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MODAL SUBORDINATION, ANAPHORA, AND DISTRIBUTIVITY

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Modal Subordination, Anaphora, and Distributivity

A Dissertation Presented
by

Craige Roberts

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Dèyè mòn gen mòn.

— *Haitian Proverb*

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Abstract

Modal Subordination, Anaphora and Distributivity

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The analysis of pronominal anaphora provides us with tools to explore linguistic structures involving the scope of operators. In this dissertation, I develop a theory of anaphora, modifying and extending existing proposals in the literature, and then use it to explore distributivity and related phenomena.

I assume that pronouns are interpreted as variables, and base a theory of anaphora on the claim that there are two kinds of constraints on how these variables may be bound. One type of constraint involves the relative positions of antecedents and anaphors in the hierarchical structure of discourse. I propose an extension of Discourse Representation Theory wherein a relation of subordination between propositions is induced by their mood. Mood is analyzed in terms of modality, and establishes the position of a proposition in the Discourse Representation. The structure which results constrains both inference and the potential for anaphora.

The other type of constraint on anaphoric binding is based on the configurational notion of c-command in the Government and Binding Theory. Recognizing that the Binding Theory and the theory of discourse anaphora are both necessary in a comprehensive theory of anaphora permits a clarification and simplification of each. It is argued that the Binding Principles hold at S-Structure, and that coindexation is only a guide to interpretation in discourse, and not necessarily an indication of coreference.

This comprehensive theory of anaphora serves as a tool for the exploration of the phenomenon of distributivity, including the group/distributive ambiguity in examples such as *four men lifted a piano.* It is argued that distributivity arises in predication when either the determiner in the subject is quantificational or there is an implicit or explicit adverbial distributivity operator. Anaphoric phenomena associated with distributivity are shown to be a consequence of the scope of operators.

This theory of distributivity, implemented in the mapping from S-Structures onto Discourse Representations, then provides further arguments that coindexation is not to be interpreted as coreference, and also illuminates the contribution of the number of a pronoun to its interpretation.

Contents

Chapter 1

Modal Subordination

Modal subordination is a phenomenon which stems from the organization of propositions in a discourse. It is reflected in two kinds of related problems, which are illustrated in the discourses in (1) – (4):

(1) The birds will get hungry (this winter).

(2) (a) If Joan forgets to fill the birdfeeder, she will feel very bad.

(b) The birds will get hungry.

(3) (a) If John bought a book, he'll be home reading it by now.

(b) # It's a murder mystery.[1]

(4) (a) If John bought a book, he'll be home reading it by now.

(b) It'll be a murder mystery.

[1]Intended anaphoric relations are indicted by underlining antecedent and anaphor. The symbol "#" here and below indicates that the sentence is infelicitous in this context.

The first type of problem involves the effect of context on the inferences which we may draw from a given sentence. In (1), for example, a proposition is asserted. But the same sentence in the context of the discourse in (2) seems more likely not to be asserted, but only to be asserted as following from the antecedent of (2a). The birds need not actually get hungry for the whole discourse to be true, so long as Joan is filling the birdfeeder, so that the proposition expressed by the antecedent of the conditional isn't true. The other type of problem involves anaphora, where the apparent antecedent is a quantified expression and the anaphor is not within its scope under standard assumptions about quantifier scope. In (3a) and (4a) we see an example of the classical "donkey" sentences of Geach (1962), which posed problems for theories of anaphora because the indefinite noun phrase a book serves as antecedent for a pronoun outside its scope, in the consequent. The discourse theories of Irene Heim (1982) and Hans Kamp (1981) provide an account of the felicity of anaphora in examples of this type. However, they do not account for several facts about the potential for anaphora in succeeding sentences. The discourse in (3) is infelicitous. (b) is only interpretable as an independent assertion in this context, and the discourse is infelicitous because we have no available antecedent for the pronoun *it*. But the syntactically similar discourse (4) is felicitous. (4b) may be interpreted as a sort of continuation of the conditional in (a), as if it were coordinated with the consequent. I will show that the facts about inference and anaphora which are displayed in (2) and (4) are the consequences of a phenomenon I call *modal subordination*. As we will see, in such cases it involves the relationship between the moods of the propositions expressed.[2]

[2]Note that this semantic notion of subordination does not reflect the traditional syntactic notion. For example, in (4a), although the antecedent clause is syntactically subordinate, the main, or consequent clause is modally subordinate to it in discourse. This will become clear below.

Modal subordination is a reflection of the fact that propositions in natural language discourse are logically related to each other in a hierarchical structure. This hierarchy is strongly reminiscent of the form of a proof in a natural deduction system.[3] The hierarchical organization of a proof is determined by a relation of subordination between its steps. To illustrate this, consider the proof in (5):

(5)

(a)	**Show:** $[(F(a) \wedge \exists x G(x) \rightarrow H(a)) \wedge (\neg H(a) \rightarrow \neg\exists\, x G(x))]$	
(b)	$F(a)$	(*premise*)
(c)	$\exists x G(x) \rightarrow F(b)$	(*premise*)
(d)	$F(b) \rightarrow H(a)$	(*premise*)
(e)	$\quad F(a) \wedge \exists x G(x)$	(*assumption*)
(f)	$\quad F(b)$	(*e, c, m.p.*)
(g)	$\quad H(a)$	(*d, f, m.p.*)
(h)	$F(a) \wedge \exists x G(x) \rightarrow H(a)$	(*e, g, cond'l pf*)
(i)	$\quad \neg H(a)$	(*assumption*)
(j)	$\quad \neg F(b)$	(*d, i, m.t.*)
(k)	$\quad \neg\exists x G(x)$	(*c, j, m.t.*)
(l)	$\neg H(a) \rightarrow \neg\exists x G(x)$	(*i,k,cond'l pf*)
(m)	$(F(a) \wedge \exists x G(x) \rightarrow H(a)) \wedge (\neg H(a) \rightarrow \neg\exists x G(x))$	(*h, l*)

[3]McCawley (to appear) independently makes a similar point: " 'Natural deduction', the scheme of formal proofs developed in such works as Fitch (1952), is 'natural' in virtue of the way that it allows formal proofs to closely mirror the structure of familiar ordinary language arguments." The anaphoric consequences of this structure, as seen in the discourses (3) and (4), strengthen this claim.

Q.E.D.

Here we are trying to show that the formula in (a), a conjunction of two conditional formulas, follows from our three premises, in (b), (c), and (d). In order to do this, we examine each of the two conjuncts of (a) in turn, showing that if we assume its antecedent, then its consequent will follow from the antecedent and our premises. Since this is so for each of them, their conjunction follows as well. The proof is a purely formal structure, with the usual rules of inference constraining the relation between its steps. However, if we were to think of the premises as expressing true propositions, they would be interpreted as true in the actual world in any model of the proof. Premises are ranged along the left margin, that is, the highest level of the proof's structure. In contrast, we have two hypothetical assumptions (e) and (i); these are subordinate to the premises, as indicated by the indentation. We only proceed *as if* they were premises, for the purpose of determining what would follow. But neither (e) nor (i) is subordinate to the other. And no step which depends in part on one of them is related to the other. Even though step (f), subordinate to (e), contains the proposition $F(b)$, and step (j), subordinate to (i), contains $\neg F(b)$, the proof is not inconsistent, because according to the rules of proof construction, inconsistency holds only between related statements. Hence, inference is constrained by the hierarchical structure of the proof. Notice also that when the existence of some entity is only assumed hypothetically, on a subordinate level of the hierarchy, we may not mention that entity as existing on superordinate levels. Although $\exists x G(x)$ occurs in step (e) of the proof, we may not instantiate it or assume the existence of some entity with the property G after we have left the indented portion of the proof. This phenomenon is reminiscent of anaphora in discourse. So, both inference and something like anaphora are constrained by the hierarchy of subordination in a proof.

In the rest of this paper I will develop a formal theory of the natural language analogue of this hierarchy as an extension of Kamp's (1981) Discourse Representation Theory. In Section 1.1, I will relate the notion of the mood of a sentence to a theory of modality in model theoretic semantics and show how this is relevant for modal subordination. In Section 1.2, I will show that in order to account for the anaphoric phenomena, we need a theory of discourse which provides discourse referents intermediate between syntactic noun phrases (NPs) and their model theoretic interpretation. I will propose an extension of Discourse Representation Theory to include modality, and show how to treat modal subordination within this framework. In Section 1.3, I will briefly discuss a generalization of modal subordination to include cases where other types of operators besides modals are involved.

1.1 Mood, modality, and modal subordination

Before we can discuss the relation between mood and modality, we must consider what it means to make an assertion in a discourse. Following Robert Stalnaker (1979), I will characterize this notion in a possible worlds semantic framework. Because we as individuals are not omniscient and do not know everything about the world in which we live, we do not know which of the possible ways that things may be, or possible worlds, is the actual world. However, as participants in a conversation, we assume a set of propositions about the way the world is; these may be introduced explicitly in the course of the conversation and mutually agreed upon, or they may be implicit presuppositions which it is assumed that all participants share. These explicit and implicit assumptions Stalnaker calls the *common ground* of the conversation, and this is enough to rule out quite a few possible worlds, those in which any of the propositions in the common ground are false. These are our premises, if you will. The larger the common ground in a given conversation, the smaller the set of possible worlds compatible with all the propositions presupposed, that is, the closer we come to being able to fully characterize the actual world. The set of possible worlds compatible with the common ground of a conversation is called the *context set.* These are the remaining candidates for the actual world. Given this framework, Stalnaker characterizes assertions as follows (1979, p.323):

> To make an assertion is to reduce the context set in a particular way, provided that there are no objections from the other participants in the conversation. The particular way in which the context set is reduced is that all of the possible situations incompatible with what is said are eliminated. To put it in a slightly different way, the essential effect of an assertion is to change the presuppositions of the participants in the conversation by adding the content of what is asserted to what is presupposed. This effect is avoided only if the assertion is rejected.

So, every time we accept some assertion about the actual world[4] we come closer to being able to completely characterize that world, and the context set of remaining possibilities becomes smaller. For example, suppose you and I are discussing the poet Lorine Niedecker. You mention that she was born near Lake Koshkonong in southern Wisconsin in 1903, a fact which I already knew. This fact is then in our common ground, and the context set determined by that common ground contains no worlds in which Lorine Niedecker was not a poet, or in which she was born in Tulsa, Oklahoma. But if this is all the information we share about Lorine Niedecker, there will be worlds in the context set where she never left Lake Koshkonong, worlds

[4]For simplicity, I will assume throughout this paper that the world which we attempt to characterize in discourse is always the actual world. However, it is often the case that we assert propositions to be true not of the actual world but of some fictional or fantasy world, as in a novel, a play, children's play, etc.

where she left there at age 20 and rarely returned, worlds where she had children, worlds where she did not, and so forth. If I tell you that Lorine Niedecker left her birthplace for only a few years in the late forties and that she never had children, and if you accept what I say as true, then we add these propositions to our common ground. We now eliminate from the context set all worlds incompatible with this information.

