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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

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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:

\[
(1) \quad j \cup m = \{j\} \cup \{m\} = \{j, m\}
\]
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:

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>name:</td>
<td>John, Mary (singular names)</td>
</tr>
<tr>
<td>singular common noun:</td>
<td><em>man, woman, cow, pig</em></td>
</tr>
<tr>
<td>plural common noun:</td>
<td><em>men, women, cows, pigs</em></td>
</tr>
<tr>
<td>verb phrase (VP):</td>
<td><em>clapped, met in the morning,</em></td>
</tr>
<tr>
<td>syncategorematic word:</td>
<td><em>the, and</em></td>
</tr>
</tbody>
</table>

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:
Two Ways to Interpret Plural Noun Phrases

[1] If \( \alpha \) is a member of category \( \text{NP} \) and \( \beta \) is a member of category \( \text{VP} \), then \( \alpha \beta \) is a sentence and \( \| \alpha \beta \|_M = 1 \) iff \( \| \alpha \|_M \subseteq \| \beta \|_M \).

[2] If \( \alpha \) is a basic \( \text{VP} \) then \( \| \alpha \|_M = V(\alpha) \) and \( V(\alpha) \subseteq D^* \).

[3] If \( \alpha \) and \( \beta \) are \( \text{VPs} \), then \( \alpha \text{ and } \beta \) is a \( \text{VP} \) and \( \| \alpha \text{ and } \beta \|_M = \| \alpha \|_M \cap \| \beta \|_M \).

[4] If \( \alpha \) and \( \beta \) are \( \text{NPs} \), then \( \alpha \text{ and } \beta \) is an \( \text{NP} \) and \( \| \alpha \text{ and } \beta \|_M = \{ \| \alpha \|_M, \| \beta \|_M \} \).

[5] If \( \alpha \) is a name then \( \alpha \) is an \( \text{NP} \), \( \| \alpha \|_M = V(\alpha) \) and \( V(\alpha) \subseteq D \).

[6] If \( \alpha \) is a plural common noun or a singular common noun then \( \textit{the} \) \( \alpha \) is an \( \text{NP} \) and \( \| \textit{the} \ \alpha \|_M \) is the greatest element of \( \| \alpha \|_M \). If \( \| \alpha \|_M \) doesn’t have a greatest element then \( \textit{the} \ \alpha \) fails to denote. [Note: For any sets \( m, S \) such that \( m \subseteq S \), \( m \) is the greatest element of \( S \) if every element of \( S \) is a subset of \( m \).]

[7] If \( \alpha \) is a singular common noun, then \( \| \alpha \|_M = V(\alpha) \) and \( V(\alpha) \subseteq D \).

[8] If \( \alpha \) is a singular common noun and \( \beta \) is the plural of \( \alpha \), 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 \( \alpha \) is a member of category \( \text{NP} \) and \( \beta \) is a member of category \( \text{VP} \), then \( \alpha \beta \) is a sentence and \( \| \alpha \beta \|_M = 1 \) iff \( \| \alpha \|_M \subseteq \| \beta \|_M \).

[2] If \( \alpha \) is a basic \( \text{VP} \) then \( \| \alpha \|_M = V(\alpha) \) and \( V(\alpha) \subseteq D^* \).

[3] If \( \alpha \) and \( \beta \) are \( \text{VPs} \), then \( \alpha \text{ and } \beta \) is a \( \text{VP} \) and \( \| \alpha \text{ and } \beta \|_M = \| \alpha \|_M \cap \| \beta \|_M \).

[4'] If \( \alpha \) and \( \beta \) are \( \text{NPs} \), then \( \alpha \text{ and } \beta \) is an \( \text{NP} \) and \( \| \alpha \text{ and } \beta \|_M = \| \alpha \|_M \cup \| \beta \|_M \).

[5] If \( \alpha \) is a name then \( \alpha \) is an \( \text{NP} \), \( \| \alpha \|_M = V(\alpha) \) and \( V(\alpha) \subseteq D \).

[6] If \( \alpha \) is a plural common noun or a singular common noun then \( \textit{the} \) \( \alpha \) is an \( \text{NP} \) and \( \| \textit{the} \ \alpha \|_M \) is the greatest element of \( \| \alpha \|_M \). If \( \| \alpha \|_M \) doesn’t have a greatest element then \( \textit{the} \ \alpha \) fails to denote. [Note: For any sets \( m, S \) such that \( m \subseteq S \), \( m \) is the greatest element of \( S \) if every element of \( S \) is a subset of \( m \).]

[7] If \( \alpha \) is a singular common noun, then \( \| \alpha \|_M = V(\alpha) \) and \( V(\alpha) \subseteq D \).

