagine a situation in which there is a group of male and female tourists. The men approach the guide and tell him that the auditorium isn't big enough to hold the whole group. Next, the women approach the guide and they tell him that the auditorium is big enough. These exchanges might be reported with the following:

(474) The men and the women disagreed about whether they would all fit in the auditorium.

It would be strange to say instead:

(475) The men and the women disagreed about whether the tourists would all fit in the auditorium.

The difference between (474) and (475) is explained as follows. The pronoun *they* in (474) is anaphoric to the phrase *the men and the women*. As such it refers to the set containing all the men and all the women, which, in the situation described, is just the set of all tourists. In (475), the pronoun is replaced by a coreferring non-pronominal making it strange for the same reason that (473b) above was. This explanation crucially relies on the assumption that the noun phrases *the tourists* and *the men and the women* corefer.

10.2 What was Decided

In the Preface, we began by thinking about concepts of set-theory and their relevance to the semantics of natural language. As a means of reviewing the conclusions of this work, I find it again useful to return to the concept of a set of sets. For concreteness, let's consider the set of sets

A defined below:

$$A=\{\{a,b\},\{c,d\}\}$$

The introduction of a set of sets entails the following three notions which played a role in our study:

i. Partition/Structure. A set of sets organizes the urelements. In the set A, the elements a,b,c,d are divided up in a certain way. We 'think' of them in unequal terms: a goes with b in a way that it doesn't go with c.

ii. Iteration. A set of sets entails the notion of embedded membership. It has members that themselves have members. Its parts have parts.

iii. Creation. A set of sets is something different from the urelements it is made up of. In 'forming' the set A, we create a set that has two members and hence is not the same as the individual urelements or even the set containing the four of them.

Beginning in chapter 1, two grammars were introduced which allowed us to transpose the concepts of set theory, a mathematical theory, into questions about natural language semantics. Important aspects of the proposals made in this book can be summarized in terms of correlates of the ideas listed in i.-iii. as follows:

i. Partition/Structure. Anytime a plurality is talked about, it is talked about under a given partition of the plurality into parts (chapter 5). This is done on a per conversation basis and it can affect the truth of an utterance, because, to take the set A above, what is true of {a,b} and of {c,d} may not be true of a, of b, of c or of d.

ii. Iteration. Pluralities have singularities as members, they never have pluralities as members. This means that the domain of reference for noun phrases has no correlate of a set of sets.

iii. Creation. Since pluralities consist exclusively of singularities, there is no such thing as two different pluralities composed of the same singularities. A plurality with several urelements never has two members (chapter 7). This means that we don't create new entities via pluralization, although that doesn't prevent us from creating new entities altogether. Collectivization creates new entities but they are new singularities. The arrangement that our florists spoke about above is one such example. It is a singularity (chapter 9) and hence differs from the roses and the violets. There is nothing in standard set theory (with one membership relation) that corresponds to collectivization.

10.3 What was Not Discussed

This book addresses a basic ontological question in the semantics of plurals. Much of the work in plural semantics that was not touched on, such as research into the relations between plurals and aspect or between plurals and mass terms, can be seen as extending the kind of system set up here. In most cases, a writer will presuppose an answer to the questions raised here about the domain of plural reference. While the full range of topics in plural semantics is beyond the scope of the present work, there are two areas of research that should be mentioned concerning issues which when properly addressed might affect the conclusions drawn here. The first is event semantics and the second is quantificational expressions.

10.3.1 Events

An analysis of the adverb *together* provides a simple case of the use of events in the semantics of plurals. Recall, in chapter 1, we classified *together* as a "plurality seeker" since it cannot occur without a plural antecedent of some sort:

(476) *John walked together.