But as we have seen in (2b) not all sentences uttered in a discourse are asserted to be true. It is the *mood* of an utterance which tells us whether or not it is asserted. The sense of *mood* which interests us here is what Jespersen (1965) calls *notional mood.* This does not concern a grammatical feature of verbs, but rather describes a feature of sentence use: it relates to the speaker's commitment to the truth of a proposition in the actual world. If a speaker indicates by conventional means that a sentence or clause is to be interpreted as true in the actual world, we say that the sentence or clause was uttered in the *factual mood.* Utterances in the factual mood are asserted, in Stalnaker's sense. Sentences in the indicative grammatical mood, such as (1), are generally interpreted as factual where there is no context to suggest otherwise. But if a clause, such as the antecedent of a conditional, expresses a hypothetical assumption, or if there is otherwise some question about the actual truth of the proposition expressed, we say that it is in a *nonfactual mood.* Nonfactual mood is expressed by a variety of conventional means. The subjunctive grammatical mood is one means; for example, I have been told (Roger Higgins, p.c.) that in German journalistic style the subjunctive may be used in main clauses to indicate that the proposition expressed is hearsay, and that the writer does not necessarily subscribe to its truth. Other languages use similar morphological devices, for example Japanese (Karina Wilkinson, p.c.) and Finnish (Anne Vainikka, p.c.). Nonfactual mood may also be indicated by expressions like *suppose that* ... or *if* ... *then* .... It may involve the use of modal auxiliaries like *would* or *could*, or adverbials like *probably*, *supposedly*, etc. And nonfactual mood may also be suggested by the sequence of tense and aspect in a discourse. In (2), for example, (b) displays the same tense and aspect as the nonfactual consequent of the preceding conditional. Grice (1967) has pointed out that we generally seek to determine the relevance of a proposition to its context in discourse, so that we consider how (2b) may be related to (2a). As we shall see, in this case the agreement in tense and aspect suggests the possibility of agreement in mood as well, and (2b) is most readily interpreted as nonfactual (although a factual interpretation is possible as well, see below).

I propose that in a possible worlds semantic framework, mood should be interpreted in terms of modality. If we make a hypothetical supposition, in a nonfactual mood, we are not committing ourselves to its truth in the actual world. But for the purpose of exploring the consequences *if* that proposition were in fact true, we temporarily add it to our common ground. This temporarily eliminates some possible worlds in the original context set — those in which the hypothetical assumption is not true. Since we do not necessarily know whether our assumption holds true, the reduced context set which results may or may not include the actual world, that is it may or may not be *realistic*. In order to express this formally, I will adopt a theory of modality in natural language which has been proposed by Angelika Kratzer (1977,1979,1980,1981a,1981b) and is compatible with Stalnaker's functional characterization of assertion. Kratzer points out that the *force* of modal operators such as *necessarily*, *possibly*, *would*, and the like in natural language is not absolute, as are the necessity and possibility operators in modal logic, but is relativized to a contextually determined set of propositions.[5] Consider, for example, (6):

[5]The account of Kratzer's theory which I present here is greatly simplified. First, in this section, I suggest that the force of a proposition is relativized only to a single set of

(6) Ella might lift that refrigerator.

Here, the modal force of *might* is that of possibility. If we translate this utterance into a sentence of a modal predicate calculus and then interpret it in the standard fashion, it means roughly, "there exists at least one member of the set of all possible worlds in which Ella lifts that refrigerator." Now, if we assume that this set of possible worlds contains not just those situations which we regard as reasonable in the actual world, but all possibilities, including, for example, a world in which ordinary women such as Ella easily lift two ton trucks, the utterance is then trivially true. It would come as no surprise that in that world such women also lift refrigerators. But this flies in the face of our intuitions about the proposition, which seems much stronger than this.

In uttering (6), the speaker is making a claim in view of what is physically possible and normal in the actual world. Following Kratzer, we will relativize the modal force of (6) to the set of possible worlds where the actual facts about this sort of thing are all true. In general, speakers tend to assume that the common ground of a given discourse includes a set of propositions which we might characterize as 'what is physically possible.'[6] This determines a context set which does not contain all possible worlds, and in particular won't contain worlds where ordinary women

propositions, which I call the "common ground", in keeping with Stalnaker's terminology. In Kratzer (1980), there may be two sets of propositions involved in such relativization, the *modal base*, which may or may not be doxastic/epistemic like the common ground, and the *ordering source*, establishing an idealized ordering on the set of worlds determined by the modal base. The ordering source is useful, for example, in characterizing deontic modality and counterfactuals. We will briefly consider such uses in Section 1.3.2.

[6]In fact, in a doxastic common ground, these propositions should be characterized as 'what we assume about what is physically possible.' Thus, in a lay conversation, speakers do not generally assume that the common ground includes propositions about quarks or the ultimate nature of light.

easily lift two-ton trucks. Relativizing the modal force of (6) to this context set, the proposition has truth conditions which are closer to our intuitions about its meaning: it will be true in case there is a possible world in which the actual facts about human strength, gravity, etc. are true, and in that world, Ella lifts that refrigerator.

This relativization of the modal force to a narrowed context set is very similar to domain selection in quantification. For example, if a speaker says "Everyone seems happy", he doesn't usually mean that absolutely all individuals whatsoever seem happy, but only those in a suitably narrowed domain; for example, 'those individuals in this room', or the like. We often are not explicit about how to select this domain, assuming that our hearers will guess what we intend from the context. Similarly, we often assume that our hearers will understand how we intend to restrict the context set of possible worlds over which modal operators range. This was the case in the refrigerator example just discussed.

Sometimes, though, a speaker is more explicit about at least some of the propositions which she wants the hearer to add to their shared common ground. Consider again example (2):

(2) (a) If Joan forgets to fill the birdfeeder, she will feel very bad.

(b) The birds will get hungry.

It has been noted by several authors (including Kratzer (1980) and Heim (1982)) that conditional sentences often have modal force, either explicit, as when the consequent contains a modal auxiliary such as *might*, or implicit (in which case the modal force is that of necessity).[7] The antecedent clause is hypothetically added

[7]Actually, *if*-clauses may serve to modify various operators, not just modals. Farkas & Sugioka (1983) point out examples like the following:

to the common ground, narrowing the context set against which the modal force is evaluated. (2a) is an indicative conditional without overt modal operators. Because of the future tense in the consequent, we are not tempted to interpret the present tense in the antecedent as a generic present, quantifying over times when Joan forgets. Thus, we interpret the conditional as having necessary modal force. In order to interpret (2a), we temporarily add the proposition expressed by its antecedent, *Joan forgets to fill the birdfeeder*, to the common ground of the conversation up to that point. Felicity conditions on the utterance of a conditional are such that we do not generally utter a conditional such as (2a) in a context where we already know the truth of the antecedent in the actual world. Thus, adding the antecedent to the preceding common ground determines a hypothetical context set of possible worlds which may or may not contain the actual world, that is, it may or may not be realistic. The modal force of the conditional is then relativized to the hypothetical context set: we only consider those worlds where Joan forgets to fill the feeder. The whole conditional is then true if the consequent, *she will feel very bad*, is true in each of these possible worlds. Thus the consequent is modally subordinate to the

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(i) Mary is usually friendly, if she's not in a hurry.

(ii) All cats like to use scratching posts, if they haven't had their claws removed.

In (i), the operator is a temporal adverb of quantification; in (ii), a universal quantifier. Often, conditionals without any explicit operator seem to have a modal flavor. However, this is not always the case. Steve Berman (p.c.) points out that the following example seems to involve quantification over times or events:

(iii) If Joan forgets to fill the birdfeeder, she feels bad. The birds get hungry.

Such examples may involve situations, however these are to be defined. See Kratzer (1985) for an approach to situations which treats them as partial worlds. In all the cases which interest us in this section, treating the *if*-clause as modifier of a modal operator presents no problem.

antecedent, just as step (f) in the proof in (5) is subordinate to the hypothetical assumption (e) on which it partly depends.

As I already noted, we may interpret (2b) as being in a nonfactual mood. The key to this possibility lies in the interpretation of its tense. As Partee (1973,1984) and Hinrichs (1986) have pointed out, the interpretation of tense has much in common with the interpretation of anaphora. Whatever the tense of a sentence, it is interpreted with respect to an implicit or explicit *reference time*, in Reichenbach's (1947) sense of that term.

The reference time of the nonfactual antecedent of (2a) is most likely that of some future time which the participants have been discussing, a time when the feeder is to be filled. The reference time of the nonfactual consequent is interpreted as a future with respect to the event referred to in the nonfactual antecedent, in keeping with the sense that the state referred to in the consequent will result from the event referred to in the antecedent. There are two ways of interpreting (2b). On the factual interpretation, the future time referred to by its tense is existentially quantified, 'there is some future time when the birds will get hungry.' This is an assertion, factual in mood. It is only indirectly relevant to the utterance of the preceding conditional. On this reading, we might take it to be a fact of life that the birds will get hungry in any case.

However, one reference time can and often does introduce the reference time for the tense of a following utterance, giving narrative continuity to the discourse. Thus, in determining the relevance of an utterance to its context, one possibility which we take into account is that its reference time may be that of the immediately preceding context. In the case of (2b), we might consider whether the reference time of its tense is the same as that of the stative consequent of the preceding conditional. Discussion of what factors enter into the assessment of such a possibility is beyond the scope of the present work. In general, there seem to be restrictions on the sequence of tenses and further considerations of pragmatic plausibility. Let us assume that these restrictions are met in the case under consideration, and that we conclude that (2b) has the same reference time as the consequent of (2a), future with respect to the antecedent. The futurity of the consequent led us to interpret the proposition it expresses as an effect of the proposition expressed by the antecedent. Further, we generally seem to prefer the most relevant interpretation of an utterance with respect to its immediately preceding context. Then if (2b) has the same reference time as the consequent of (2a), we might consider whether it too is an effect of the event expressed by the antecedent. But if so, (2b) is also nonfactual. (We don't have factual effects of nonfactual causes.) In terms of the account I am proposing, this means that, although (2b) contains no overt modal operators, it is to be interpreted against a possibly non-realistic common ground which includes the antecedent of the preceding conditional. If we do this, we get an interpretation like 'If Joan forgets to fill the birdfeeder, she will feel very bad and the birds will get hungry.' This seems to give the right truth conditions. So the notion of mood in conjunction with a theory of modality along the lines suggested by Kratzer seems to give an account of the inferential properties of discourses with intersentential modal subordination.

1.2 Modal subordination and constraints on anaphora

1.2.1 The insertion approach

To account for the facts about anaphora illustrated in examples (3) and (4), the Stalnaker-Kratzer approach I have just sketched will not alone suffice. This is because this approach by itself has no provision for describing structural relations between NPs above the sentential level; hence, we do not have the means to discuss formal constraints on anaphora in discourse. Irene Heim's File Change Semantics (1982) and Hans Kamp's Discourse Representation Theory (1981) were initially developed to deal with problems in anaphora, and extending them to include the theory of modality I have just described will provide us with the basis of a theory of anaphora in modal subordination. The extension I envision will permit us to express formally the analogy between the logical structure of discourse and that of a proof which I already suggested. And it will permit us to see how anaphora is constrained in discourse in much the same way as existential instantiation is constrained in a proof. In what follows I will use Discourse Representations (DRs) to illustrate the theory; however, a very similar theory may be developed using Heim's Files.[8]

Both discourse theories utilize the variable-like *discourse referents* originally proposed by Lauri Karttunen (1976) to serve as intermediate representations of syntactic noun phrases on the DR (or File) level. For Kamp, the relative location of two discourse referents in the structure of the DR determines whether one of these may serve as antecedent to the other.[9] If a proposition is in a factual mood, it is mapped onto the top level of the DR, analogous to being entered along the far left margin of a proof. Consider the DR for the simple sentence *John bought a book* in (7):

[8] See Section 1.3.2 for some discussion of Heim's own recent work on related problems.