[8] If \( \alpha \) is a singular common noun and \( \beta \) is the plural of \( \alpha \), then
\[ \| \beta \|_M \text{ is the set of all non-empty subsets of } \| \alpha \|_M. \]

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: \( \| \text{John} \| \) is the denotation of \text{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 \textit{boy}, by rule [7], denotes a set of individuals in \( D \). By rule [8], \textit{boys} denotes the set of all non-empty sets of boys. By rule [6], \textit{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 \textit{clapped} then sentence (2) is true. Note, by rule [2], \textit{clepped} 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, \( M = \langle \{1,0\}, D, D^*, V \rangle \):

(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 \textit{boys} as denoting a set of sets is partially motivated by its predicative use. Intuitively, the predicate \textit{are boys} should apply truthfully to a term denoting any set of boys (e.g. \textit{the older boys are boys}). Bearing rule [1] in mind, this would suggest that in the extension of \textit{are boys} we find every set
of boys. 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 \textit{the girl} denotes, it denotes the one girl in D and according to rule (1), if she is in the extension of \textit{clapped} then (4) is true. So if (4) is true, \textit{clapped} will have individuals in its extension. Now, recall rule (2) repeated here:

(2) \quad \text{If } \alpha \text{ is a member of category VP then } \| \alpha \| \subseteq D^*.

This requires that \textit{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, $M = \langle \{1,0\}, D, D', V \rangle$ repeated in (5):

(5) \quad \text{Any non-empty subset of } D \text{ 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) \quad \text{If } \alpha \text{ and } \beta \text{ are NPs, then } \alpha \text{ and } \beta \text{ is an NP and } \| \alpha \text{ and } \beta \| = \{ \| \alpha \|, \| \beta \| \}.

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') \quad \text{If } \alpha \text{ and } \beta \text{ are NPs, then } \alpha \text{ and } \beta \text{ is an NP and } \| \alpha \text{ and } \beta \| = \| \alpha \| \cup \| \beta \|.

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) \quad \text{Ray and Tess wrote poems.}

On the sets theory, $\| \text{Ray and Tess} \|$ 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, $\| \text{Ray and Tess} \|$ 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, $\parallel$ the boys $\parallel$ is the set of all the boys. On the sets theory $\parallel$ Ray and the boys $\parallel$ is a set containing two elements: Ray (an individual, which is equivalent to a singleton of an individual) and $\parallel$ the boys $\parallel$ (which is a non-singleton set given our assumption that $D$ contains two or more boys). On the union theory, $\parallel$ Ray and the boys $\parallel$ is the union of Ray and $\parallel$ the boys $\parallel$ 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 \( D \).

\(^2\) 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:

\[
F_{S12n}(\delta_1, \ldots, \delta_n) = \{\delta_1, \ldots, \delta_n\}.
\]
Two Ways to Interpret Plural Noun Phrases

(10) Sets theory$^3$:

\[
D_0 = D \\
D_{n+1} = D_n \cup \text{POW}_{\geq 2}(D_n) \\
D^* = \bigcup D_n \\
\text{n} < \omega
\]

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.

---

$^3$ $\text{POW}_{\geq 2}(X)$ 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 Bentham.
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.
A list with one name on it was given to the CIA.
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:

Two lists of CIA agents.
Two descriptions of CIA agents.

*Two 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

\(^4\) 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:

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 \(\parallel\cdot\parallel\), 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.]
Two Ways to Interpret Plural Noun Phrases

(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.

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 $\alpha$ is a VP then each-$\alpha$ is a VP and
$\forall S \ [ S \in D \rightarrow (S \in \parallel \ each \ \alpha \parallel \leftrightarrow$
$S \subseteq D$ and $|S| \geq 2$ and $\forall x [x \in S \rightarrow x \in \parallel \alpha \parallel ]$.

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 $|S| \geq 2$" 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.

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 \[\text{awoke early}\] and so is Tess. Given a cumulativity restriction on \[\text{awoke early}\], \[\text{awoke early}\] must contain \[\text{Ray and Tess}\] as well. Now, \[\text{met in the ballroom}\] will not contain either Ray or Tess because of the type of predicate it is. However, it will, given c., contain \[\text{Ray and Tess}\]. This means that \[\text{Ray and Tess}\] is in the denotations of both predicates and therefore is in the (set) intersection of these two denotations. By rule [3] above, \[\text{awoke early and met in the ballroom}\] 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. \( \forall x [ P(\text{Ray}'') \land P(\text{Tess}'') ] \)

(44) a. The authors awoke early.
    b. \( \exists x [ \text{author}'(x) \rightarrow P(x) ] \)
    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

\(^6\)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)?