It has often been claimed that the function of this adverb is to indicate a non-distributive reading (by "non-distributive" I mean there is no distribution to singularities). A simple version of this idea would claim that the sentence in (477a) below has a distributive and a non-distributive reading and the addition of *together* in (477b) disambiguates towards the non-distributive reading. (477a) entails (477c) on its distributive reading but it doesn't on its non-distributive reading and (477b) doesn't either. On this view, *together* behaves like the counterpart of floated *each*.

(477) a. John and Mary own houses.
b. John and Mary own houses together.
c. John owns houses.

The problem with this story is that while *together* adds something to the meaning of (478a) below, (478b) is not ambiguous in the way that (477a) was. It entails (478c) on any reading.

(478) a. John and Mary walked together.
b. John and Mary walked.
c. John walked.

To see where events might come in, notice that intuitively (478b) could be true of a situation which one might describe as a single event in which John and Mary walked and that it could also be true if there is an event in which John walked and a separate event in which Mary walked. One could envision capturing these two descriptions in terms of distributivity with respect to a predicate of the form:

$$\lambda x \exists e[\text{event}(e) \ \wedge \ (x \text{ walked in } e)]$$

The separate events description would involve distributivity down to singularities while the single event description would the non-distributive reading. Under this view, we can again describe the use of *together* in (478a) as disambiguating towards a non-distributive reading.

Krifka (1989), Moltmann (1992), Lasersohn (1995) and Landman (to appear) are examples of some of the recent work on the semantics of plurals using events. Schein (1993) argues that a semantics based on the notion of a plurality, such as the one used in this book, is incoherent and his alternative proposal makes essential use of a Davidsonian event semantics.

10.3.2 Plural Quantification

With the exception of the discussion in section 2.3, we have confined our interest to examples with non-quantificational noun phrases. In the discussion of reciprocals (chapter 6), we considered example (479a) below, but no example like (479b) where the subject is quantificational:

(479) a. The books in the chart below complement each other.
b. Several books in the chart below complement each other.

This latter type of example raises a number of issues. To begin with, one needs to determine what the domain of quantification for the quantifier in the subject is. In the work reviewed in section 2.3, quantifiers quantify over singularities, however a number of researchers have allowed for quantification over pluralities or "plural quantification". Another issue is the scopal interactions between a plural quantificational NP and other quantifiers. This would include other quantificational NPs as well as the implicit quantifier over elements of a cover that played a role in our analysis of (479a). Recently, van der Does (1992,1993) has argued against an analysis of distributivity in terms of covers, claiming that it allows for seemingly unavailable readings for sentences with plural quantificational noun phrases. In fact, van der Does assumes existential quantification over covers as opposed to the context dependent analysis argued for in section 5.2.3. For this reason, he appears to test intuitions for the 'unavailable' readings in the absence of a context where the relevant cover would be salient. This is not to say that a pragmatic covers analysis is straightforwardly combined with a semantics that handles quantificational NPs. Such a combination might for example requires us to abandon the assumption that the value for the cover variable is set once and for all as opposed to being dependant on the quantifier in whose scope it lies.

DRT would be an obvious setting in which to study this last mentioned issue and in their introduction to DRT, Kamp and Reyle (1993) have a chapter on the plural. In addition to other work specifically on plurals and plural quantification, there is much that is relevant to this topic in the burgeoning generalized quantifier literature.

Appendix
Quine's Innovation

In Quine's *Set Theory and Its Logic*, in the vicinity of pages 30-32, he introduces sets as objects that can be quantified over. He assumes, for "smoothness," that variables range over sets as well as over individuals (read "singular individual"). He then introduces the axiom of extensionality:

$$(x)(x \in y \;.\!\equiv.\; x \in z) \;\rightarrow.\; y = z$$

But what, he wonders, should one say about the sentence "$x \in z$" when "z" is an individual. Let's say it is false. This will have the consequence that for any two distinct **individuals**, y and z, the antecedent of the axiom of extension will be true, and it will unfortunately follow that $y = z$. So Quine assumes instead that when z is an individual, $x \in z$ is true just in case $x = z$. With this assumption, for **distinct** individuals y, z, $(x)(x \in y \;.\!\equiv.\; x \in z)$ is false and so it no longer follows that $y = z$.