[9] Chierchia & Rooth (1984) pointed out that this is really a matter of the scope of the operators involved in the interpretation of the DRs and not of configurationality. However, we can ignore this point here.

(7)

$$\boxed{\begin{array}{c} x \quad y \\ \text{John}(x) \\ \text{book}(y) \\ \text{bought}(x,y) \end{array}}$$

Kamp proposes an algorithm for mapping from sentential syntactic structures onto DRs. In Chapter 2 I will propose a different approach, which permits us to retain the insights of the Binding theory of the Government and Binding framework of Chomsky (1981) and associates. For our purposes here, the important feature which these approaches share is that each NP in a discourse will be mapped onto a discourse referent in the DR. Both the content of the original NP and the content of anything predicated of that NP in the sentence are then entered as conditions on its discourse referent. (Universally quantified NPs induce a more complex DR; see Kamp (1981) and below.) In the case of (7), each NP in the original sentence is correlated with a distinct discourse referent, *John* with x, and *a book* with y. The proper name *John* and the common noun *book* have become conditions on the discourse referents correlated with their respective NPs, and a further condition specifies that the relation *bought* holds between x and y.

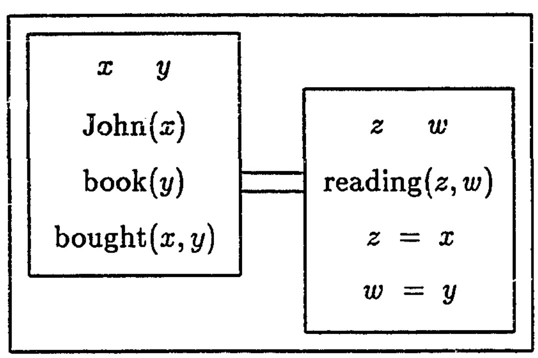
The resulting DR is still an uninterpreted formal structure, logically syntactic in Carnap's sense. To interpret this structure, we use another algorithm to *embed* it in a truth conditional model. Formally, an embedding is a function from discourse referents onto individuals in the model, such that the individual which a given discourse referent r is mapped onto displays each property corresponding to a condition on r. Informally, discourse referents on the top level of a representation are interpreted as if they were existentially quantified. (7) may be interpreted in a model as asserting that there is an individual to which x may be mapped, *John*, and an individual to which y may be mapped, which is a book, such that the individual corresponding to x bought the individual corresponding to y.

If a proposition is in a non-factual mood, the common ground against which it is interpreted is not realistic. Entities which are introduced with an indefinite NP in that section of discourse may not actually exist. So the clause expressing the proposition is mapped onto a subordinate level of the DR, reminiscent of the way in which hypothetical assumptions are indented in a proof. Consider the sentence which occurs in (3a) and again in (4a):

(3) (a) If John bought a book he'll be home reading it by now.

This is another example of modal subordination in a conditional sentence, as with example (2a), but here anaphora is involved. As before, although the entire conditional is asserted, neither the antecedent nor the consequent is factual in mood. Because the antecedent is not factual, it must be entered into the DR on a level subordinate to the top level, as in the DR in (8):

(8)



Here, the representations of the antecedent and consequent are each in a box which is subordinate to the top level. The raised lefthand box, representing the antecedent, is as in (7). The righthand box represents the consequent. In Kamp's theory, when two boxes represent the antecedent and the consequent of a conditional, we say that the righthand box, that representing the consequent, is subordinate to the lefthand, or antecedent, box. (Note again how this notion of subordination differs from the syntactic one.) When we represent a clause containing a pronoun, as in the consequent of (3a), we must indicate an antecedent for the pronoun, or the resulting DR will be ill-formed. We enter a discourse referent for the pronoun on the appropriate level of the discourse structure, here z for *he* and w for *it* in the consequent box. To find an antecedent, we locate any discourse referent on the same or a higher level of structure. We say that the potential antecedent is *accessible* to the pronoun's discourse referent. In (8), since the box representing the antecedent of the conditional is superordinate to that for the consequent, the discourse referents for the pronouns in the consequent box, z and w, may take the discourse referents for *John* and *a book*, x and y, as their antecedents. This is symbolized by equating anaphors with their accessible antecedents.

The raised antecedent box in (8) is intended to serve as a restricted necessity operator in interpreting the DR.[10] In line with Kratzer's theory of modality, its truth conditions should be 'For all worlds in which there is an individual John x and a book y, and x bought y, then $z(=x)$ is reading $w(=y)$.' As an assertion, this utterance instructs the participants in the discourse to reduce the context set as follows: "Consider all worlds in the present context set. (These are all candidates for the actual world. That is, they are all worlds in which all the presuppositions

[10]Compare Kamp's representation for the generic interpretation of sentences such as (*i*), in (*ii*):

(*i*) Every farmer who owns <u>a donkey</u> beats <u>it</u>.

in our common ground so far are true.) Now consider only those worlds in that set where there is an individual John, x, and there is a book, y, and x bought y. In each of those worlds, you should find that there is an individual $z (= x)$ and an individual $w (= y)$ and that z is reading w. If not, discard that world from the context set." We see that the notion of modal subordination which we expressed using Kratzer's theory of modality in the birdfeeder example translates readily into Kamp's configurational subordination. Just as in that example, after I have modified the original context set, containing candidates for the actual world, by the hypothetical addition of the antecedent of the conditional to the common ground, I no longer know whether the resulting context set contains the actual world. We haven't asserted the antecedent, but only assumed it temporarily, like an indented assumption in a proof. So we have only temporarily assumed the existence of the entities referred to in the antecedent. Since the consequent is subordinate to the antecedent, we may continue to assume the existence of those referents, and their discourse referents may serve as antecedents for anaphors in the consequent.

Now consider (3b):

(*ii*)

$$\boxed{\boxed{\begin{array}{c} x \quad y \\ \text{farmer}(x) \\ \text{donkey}(y) \\ \text{owned}(x, y) \end{array}} \Longrightarrow \boxed{\begin{array}{c} w \\ \text{beat}(x, w) \\ w = y \end{array}}}$$

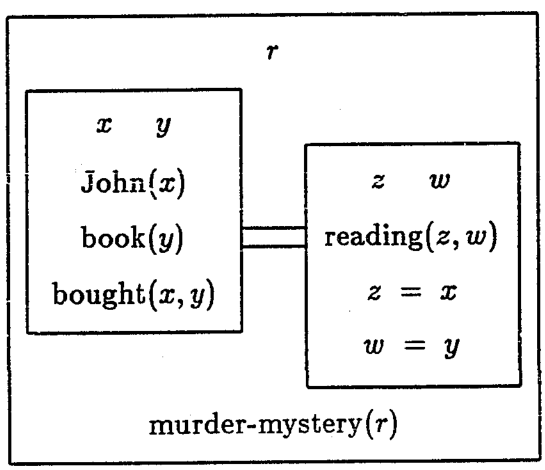
Here, the symbol between the antecedent and consequent boxes is reminiscent of the symbol for the material conditional, used in representing conditions on variables bound by universal operators in standard predicate calculus. The extensional embedding conditions for such a representation specify that there must be a way to extend ANY embedding of the antecedent box to an embedding of the consequent box as well. Thus, any farmer/donkey pair which stands in the *own* relation must stand in the *beat* relation as well. This explains the seemingly universal force of the indefinites in the antecedent without treating them as universal quantifiers.

(3) (a) If John bought a book, he'll be home reading it by now.

(b) # It's a murder mystery.

There is no modal in (3b), so that there is no plausible dependency relation between the reference time of its simple present tense and the conditional present of the consequent of (3a). Further, a conditional such as (3a) is only felicitous where we do not know the truth of its antecedent, and in this case, this entails not knowing whether John bought a book. But (3b) seems to be about some actual thing which is a murder mystery. Hence, we are not tempted to interpret the two clauses as in the same, nonfactual mood, and there is no evidence of modal subordination. Since (3b) appears to be in the factual mood, we enter it on the top level of the DR, assigning a discourse referent, r, to the pronoun *it*, and adding the condition *murder-mystery(r)*, as shown in (9):

(9)



But now the discourse referent for *a book*, y, is in a box which is subordinate to the discourse referent for *it*, r, and so y is not an accessible antecedent for r. The discourse is not felicitous unless there is another discourse referent in prior discourse which would be a plausible antecedent for the pronoun, or where the pronoun is deictic.[11]

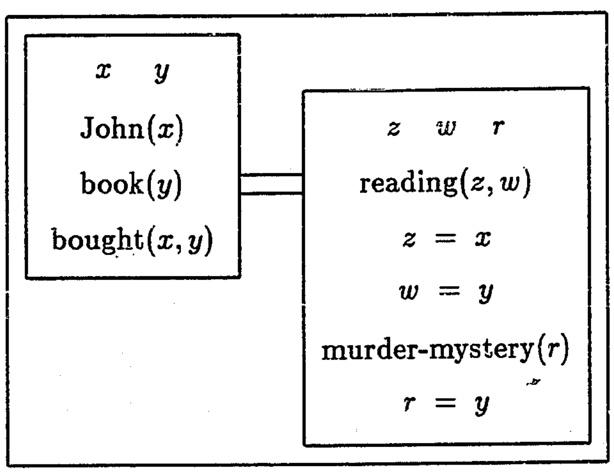
(4b), on the other hand, is in the same conditional tense as the consequent of the preceding conditional sentence, and it is readily interpreted as an extension of the nonfactual mood:

(4) (a) If John bought a book, he'll be home reading it by now.

(b) It'll be a murder mystery.

One way to represent the resulting modal subordination would be to simply add the representation of (4b) to the consequent box of the DR (8), as in (10):

(10)



Here, a new discourse referent, r, has been added to the consequent of (8), along with the condition *murder-mystery* on r. r has then been equated with the accessible discourse referent y. Let us call this way of representing modal subordination the *insertion approach.* In this example, the result gives us the correct truth conditions.

[11]These two cases may be the same from the point of view of discourse theory. For some discussion, see Heim (1982).

(10) would be interpreted as 'In all worlds where there is a book which the individual named John bought, you will find that John is reading the book and that it is a murder mystery.' As an assertion, the conditional is an instruction to remove from the context set determined by the prior common ground any worlds in which the antecedent is true and the consequent false.

1.2.2 The accommodation of the missing antecedent approach.

There are a number of examples which show that the insertion approach is inadequate. (11) is due to Fred Landman (p.c.):

(11) (a) A wolf might walk into the house.

(b) It would eat you first.

In (11a), *might* leads us to interpret the proposition in its scope as nonfactual. Uttering this sentence does not commit the speaker to the existence of an event in the actual world. Rather, it asserts that among the candidates for the way things are, the possible worlds in the present context set, there is at least one where a wolf walks into the house. Just as in Kratzer's theory of modality, *might* will be interpreted as the possibility operator in modal logic, relativized to the context set. The DR of (11a) is shown in (12):

(12)

$$\boxed{\quad \Diamond \quad \boxed{\begin{array}{c} x \\ \text{wolf}(x) \\ \text{walk-into-the-house}(x) \end{array}}}$$

The modal *might* is translated by the diamond operator on the left. The nonfactuality of the remainder of (11a) is expressed by entering its representation on a subordinate level of the DR, the box on the right in (12). We would typically utter (11) in a situation where all the participants in the discourse already have certain assumptions, background propositions like, 'Given that we're living in the woods' or 'Given that a lot of dangerous animals have escaped from the nearby circus.' The modal force here is possibility, indicated in the DR by the diamond operator. In this example, I think the most natural sense of possibility is that of future possibility. An adequate embedding algorithm for this DR will require us to examine each world in the context set to determine whether among the possible futures which branch out from the present moment in that world there exists at least one in which the box on the right in (12) may be truthfully embedded. If this is so, the world is retained in the context set after the utterance of (11a). If not, it is removed. Informally, its truth conditions might be paraphrased, 'There exists some possible future in which a wolf walks into the house.'

Now, if we try to represent (11b) by inserting material into the righthand box in (12), as in (13), we will get the wrong truth conditions:

(13)

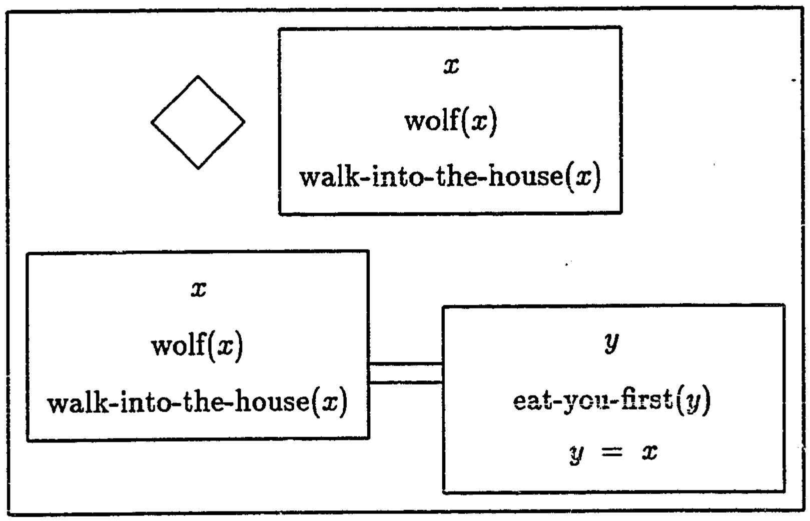
$$\boxed{\Diamond \; \boxed{\begin{array}{c} x \quad y \\ \text{wolf}(x) \\ \text{walk-into-the-house}(x) \\ \text{eat-you-first}(y) \\ y = x \end{array}}}$$

Here, I have added a discourse referent, y, for *it*, and the appropriate condition, *eat-you-first*, on y, equating y with the accessible antecedent x. The model theoretic interpretation of this DR could be paraphrased, 'It's possible that a wolf will walk into the house and eat you first.' But this is not our understanding of (11). In uttering this discourse, I don't simply assert that a wolf *might* eat you first. I'm saying something stronger: 'It's possible that a wolf will walk into the house, and IF IT DOES, it will undoubtedly eat you first.' The problem, of course, is that (11b) has a different modal force than (11a). *might* in (11a) has the force of possibility; whereas, *would* in (11b) has the force of necessity. Instead of inserting the non-factual proposition expressed in (11b) under the scope of the possibility operator in (11a), we must treat the modal auxiliary *would* as indicating that (11b) is a modally subordinated clause which is, like the consequent of a conditional, in need of an antecedent. The approach I suggest, which I will call the *accommodation of the missing antecedent* approach to modal subordination, is the pragmatic *accommodation* of a contextually given hypothetical common ground to be the antecedent of the modally subordinated clause. I use the term *accommodation* in an extension of the logician David Lewis' (1979) sense, where to accommodate a presupposition is basically to add it to our common ground because without that presupposition, we cannot assign a truth value to an utterance, i.e., cannot make sense of it. Here is Lewis' definition:

> If at time t something is said that requires presupposition P to be acceptable, and if P is not presupposed just before t, then — *ceteris paribus* and within certain limits — presupposition P comes into existence at t. (p.340)

Stalnaker (1979 and elsewhere) identifies the set of propositions in the common ground of a discourse as the presuppositions of that discourse. We do not always introduce such presuppositions explicitly. Rather, we often assume that we share certain knowledge about the world with other members of the discourse, that is, we presuppose the propositions expressing that knowledge. In discussing (11), for example, I said that it would be felicitously uttered where the participants in the discourse already had certain assumptions about the actual world which made it probable. But these assumptions might not have been explicitly introduced into the discourse. Perhaps we've both lived in the woods all our lives. I know there are wolves out there and you know it too, so we don't need to say it. It is presupposed. That is, in a Kratzer-type theory where we relativize the force of a natural language modal element to some context set, the propositions which determine that context set may be implicit in whole or in part. So, when we encounter the modal *would* in (11b), we may assume that certain relevant assumptions should be added, at least hypothetically, to our common ground. To illustrate how accommodation works in modal subordination, consider the DR for (11) in (14):

(14)



The upper portion of (14) contains the representation of (11a) which we saw in (12). The diamond possibility operator is intended to have scope only over this top box. The lower portion contains the representation for (11b). The necessary modal force of *would* induces the form for the representation of necessity which we have seen above. (11b) itself is represented in the righthand, or consequent box, while in the lefthand box we have accommodated the contextually available representation of the proposition *a wolf walks in* as a hypothetical common ground, narrowing the context set over which the necessary force of *would* will range. Notice that this accommodation is very naturally licensed by our assumptions of the relevance of (11b) to its context. This representation now gives the correct truth conditions when interpreted in a model. That is, something like 'Given what we already know in common about the actual world, it is possible that a wolf will walk into the house. In all such worlds where a wolf walks into the house, it eats you first.'

In general, then, the antecedent of conditional sentences serves as an explicit hypothetical addition to the common ground against which the consequent is to be evaluated, but in sentences which are not conditional in form, modal subordination involves the pragmatic accommodation of a contextually salient proposition (or propositions) to serve as antecedent for the nonfactual clause.

Further research will be required to determine whether cases such as (4) should also be accounted for via accommodation, or whether the insertion account given in Section 1.2.1 and illustrated in (10) suffices for these cases. If it proves to be desirable to generalize the accommodation approach, we would extend the DR for (4a), (8), as follows:

(15)

$$\boxed{\begin{array}{l} \boxed{\begin{array}{c} x \quad y \\ \text{John}(x) \\ \text{book}(y) \\ \text{bought}(x,y) \end{array}} = \boxed{\begin{array}{c} z \quad w \\ \text{reading}(z,w) \\ z = x \\ w = y \end{array}} \\ \\ \boxed{\begin{array}{c} x \quad y \\ \text{John}(x) \\ \text{book}(y) \\ \text{bought}(x,y) \end{array}} = \boxed{\begin{array}{c} r \\ \text{murder-mystery}(r) \\ r = y \end{array}} \end{array}}$$

Here we have taken the preceding antecedent box as our accommodated hypothetical common ground for the representation of (4b). The interpretation of (15) might be paraphrased, 'In all worlds where there is a book which the individual named John bought, you will find that John is reading the book. And in every world in which there is a book which the individual named John bought, the book is a murder mystery.'

There is one worry about the use of accommodation: It is a very powerful device. What prevents us from simply accommodating an appropriate common ground, including a potential anaphoric antecedent, in every case where we have a pronoun in discourse with no apparent antecedent. If this were possible, we would have no account of the infelicity of examples such as (3b). We seem to need constraints on the power of accommodation. One which is already clear from prior discussion is that modal subordination, and thus the accommodation which it triggers, requires nonfactual mood. Further, it must be plausible that the modally subordinate utterance has a hypothetical common ground suggested by the immediately preceding context. The examples which we have examined so far occur after a conditional or contain an explicit modal operator such as *would* or *might* to trigger the subordination. Another type of example involves *or*, the disjunction operator. (16) is due to Barbara Partee:[12]

(16) Either there's no bathroom in this house or it's in a funny place.

Here we find no overt modal in the second conjunct, yet the quantified noun phrase *no bathroom* appears to serve as a sort of antecedent for a pronoun, *it*, which is outside its scope under standard assumptions about quantifier scope.

[12]This is very similar to a sentence in Evans (1977):

(i) Either John does not own a donkey, or he keeps it very quiet.

On pragmatic grounds, we may assume that neither disjunct of a disjunction is asserted, and hence that both are nonfactual. We have seen above that any sentence uttered in a nonfactual mood may justify the accommodation of a hypothetical common ground. Further, we have also noted that relevance to context often dictates the choice of such an accommodated common ground. We often take the two disjuncts in a propositional disjunction to be alternative answers to the same topic of discussion. In (16), we may naturally assume that that topic is whether there is a bathroom in the house. The first disjunct entertains a negative answer to that question, so it seems perfectly natural to assume that the second disjunct pertains to the possibility of a positive answer to that same question. Thus, the accommodation of the portion of the representation of the first disjunct which is under the scope of the negation operator may be seen as the most natural means of providing an antecedent for the second disjunct, and hence for the pronoun *it* within it.[13] We may then build a DR for (16) such as (17):

[13]Higginbotham (p.c.) also points out that this procedure can be iterated for multiple disjunction operations, as in (i):

(i) Either there's no bathroom in this house, or it's in a funny place, or I just failed to spot it.

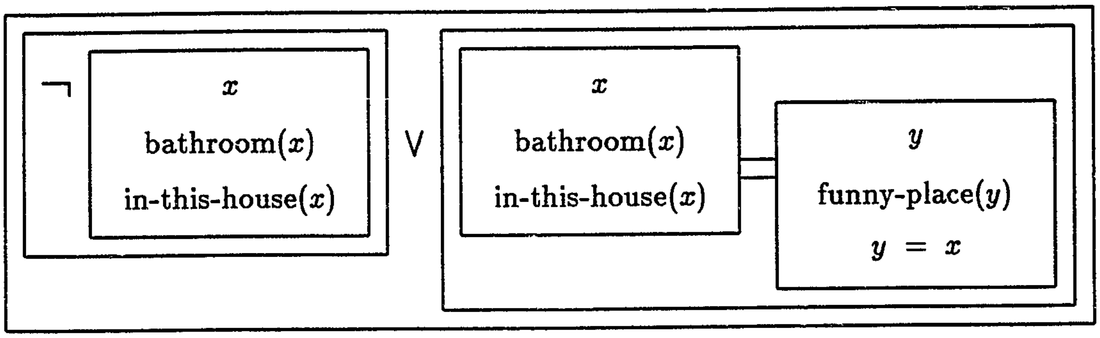
where the logical form would be (ii):

(ii) $\neg P \vee (\neg\neg P \rightarrow Q) \vee (\neg\neg P \wedge \neg Q \rightarrow R)$

which is logically equivalent to (iii):

(iii) $\neg P \vee Q \vee R$

(17)



Here, the symbol preceding the lefthand box recalls the negation symbol in the predicate calculus;[14] it is intended to have scope only over that box. The negation and the lefthand box together represent the first disjunct in (16). A box under the scope of the negation symbol may be properly embedded only in a model where it is not the case that the box itself may be properly embedded. The symbol following the lefthand box recalls the disjunction symbol. The embedding algorithm will take the disjunction symbol as an instruction that every proper embedding of the entire DR must be a proper embedding of at least one of the disjuncts as well. Thus, the DR in (17) would receive an interpretation along the lines of 'Either it is not the case that there is a bathroom in this house, or, if there is a bathroom in this house, it's in a funny place.'