However, now if we apply the axiom of extension to x and the singleton set containing x, we find they are equivalent. In fact, $x = \{x\} = \{\{x\}\}$ ... This leads to a definition of individual not as "nonclass" but as those things that are identical with their unit class. I let Quine take over here:

> Everything comes to count as a class; still, individuals remain marked off from other classes in being their own sole members.
> For I am by no means blurring the distinction between y and its unit class where y is not an individual. If y is a class of several members or of none, certainly y must be distinguished from its unit class, which has one member. If y is the unit class of a class of several members or of none, still y must be distinguished from its unit class since the one member of y is, by the preceding sentence, different from the one member of the unit class of y. In general thus the distinction between classes and their unit classes is vital,

and I continue to respect it. But the distinction between individuals and their unit classes serves no discoverable purpose, and the awkwardnesses that attended the law of extensionality can be resolved by abolishing just that distinction.

The adoption of this innovation leads to some welcome departures from what is normally assumed in working with sets. I illustrate some of these below.

Let D be the set whose members are a,b,c:

$$D = \{a,b,c\}.$$

$\mathcal{P}(D)$, the power set of D, is as follows:

$$\mathcal{P}(D) = \{\varnothing, \{a\}, \{b\}, \{c\}, \{a,b\}, \{a,c\}, \{b,c\}, \{a,b,c\}\}$$

but now contrary to what is normally assumed:

$$\mathcal{P}(D) = \{\varnothing, a, b, c, \{a,b\}, \{a,c\}, \{b,c\}, \{a,b,c\} \}$$

this means that not only is it true that:

$$D \in \mathcal{P}(D)$$

it is also true that:

$$D \subseteq \mathcal{P}(D).$$

and that:

$$\mathcal{P}(D) - D = \{\varnothing, \{a,b\}, \{a,c\}, \{b,c\}, \{a,b,c\} \}$$

With some degree of obfuscation we could write:

$$D = \{a, b, c \} = \{\{a\},\{b\},\{c\}\}$$

And the following statements about $\mathcal{P}(D)$, the power set of D are true:

$$\mathcal{P}(D) = \{\varnothing, \{\{a\}\}, \{\{b\}\}, \{\{c\}\}, \{\{a\},\{b\}\}, \{\{a\},\{c\}\}, \{\{b\},\{c\}\}, \{\{a\},\{b\},\{c\}\} \}$$

$$\wp(D) = \{\varnothing, \{a\}, \{b\}, \{c\}, \{a,b\}, \{a,c\}, \{b,c\}, \{a,b,c\}\}$$

The following (non-standard) equivalences hold:

$$\{a, \{a\}, \{a,b\}\} = \{a, \{a,b\}\} = \{a, \{ \{a\}, \{b\}\}\}$$

We can now speak sensibly of the intersection and union of an individual and another set. The following are true when a,b,c are distinct individuals:

$$a \cap b = \varnothing \qquad a \cup b = \{a,b\} \qquad a \cap \{a,c\} = \{a\} = a$$

The power set of an individual is the set that contains the individual and the empty set:

$$\wp(a) = \{ a, \varnothing \}$$

If we employ the phrase "the greatest element of X" to refer to that element of X such that all elements of X are subsets of it, then for:

$Y = \{a,b, \{a,b\}\}$, the greatest element of Y is $\{a,b\}$.

$Z = \{a\}$, the greatest element of Z is $a = \{a\} = Z$.

Notice that while $D = \{a,b,c\}$ has no greatest element, as would be the case on more familiar versions of set theory, individuals **do** have greatest elements on the version we are assuming. The greatest element of the individual b is b itself.

Finally, if $D = \{a,b,c\}$ then the closure under union of D is just $\{a,b,c, \{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$ or the power set of D minus the empty set.

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