With respect to the representation of the first disjunct as a negated existential sentence, rather than the logically equivalent form with the negation under the scope of a universal quantifier, note that this is partly justified by generally recognized properties of sentences of the form *there is* ...,which do not generally permit universally quantified NPs after the copula. Also, James Higginbotham (p.c.) points

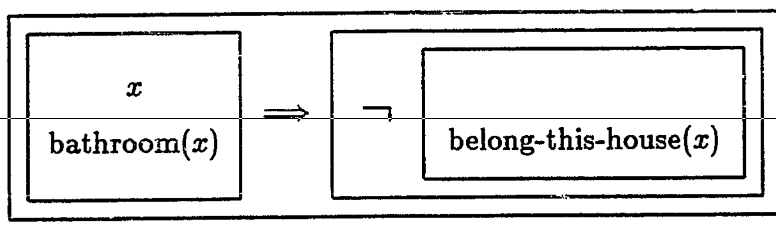
[14] I borrow this treatment of negation in DRs from M. Carlson (1982).

out that though (18) is logically equivalent to (16), (18) does not appear to license the anaphora we find in (16):

(18) # Either every bathroom does not belong to this house, or it's in a funny place.

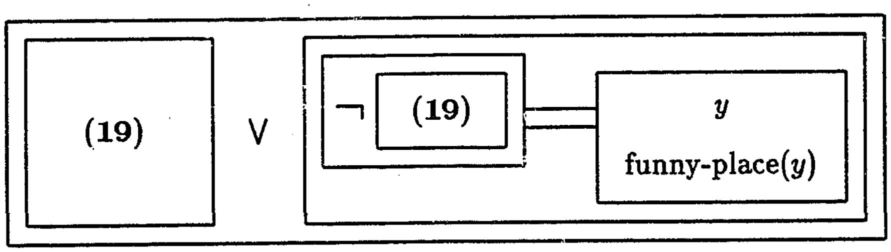
This follows from the general algorithm for mapping from sentences with universally quantified NPs onto DRs, as we saw, e.g., in (8) above. Using this algorithm, the first disjunct in (18) would map onto the DR in (19):[15]

(19)



If we then represent the second disjunct as we have done for (16) in (17), we would derive (20):

(20)



(In (20), *(19)* refers to the entire DR in (19) above.) But here, the discourse referent for *every bathroom*, x, is in a subordinate box within the sub-DR (19), which is itself under the scope of a negation, so x is not an accessible antecedent to the discourse

[15] Here, the universal quantifier induces the standard box-splitting of Kamp's treatment, as exemplified also in Footnote 10 above.

referent for *it*, y; the box in which y occurs is only subordinate to the top level of the DR (19). That is, the more complex logical structure of the first disjunct does not provide us with an appropriate representation to be accommodated as antecedent of the second disjunct, and so anaphora seems infelicitous.

The derivation of the DR for (16) in (17) is not intended to be algorithmic. That is, it is not always the case that where we have disjunction we accommodate the negation of the first disjunct as antecedent for the second. Rather, accommodation may be licensed by various entailments, implicatures and presuppositions in the discourse, just as in constructing a proof we have various rules and strategies for deriving steps from those which precede them. For example, consider Steve Berman's (p.c.) (21):

(21) Either there's a bathroom on the first floor, or it's on the second floor.

Here, accommodating the negation of the first disjunct would not achieve the desired results. The discourse referent for *a bathroom* would be under the scope of a nagation operator, and hence not accessible to *it*. However, (21) seems most felicitous when there is no intonational pitch accent on *bathroom*. (Compare this with (16), which always has a pitch accent on *bathroom*, and may even have a phrase boundary after it.) This may be taken as a signal that the speaker presupposes there is a bathroom, and it is this conventionally indicated presupposition which licenses the hearer to introduce a representation for *there's a bathroom* on the highest level of the DR, providing a discourse antecedent for *it*.[16] I assume that relevant contextually supplied and conversationally implicated material, as well as accommodated

[16]See Pierrehumbert (1980) and Selkirk (1983) for discussion of the phonology of pitch accent placement, and Ladd (1980) and Selkirk (1983) for discussion of the relationship of "old information," including presupposition, to lack of pitch accent.

material, may be introduced into the same DR as the explicit text. See Kadmon (1985) and especially Kadmon (1986) for independent evidence to this effect.

The contrast between (16) and (18) points to an important constraint on the type of accommodation we have been using, where anaphora is involved: it requires the explicit prior representation of potential antecedents. We may not simply infer their existence. Heim (1982, Chapter III) discusses the accommodation of antecedents for definite noun phrases and shows that it is constrained by the requirement that new file cards introduced under this type of accommodation must be crossreferenced to some pre-existing file card. But she claims in Section 5.3 that antecedents for pronouns are not generally "accommodable" in this fashion, due to their relative lack of descriptive content. The examples under discussion here provide further evidence for this claim. In these cases, we do not accommodate antecedents for pronouns directly; rather, it is the independently required accommodation of appropriate hypothetical common grounds for nonfactual utterances which supplies pronominal antecedents in these cases. Though independently motivated, this type of accommodation may not serve to introduce previously unmentioned discourse referents, new file cards in Heim's terms, to serve as antecedents for pronouns.

Although we may infer the first disjunct of (16) from the logically equivalent first disjunct of (18), (18) still may not license the same anaphoric relations as (16). This is shown clearly by another example from Barbara Partee, (22):

(22) (a) Nine of the ten marbles are in the bag.

(b) # It's under the couch.

Here, although (22a) conversationally implicates that there exists a tenth marble which is not in the bag, we may not accommodate this information directly into the DR, for if we did we would have a potential antecedent for *it* in (22b), and

(22b) seems infelicitous precisely because there is no available antecedent for *it*. Notice, however, that (22b) seems more felicitous after a long pause, especially if after uttering (22a) the speaker notices that the hearer is looking for something. A solution to this problem was suggested by Lyn Frazier (p.c.). She points out that in order to infer that there is one marble which is not in the bag the hearer must perform a mathematical calculation: she must subtract nine from ten. Even though this calculation seems quite trivial to us, it introduces a factor which was not involved in the previous examples, a nonlinguistic operation. Notice also that in previous examples the accommodated information was simply copied from portions of a pre-existing DR. This would not be the case here, where the representation for (22a) does not involve a discourse referent for a single marble, but only plural referents for the groups of nine and ten marbles. We cannot automatically assume that the hearer has performed the necessary calculation. However, as Heim (1982) discusses, once it is clear that some entity is salient in the context for all participants in a discourse, as is the case with deixis, for example, we may accommodate a discourse referent for that entity. In the case where the speaker of (22a) notices the hearer looking for something, the speaker may assume that the hearer has performed the calculation, has realized that there is a missing marble, and is looking for it. A discourse referent for the missing marble may then be accommodated, introduced after the fact, and serve as antecedent for the pronoun *it* in (22b).[17]

[17]The account proposed for this example should suffice as well for the contrast in anaphoric potential of the following sentences from Isard (1975):

(i) First square 19 and then cube it.
(ii) First take the square of 19 and then cube it.

In (i), where the square of 19 has not been explicitly mentioned as such, *it* may only refer to *19*, while in (ii), *it* may either refer to *19* or to the referent of the NP *the square of 19.*

1.2.3 Concluding remarks on modal subordination

I have argued that intersentential modal subordination requires uninterrupted mood, and that the best means of representing it is via the accommodation of missing antecedents, where accommodation is constrained by the requirement of explicit prior representation of potential antecedents. There is a further point which I would like to note: The phenomenon of anaphora licensed by modal subordination provides an independent argument for a level of discourse representation intermediate between syntactic representation and model theoretic interpretation. Cases such as Landman's (11) and Partee's (16) show that pragmatic accommodation is required, so that neither a syntactic representation such as S-Structure in Government and Binding theory, nor a simple transform of S-Structure such as LF, would suffice to explain the data. An approach which posits operators with discourse scope in an extended version of LF, such as that in Heim (1982, Chapter II), would run into the same problems with mixed modals as the insertion approach considered earlier. On the other hand, given the assumptions we have made here about the form of a grammar and its interpretation, we may not explain modal subordination in terms of direct interpretation in a model. Standard models fail to provide discourse referents in a hierarchical structure, which we have seen to be crucial to this account. In addition, consider the discourse in (23):

(23) (a) <u>One of the 10 marbles</u> is out of the bag.

(b) <u>It</u>'s under the couch.

If we assume that (22a) conversationally implicates that one marble is *not* in the bag and that (23a) implicates that nine marbles *are* in the bag, then (22a) and (23a) will be true in exactly the same worlds. Yet unlike (22a), (23a) provides an antecedent for *it* in the (b) sentence, and the discourse is felicitous. Hence, I believe that the phenomenon I have described here argues for an intermediate level of Discourse Representation.

1.3 Generalized subordination in discourse

The examples of subordination in discourse which we have examined so far all involve modality and can be accounted for in a relatively straightforward fashion with the notion of a hypothetical common ground. But there are cases of subordination involving nonmodal operators which demonstrate the need for a generalized notion of discourse subordination. And still other examples show that even the treatment of subordination under modal operators requires a more complex conception of discourse than the notion of common ground alone can provide.

1.3.1 Subordination with non-modal operators

Examples involving temporal factors, adverbs of quantification (Lewis 1975), and universal quantifiers display close parallels to modal subordination. The donkey sentences which originally concerned Kamp (1981) and Heim(1982) involved quantification over cases or situations in the actual world, rather than over possible worlds. Like the epistemic modal examples in (3) and (4), the generic example in (24) displays discourse subordination phenomena, so that (24a) may be felicitously followed by (24b), but not by (24b′):

(24) (a) If a farmer owns <u>a donkey</u>, he beats <u>it</u>.

(b) <u>It</u> always develops festering wounds.

(b′) # <u>It</u> developed festering wounds.

In Kamp (1981), the conditional sentence in (24a) is represented in the same way as universal donkey sentences (see Footnote 10 above for an example). The discourse subordination licensing the anaphora in (24b) might be represented by insertion, as in (25), which is parallel to the representation of (4) in (9) above:

(25)

$$\boxed{\boxed{\begin{array}{c} x \quad y \\ \text{farmer}(x) \\ \text{donkey}(y) \\ \text{owns}(x,y) \end{array}} \Longrightarrow \boxed{\begin{array}{c} z \quad w \quad r \\ \text{beats}(z,w) \\ z = x \\ w = y \\ \text{develops-wounds}(r) \\ r = y \end{array}}}$$

The truth conditions for (25) might be paraphrased, 'For every situation in which there is a farmer and a donkey which he owns, then the farmer beats the donkey and the donkey develops wounds.' But in this case, the subordination of r and the condition on r is licensed not by a modal, but by the adverb of quantification *always* in (24b).

Karttunen (1976) noticed cases like (26):

(26) (a) Harvey courts <u>a girl</u> at every convention.

(b) <u>She</u> always comes to the banquet with him.

(c) <u>The girl</u> is usually very pretty.

Subordination in (26) is also induced by adverbs of quantification: *at every convention* in (a) establishes a limited set of cases or situations which are contextually salient and serve to restrict the domain of *always* in (b) and *usually* in (c). This approach also accounts for the anaphoric relation between the definites and the preceding indefinites in (27), from Stenning (1978):

(27) (a) In each room, there was [a cat]$_i$ and [a goldfish]$_j$.

(b) [The goldfish]$_j$ dived.

(c) [The cat]$_i$ caught [it]$_j$.

Here, the adverbial *in each room* quantifies over locations, and (b) and (c) are implicitly offered as instantiating the situation in such a location.

Temporal parallels were noted in Sells (1985a). His example (29b) is shown as (28):

(28) (a) <u>A train</u> leaves every hour for Boston.

(b) <u>It</u> always stops in New Haven.

The relevant reading of (28a) is that in which *a train* is under the scope of the temporal quantifier *every hour.* Partee (1984) has offered an analysis of temporal quantifiers, introducing discourse referents for events into DRs. The scope of such operators generally seems to be limited to the sentential domain, as with other types of operators. Yet, *it* in (28b) seems to refer back to *a train.* Our intuition that (28b) is temporally subordinate to (28a) is confirmed by the most natural interpretation of the optional temporal adverb *always.* We do not take it to quantify over all times; rather, as in the modal cases we have considered above where the operator's domain is restricted by the accommodation of contextually salient material, the domain of *always* here is restricted to the salient set of times: those in which a train leaves for Boston.

Another type of case involves universal quantifiers. (29) is due to Barbara Partee (p.c.), (30) to Sells (1985a):[18]

(29) (a) Each degree candidate walked to the stage.

(b) He took his diploma from the Dean and returned to his seat.

(30) (a) Every chess set comes with a spare pawn.

(b) It is taped to the top of the box.

Partee terms this the "telescoping" phenomenon: from a discussion of the general case, we zoom in to examine a particular instance. In (29), *he* and *his* seem to instantiate *each degree candidate*, though it is in the prior sentence. Here, insertion of (b) in the righthand, or consequent box of the conditional-like DR induced by (a) would seem to be the most natural treatment of the subordination. In (30), on the preferred reading where *a spare pawn* is under the scope of the subject of (a), the insertion of (b) in the consequent of the DR of (a) explains the accessibility of the discourse referent for *a spare pawn* to serve as antecedent for *it* in (b).

[18] Sells offers (30) [=his 31] as an example of temporal subordination. The reference time of (b) is that provided by (a); however, this reflects the general requirement for narrative continuity in discourse subordination (see below), and does not in all cases mean that temporal subordination is involved. In Sells' example (28), on the other hand, the quantifier in (a) under whose scope (b) seems to fall is a quantifier over times.

Sells also offers (i) [=his 33b] as an example of temporal subordination:

(i) (a) [Every rice-grower in Korea]$_i$ owns [a wooden cart]$_j$.

(b) Usually [he]$_i$ gets [it]$_j$ from [his]$_i$ father.

Although the adverb of quantification *usually* is sometimes temporal, I don't believe it is in this case. Rather, here it seems to quantify over something like cases or instances of the rice-grower/wooden cart pairs introduced in (a). Hence, I take (i) to illustrate a case of subordination to the universal quantifier.

A pair of examples from Fodor and Sag (1982) show that the possibility of anaphoric relations in such telescoping cases, involving subordination to a universal quantifier in a preceding utterance, depends in part on the plausibility of a sort of narrative continuity between the utterances in the discourse:

(31) Each student in the syntax class was accused of cheating on the exam, and he was reprimanded by the dean.

(32) # Each student in the syntax class was accused of cheating on the exam, and he has a Ph.D. in astrophysics.

Even though the second conjunct of (32) is in the present tense, unlike the first conjunct, this does not seem to be the source of the unacceptability of the anaphoric relation indicated, as can be seen by replacing *has* with *had.* Neither does the second conjunct itself seem implausible as a general statement; consider the felicity of (33):

(33) Each candidate for the space mission meets all our requirements. He has a Ph.D. in astrophysics and extensive prior flight experience.

In these cases, we begin a narrative with a statement about a class of individuals, then, as Partee's term suggests, we 'zoom' in on one instantiation of that class to continue the narrative. The problem with (32) seems to be that the second sentence does not comfortably continue the narrative in this fashion, but the precise character of the constraints on telescoping must be left for further study, and I will not discuss them further here.

Summarizing, all the cases of subordination in discourse which we have examined so far display the following features in common:

1. There is explicit prior mention of the antecedents of any anaphors. Even where accommodation is involved, if the accommodated material includes the antecedent of an anaphor, that material must be 'borrowed' from the prior representation of an explicit utterance.

2. The clause with the antecedent is part of the common ground (factual or hypothetical, explicit or accommodated) of the utterance containing the anaphor. The DR reflects this in configurational terms: the clause with the antecedent is on the same or a higher level of the DR as that containing the anaphor.

3. There must be a plausible narrative continuity between the clause with the antecedent and the clause containing the anaphor. This is reflected in restrictions on the relation between the Reference Times for the two clauses, though we have not tried to specify such restrictions here.

1.3.2 Subordination with non-epistemic modality, counterfactuals, and propositional attitudes

In the examples of modal subordination which we examined in Sections 1.1 and 1.2 above, the explicit or implicit hypothetical extensions of the common ground which provided the antecedents for anaphora were all live possibilities in the discourse up to that point: that is, they were doxastically plausible from the point of view of the common ground of the participants (at least, from the point of view of the participants as a group, though one or more may have had evidence to the contrary). But many examples involve propositions which are contrary to the facts about the actual world included in the common ground of the conversation in which they are uttered. In this section, I will briefly consider a few examples of this type and note some of the problems entailed in incorporating such phenomena into a general account of subordination in discourse.

Consider the following examples:

(34) (a) You should eat a bagel.

(b) It would fill you up.

(35) (a) If I had brought a book with me to Georgia, I could have read it on the plane.

(b) I would probably have finished it by now.

(36) (a) John believes that a mermaid lives in his swimming pool.

(b) He wants her to leave.

The modal auxiliary *should* in (34a) has the force of necessity. Its utterance in a given context should not be taken as a suggestion by the speaker to remove all worlds from the context set in which the hearer does not eat a bagel, i.e. as the assertion that it is impossible in this context that the hearer not eat a bagel. Rather, it is a suggestion that it would be ideal in some sense if she ate a bagel, though we generally acknowledge that ideals will not necessarily be realized. (35a) may be uttered in a context in which in fact I did not bring a book with me to Georgia, and in which this fact is part of the common ground shared by the participants in the discourse. We do not regard it as a suggestion to remove all the worlds in the context set in which (35a) is false, for that would leave us with an implausibly empty context set. In both (34) and (35) we observe an instance of anaphora which seems parallel to the cases of anaphora licensed by modal subordination, yet the account I developed above in terms of the common ground and context set is inadequate in these cases. Finally, *a mermaid* in (36a) may be taken to have narrow scope under the opaque verb *believes* and yet seem to serve as an antecedent for the pronoun *her* in (36b), outside the scope of *believes*. This too is strongly reminiscent of anaphora licensed under modal subordination, but there are no overt modal operators here, and in addition, we can discuss John's belief in a context where all participants agree that there are no such things as mermaids.

Kratzer (see references) develops compelling arguments for a unified theory of modals, conditionals, and counterfactuals. And we have just seen that subordination seems generally possible in all these cases. The parallels are clear: In each case, as with the other types of operators discussed in 2.3.1, the speaker first establishes a set of worlds, times, events, or situations in which some individual *a* is said to exist. So long as we continue to talk about that world/time/etc., we may continue to assume *a*'s existence and to refer anaphorically to the discourse referent with which *a* was originally introduced into the conversation. Where propositional attitudes are involved, we know that someone believes/claims/knows/etc. that an entity *a* exists, and so long as we continue to talk about the beliefs/claims/etc. of that person, we may continue to refer back to *a* via its discourse referent.

Given this parallel, we would like to find a more general approach to modal subordination which can account for (34) – (36) as well as the cases already discussed. Heim (1985) has suggested a promising approach to cases involving propositional attitudes, nonepistemic modals, and counterfactual modals. I will briefly sketch her idea and how it may apply to the cases under consideration.

Heim proposes that we use Stalnaker's (1985) idea of a *derived context* set to characterize the belief set of the subject of a sentence such as (36a). She gives a formal account in terms of her theory of file change semantics, but our discussion will be informal. She suggests that we determine the derived context set for (36a) as follows: For each world w in the context set at the point where (36a) is uttered, we consider the set of worlds where all the propositions John believes in w are true. This is the set of worlds accessible to w under the relation 'what John believes.' If the participants in the conversation take the assertion (36a) to be true, then they eliminate from their context set any world w where 'there is a mermaid in my pool' is not true in all the worlds accessible to w under the relation 'what John believes.'

Heim then proposes that we treat (36b) by means of what Kratzer (see references, especially 1980) calls an *ordering source* on the derived context set. As I mentioned in Footnote 5, Kratzer relativizes the modal force of a modal or conditional using two distinct sets of propositions. The first is called the *modal base*; the modal base may be epistemic or doxastic, as in the case of most of the cases of modal subordination we examined above, or circumstantial (facts, of course, need not be known; the wolf example, (11), might be considered a case where the modal base is circumstantial, though here the facts may be part of our common ground as well). The derived context set established by *believe* is a possibly nonrealistic modal base, since beliefs need not reflect reality. The other set of propositions used to relativize modal force is the ordering source. These propositions reflect a possibly counterfactual ideal, and they induce an ordering on the members of the set of worlds given by the modal base: only those worlds given by the modal base which also come closest[19] to realizing the ideal given by the ordering source will be in the domain of the modal operator involved. A world w 'comes closer' to the set of

[19] Actually, there may be no 'closest' set of worlds. cf. Lewis (1973) for discussion. Kratzer (1980) takes this into account in her formal definition of the ordering source. I will ignore this complication in what follows in the interest of conveying the basic intuition more clearly. However, it will be an important part of any formal account.

propositions in an ordering source O than a world w' if more of the propositions in O are true in w than in w'. In the case of (36b), an ideal is established by the set of propositions characterized as 'what John wants' (presumably this set of propositions is a subset of the propositions he regards as possibly true in the future, unlike what he wishes). If (36b) is taken to be a true assertion, then the participants in the conversation will proceed as follows: given a world w in the context set at that point, they consider the set of worlds accessible to w under the relation 'what John believes.' Call this set B. Since we are evaluating (36b) after the utterance of (36a) has been accepted, we already know that in each member of B it is true that there is a mermaid in John's swimming pool. Now we check the subset of B which comes closest to fulfilling 'what John wants:' call this subset W. If it is true in each member of W that the mermaid leaves, then w remains in the context set of the conversation after the utterance of (36). If it is false, then w is eliminated from the context set.

Given this informal characterization of Heim's proposal, we can see how the same approach may be useful in attempting to account for cases like (34) and (35) as well. For example, in (34a), *should* is deontic; imagine that the modal base in this case includes several propositions which are in our common ground, such as the fact that the hearer is hungry, that the hearer doesn't want to be hungry, and that eating a bagel will still the hunger. However, this modal base need not include all the propositions in our common ground: for example, it may not include the fact that the hearer is anorexic and refuses to eat anything. That is, the set of worlds determined by the propositions in this modal base is not necessarily the same as the set of possibilities determined by the common ground at this point in the conversation, but is a derived context set. Assume further that for each world w in the original context set the ordering source characterizes the set of worlds where what are considered good nutritional and other health practices in w are most often followed; let us call the set of worlds in w's nutritional ideal N. Under these assumptions, the speaker's assertion amounts to an instruction to discard any worlds w whose nutritional ideal N includes worlds in which the hearer doesn't eat a bagel. *Would* in (34b) then continues the nonfactual mood; if we accept it as true, it serves as an instruction to remove any remaining worlds w from the original context set in which the proposition that the hearer is full as a result of eating the bagel is not true in all the worlds in w's nutritional ideal N. Note that the modal base for *should* did not include all the propositions which were in the common ground prior to uttering (34), and in particular not the propositions that the hearer is anorexic and will refuse to eat anything. This permits us to readily extend (34a) as in (37), without contradiction:

(37) You should eat a bagel, but I know you won't.

(35) is quite similar to (34), but here for any worlds w in the context set of the conversation at that point, the set of worlds accessible to w is determined by the counterfactual antecedent of the conditional: in the set of worlds accessible to w we include all those worlds in which the antecedent of (35) is true, i.e. in which I did bring a book. We then order those worlds so that only those which are most like w in all respects except for the truth of the antecedent are in the ideal. It is then in these ideal worlds that we require the truth of the consequent. If the consequent is not true in all the ideal worlds accessible to w, then w is eliminated from the context set. Otherwise, it is retained. The domain of the modal in (35b) is then restricted using the derived context set and ideal of (35a), where we already know that for any world in the context set it is true in all worlds in its ideal that I brought a book and read it on the plane.

In both (34) and (35), we accommodated the derived context and ideal suggested by the (a) sentence as modal base and ordering source for the (b) sentence. In (36), this accommodation was required by the semantics of *want*. But it appears that there may be some cases of this sort where the insertion approach is appropriate. Fred Landman (p.c.) suggests that this is true for (38):

(38) The author claims that <u>Vulcan</u> exists after all. <u>It</u> has circled around Mercury for ages without us ever noticing it.

Here, the second sentence simply seems to continue the exposition of the author's claims without explicitly indicating it. One can easily imagine similar examples with other propositional attitude verbs. Jerry Morgan (p.c.) also pointed out to me the following example:

(39) Last night I dreamed I got <u>a red Porsche</u> for my birthday. I drove <u>it</u> all over the countryside and loved every minute of it. This morning I woke up and much to my surprise found <u>it</u> parked in my driveway.

Here, the second sentence seems implicitly to be a continued description of the speaker's dream, while the third requires us to accommodate the information that the dream was, after all, about a real car.

Heim's approach to the propositional attitude cases and the counterfactual and deontic conditionals seems promising. Here, the modal base of a modal in Kratzer's theory need not always equal the prior common ground plus one or more hypothetically added, noncounterfactual propositions, as it did in the simpler examples in Sections 1.1 and 1.2. Part or all of the prior common ground may be eliminated from the modal base, in order to avoid inconsistency with counterfactual propositions.

And an ordering source may further restrict the domain of the modal operator to an ideal subset of the set of worlds determined by the modal base.

The simpler modal examples in earlier sections may be included in this more complex account quite readily: Suppose we are evaluating an indicative conditional with an epistemic modal, *If A, then B*. We use a totally realistic modal base, so that for any world w in the prior context set, the set of worlds to which w is accessible will be the intersection of $\{w\}$ and the proposition (a set of worlds) denoted by A, that is, it will be the set of worlds where all the propositions in the prior common ground and the proposition denoted by A are true. This is just the hypothetical context set which we obtained in Sections 1.1 and 1.2. The ordering source for such a case will often be empty, so that the ideal against which the modal force is relativized will be just the set of accessible worlds.

Finally, the cases we have discussed in this section fall under Stalnaker's sense of assertions (see his definition in Section 1.1 above). If accepted by the participants in the discourse, the assertion of a counterfactual, like the assertion of an indicative conditional, may result in the reduction of the context set by the elimination of all possible worlds w in which the consequent does not follow from all worlds in w's accessible ideal.

Chapter 2

Anaphora, Coreference and the Binding Theory

There are two kinds of theories of anaphora in the current literature on natural language: One deals with constraints on anaphora in discourse. This is the sort of theory I explored in the discussion of modal subordination in Chapter 1. The other is primarily a sentence-level theory and is exemplified by the Binding Principles of Government and Binding Theory (see Chomsky (1981)). This theory seeks to explain anaphora in terms of configurational notions such as *c-command* and *governing category*. While there is some overlap in the concerns of the two types of theory, such as in the relation of quantifiers to the variables they bind, neither seems to address the full range of anaphoric phenomena. As a result, I will argue, there is no clear delineation of which anaphoric constraints are dependent on sentence-internal configurations and which are best explained in terms of the structure of discourse.

In this chapter I will suggest how this might be clarified, proposing that although the basic thrust of Binding Theory is correct, at least for English, many problems can be resolved by reconsidering the role of indices in semantic interpretation. Some of the problems which will concern me are exemplified in (1) – (3). Each case poses a problem for the interpretation generally assumed of the randomly assigned indices — that coindexed noun phrases are coreferential, while non-coindexed noun phrases are not:

(1) Alan and Margaret ate their dinner.

(2) Mary thought she had the mumps and Alice did too.

(3) (a) Only Reagan voted for himself.

(b) Only Reagan voted for Reagan.

In (1), due to Daniel Seely (p.c.), the relation between the indices of each of the proper nouns and that of the conjoined NP they form (or of *their*) is a problem. Neither NP is co-referential with the whole or with *their*, so they must receive different indices. Yet, neither are they disjoint in reference. In (2) we see an example from Reinhart (1983) of Ross' (1967) sloppy identity. Alice may think that she herself has the mumps (the sloppy reading) or that Mary does (the non-sloppy reading). Given that *she* in the first sentence may take *Mary* as antecedent on either reading, we must have a way of indexing the pronoun that permits each reading of the second sentence after the verb phrase has been copied.

In the cases in (3), of a type originally due to James McCawley and discussed in Evans (1980), the (b) sentence seems acceptable with the two instances of *Reagan* coreferential, despite violation of Principle C of the Binding Theory. Note that (a) has different truth conditions than (b), e.g. in a situation in which many people voted for Reagan, (a) may be true while (b) may not.

In developing a solution for problems of this sort, I will propose that the role of indices in semantic interpretation should be indirect: coindexation, assigned on the basis of S-Structure configurations of the sort discussed in Chomsky (1981), has no inherent semantic value, but serves as a guide in the mapping from that representation onto a discourse representation. The principles of the Binding Theory are no longer viewed as constraints on the grammaticality of representations, but their desirable effects are retained via constraints on i) coindexing at S-Structure and ii) the subsequent mapping to a discourse representation.

This proposal is intended, then, as a revision of Binding Theory in the light of a more inclusive theory of anaphora in discourse. It is designed to implement a crucial notion: there are two kinds of binding, constrained by relations on structures in distinct domains.[1] Here we see a clear example of the virtues of modularity. Theories of anaphora in each domain will be simpler and more adequate as they recognize which cases of binding fall within their purview and which do not. I will begin in Section 2.1 by briefly reviewing some of the problems encountered by Chomsky's (1981) Binding Theory, as well as relevant work by Reinhart (1983). In Section 2.2 I will introduce a revised binding theory, including an indexing procedure and a sketch of how coindexation constrains the mapping from S-Structure to Discourse Representations. In light of this discussion we will see that many of the examples

[1]This idea has been foreshadowed elsewhere in the literature. In particular, Partee (1978) suggests that there are two kinds of pronoun, a bound variable and one whose reference is pragmatically determined. Bach & Partee (1980), Partee & Bach (1981) and Reinhart (1983) all assume that there are pronouns which should not be treated as bound variables, but are otherwise related to their antecedents. With the advent of discourse theories such as Heim's and Kamp's, the nature of this other type of relation can now be clarified and its constraints explored, as we have done in Chapter 1. Note that unlike Cooper (1979), I am not here proposing that pronouns which are bound in the two different fashions receive different semantic interpretations: every pronoun will be represented as a discourse referent in the discourse representation and ultimately behave as if it were a bound variable in a model theoretic interpretation.

which pose problems for the present Binding Theory find their proper explanation in terms of discourse constraints. I hope to show that the combined constraints of the Binding and Discourse Theories may account for the full range of anaphoric phenomena. Also, the approach taken here suggests an alternative account of the classic cases of weak and strong crossover, and this is discussed in Section 2.2.3. Finally, in Section 2.3 I will review in detail the proposals of Haïk (1984) concerning binding and quantifier scope.

2.1 Problems in the theory of binding

2.1.1 Syntactic problems

In this section I will examine the Binding Theory as it is outlined in Chomsky (1981), *Lectures on Government and Binding* (hereafter LGB). The theory pertains to relationships between NPs in A-positions (intuitively, argument positions in matrix clauses, as opposed to preposed or extraposed positions). There are two basic notions in this theory. The first is that of *government*, defined as follows (LGB, p.250):

(4) Consider the structure (i):

(i) $[_\beta \ldots \gamma \ldots \alpha \ldots \gamma \ldots]$, where

(a) $\alpha = X^0$ or is coindexed with γ

(b) where ϕ is a maximal projection, if ϕ dominates γ then ϕ dominates α

(c) α c-commands γ

In this case, α *governs* γ

The derived notion of a *governing category* is defined in terms of (4) (LGB, p.211):

(5) β is a *governing category* for α *iff* β is the minimal category containing α, a governor of α, and a SUBJECT accessible to α.[2]

The other basic notion is that of binding, defined as follows for NPs in A-positions (cf. LGB, p.184):

(6) α is *A*-bound by β if and only if α and β are coindexed, β c-commands α, and β is in an *A*-position.

For our purposes here we may assume that a node β c-commands a node α *iff* the first branching node which dominates β dominates α. If an NP is not bound, then it is *free*. The Binding Theory is then as follows:

(7) **Binding Theory**

(A) An anaphor is bound in its governing category.

(B) A pronominal is free in its governing category.

(C) An R-expression is free.

Anaphors in this theory include reflexives and the traces of NP-movement. All other pronouns are pronominals. Other NPs and traces of *wh*-movement are R-expressions. In order to avoid the confusion which may arise between the more traditional uses of these terms and their technical sense in GB theory, I will refer to reflexives and reciprocals as A-pronouns (pronouns governed by Principle A) and to other pronouns as B-pronouns (those governed by Principle B).

[2]See LGB, pp.209-211 for discussion of the notion of SUBJECT.

The focus of inquiry here will be on the problem of determining at which level of the syntax to apply the Binding Theory. In LGB (p.196ff.) Chomsky adopts the position that the Binding Theory applies at S-Structure (SS). Brody (1979) pointed out that applying Principle C at Logical Form (LF) gave incorrect results. For example, consider the sentences in (8) and their LFs in (9) (LGB pp.196–7):

(8) (a) which book that John$_i$ read did he$_i$ like

(b) * he$_i$ liked every book that John$_i$ read

(9) (a) for which book x that John$_i$ read, he$_i$ liked x

(b) for every book x that John$_i$ read, he$_i$ liked x

The binding possibilities for (8a) and (8b) differ at SS, since in (b) *John*, an R-expression, is bound, violating Principle C of the Binding Theory. But their LFs are essentially identical — in neither case does *he* c-command *John*, and hence both would be predicted to be grammatical if all the binding principles applied at LF.

Binding cannot apply at Deep Structure (DS) because of the effect of move-α on binding possibilities, as in (10):

(10) (a) * it seemed to themselves that the athletes were fit for the race

(b) The athletes seemed to themselves to be fit for the race.

However, the analysis of crossover (cf. pp.193-4) seems to require the application of the Binding Theory, or at least Principle C, at LF. The typical strong crossover paradigm is as in (11):

(11) (a) * who$_i$ did he$_i$ say Mary had seen t_i

(b) * he$_i$ said Mary had seen everyone$_i$

(c) who$_i$ t_i said Mary had kissed him$_i$

In terms of the Binding Theory, (a) is ungrammatical because t_i, an R-expression, is bound by *he*$_i$, violating Principle C. After Quantifier Raising (QR) at LF, the (b) case is ungrammatical for the same reason, the trace of *everyone*$_i$ bound by *he*$_i$, while (c) is grammatical because the R-expression t_i is A-free, being bound only by the operator in A$'$ position, *who*$_i$, and A-binding in turn the pronominal *him*$_i$. The parallel between (a) and (b) depends upon the LF rule of QR.

Chomsky considers an alternative explanation of the crossover facts in (9) in which (b) is ruled ungrammatical by Principle C at SS, *everyone*$_i$ being treated as an R-expression. This would resolve the apparent conflict between the facts in (6) and (9). We might then consider whether the principles of the Binding Theory all apply at SS.

However, there is another type of case which seems to require the application of the Binding Theory at LF; this includes examples with preposed NPs, as in (12) and (13):

(12) which picture of himself$_i$ does John$_i$ like

(13) that picture of himself$_i$ John$_i$ likes

In neither of these cases does *John* c-command *himself* at SS. It is generally assumed that the proper configuration can be obtained by a rule of reconstruction at LF. After application of such a rule, (13) would presumably look like (14):

(14) John$_i$ likes that picture of himself$_i$

where the proper c-command and governing category requirements of the Binding Theory are met.[3] However, in the usual representation of questioned sentences at LF, the *wh*-phrase is treated as an operator, with the pied-piped material acting like a domain restrictor:

(15) For which x, x a picture of himself$_i$, John$_i$ likes x

Here, the proper structural relation between anaphor and antecedent is still not obtained.

Van Riemsdijk & Williams (1981), point out that to obtain the required configuration in such a case, either an undesirable structure building rule is required at LF, or we must assume an ill-motivated system of layered traces. They suggest that the answer to the reconstruction problem is to divide Move-α into two rules: NP-movement applying to DSs to derive representations at a new level, NP-Structure, followed by *wh*-movement, yielding SS. The Binding Theory, then, would apply at NP-Structure. They assume that topicalized NPs originate in the matrix sentence, are *wh*-moved into COMP and then dislocated and raised into topic position. Hence their proposal is intended to account for cases like (12) and (13). But note that their analysis also encounters problems with anaphora and *wh*-movement. Consider (16) and (17):

[3] I ignore here the problem of how the rule would be formulated. Given the special Topic node under S$''$ proposed in Chomsky (1977), and subsequent work by Koster on sentential subjects (1978), we might either suppose that topics are first *wh*-moved and then dislocated from COMP into TOP, or that they are base generated in TOP, with a PRO base-generated in the matrix clause and *wh*-moved into COMP, along the lines of Chomsky's treatment (1981) of purpose clauses. In neither case, then, would "reconstruction" be simply a case of undoing *wh*-movement.

(16) (a) That picture of John_i he_i likes

(b) Which picture of John_i does he_i like

(17) (a) * He_i likes that picture of John_i

(b) * He_i likes which picture of John_i

The sentences in (16) seem perfectly fine after *wh*-movement, while the corresponding unmoved examples in (17) are ungrammatical. If Binding principles apply at NP-Structure, but *wh*-movement occurs in the mapping from NP-Structure to S-Structure, then these facts would not be predicted.[4]

Finally, we might consider whether we can resolve these problems by making reconstruction of a *wh*-moved constituent optional at LF. David Pesetsky (p.c.) has pointed out examples like (18a):

(18) (a) [Which picture of himself_i that Mary_j $\text{likes}]_k$ will John_i give her_j t_k

(b) * John_i will give her_j which picture of himself_i that Mary_j likes

Here, reconstruction of the *wh*-moved constituent into the position of t_k as in (18b) is both obligatory, so that *John* may bind *himself*, and impossible, since then *her* would

[4]Since the proposal in this chapter was developed, Williams (1986) has suggested a different approach to anaphora at NP-Structure. His approach has many of the advantages of this proposal, and in particular utilizes a similar treatment of reconstruction which permits him to account for the difference between (16) and (17). Williams' NP-Structure is fairly abstract, and is not transformationally related to D-Structure or S-Structure. This permits him to account for bound anaphora, including reflexives, in pseudo-clefts and other constructions where there are clear arguments against a transformational relation to S-Structure (see Higgins (1972) for decisive arguments against such a transformational relation).

c-command *Mary*. Since the intended reading of (18a) seems perfectly felicitous, we may conclude that optional reconstruction is not the answer to our problem.

Hence, we face problems whether applying Binding Theory at LF, SS or NP-Structure. A further possibility is that while Principle C applies at SS, Principles A and B apply at LF. However, in view of the problems just noted with reconstruction, it is not clear how this proposal would be an improvement.

2.1.2 Problems of interpretation

It has never been made entirely clear in the Government and Binding framework how indices are to be interpreted, although the terminology used in describing the intuitions on which the theory is based, e.g. "coreference" and "disjoint reference," strongly suggests that indices are to be interpreted. In fact, as Reinhart (1983) has pointed out, if you treat indices just as uninterpreted syntactic devices, then you still have a problem with sentences like (19), which motivated Lasnik's (1976) important discussion of disjoint reference conditions, leading to Principles B and C of the Binding Theory:

(19) Felix likes him.

If indices are uninterpreted, then even though you may rule out a derivation in which *Felix* and *him* are coindexed, there is nothing to prevent *him* from picking up the same referent as *Felix* from some previous mention of that individual in discourse. Hence, we must seek an adequate interpretation.

In the LGB system, single indices are assigned at random somewhere before SS. Then the relation of binding is defined over pairs of coindexed NPs where one c-commands the other. If not bound in this fashion, an NP is free. It seems that the usual, though tacit interpretation of the LGB system is simple: if two NPs are coindexed, whether bound or free, they are coreferential; if they are not coindexed, they are not coreferential. The bound/free distinction only serves to identify the environments in which A-pronouns must be bound and in which disjoint reference holds, via the independent Principles A, B and C of the Binding Theory.[5]

Note that "coreferential" here is used in a fairly loose sense. Chomsky is careful to note (LGB,p.314):

> Recall that we are not considering the problems of the theory of reference. . .but are concerned rather with properties of LF-representation that enter into interpretations of sentences in terms of intended coreference and intended distinct (disjoint) reference, where the "reference" in question does not carry ontological commitment.

The consequences of this view, especially for disjoint reference, have not been made sufficiently clear in the framework. Chomsky (p.315, fn.3) briefly considers the following example:[6]

(20) I dreamed I was Jesus and <u>I</u> forgave <u>me</u> for <u>my</u> sins.

He points out that "a different 'referent' will presumably be assigned to *I* and *me* in the 'constructed world' of the dream," though there is another sense in which one might claim that the two terms corefer.

[5]Reinhart (1983) seems to interpret the system in LGB somewhat differently; cf. especially pp. 52 – 53.

[6]Compare (i), from Lakoff (1972):

(i) I dreamed that I was Brigitte Bardot and that I kissed me.

From this point of view, consider (21):

(21) I_1 like me_2

Lasnik (1980) argues that (20), like the variation where the pronouns are coindexed (ruled out by Principle B), should be ungrammatical because of the lexical meaning of the pronouns. But the apparent awkwardness of this sentence can be overcome in the proper context:

(22) I dreamed I was a beagle, and as soon as I laid eyes on me in the kennel, <u>I liked me</u>.

We see, then, that like example (20), (21) is not ungrammatical, but only pragmatically odd, in the sense that we seem to be referring to the speaker with two terms which are not coreferential.

A similar problem underlies Lasnik's (23):

(23) We_1 like me_2

The coindexed version of this sentence would be ungrammatical, since *we* and *me* are only overlapping in reference, not coreferential.[7] But to interpret non-coindexation as disjoint reference in the strictest sense seems incorrect, given the meanings of the pronouns.

Now consider the following:

[7] Lasnik argues convincingly against allowing coindexation to be interpreted as overlapping reference. I will not repeat his arguments here.

(24) (a) He_1 bought himself_1 a dog (bought a dog for himself_1).

(b) * He_1 bought him_1 a dog (bought a dog for him_1).

(c) * We_1 bought myself_1 a dog (bought a dog for myself_1).

(d) * We_1 bought myself_2 a dog (bought a dog for myself_2).

(e) We_1 bought me_2 a dog (bought a dog for me_2).

(f) We_1 heard me_2 on the radio.

In (24a – b), we see that a reflexive is required for coreference in this configuration.[8] But in (c) and (d), reflexive *myself* is not grammatical; this is because of lack of agreement in (c), violation of Principle A in (d). However, *me* is acceptable in (e), though presumably it could not be coindexed with *we*. (f) simply provides another grammatical example of this relation. So what seems to be at issue, again, is coreference-under-a-description or some related notion, rather than coreference in the strictest sense.[9]

In this light, consider some of the problems raised by Evans (1980). One type of example shows that non-coreference must be defined with respect to speakers' intentions. Among these are cases of mistaken identity, as in the utterance of (25) where the speaker does not recognize that the man in the sunglasses is in fact Lou:

---

[8]Except in certain hillbilly dialects, where *him* is acceptable in (b).

[9]Consider Chomsky's related example, (LGB, 5.1, 1.ii)):

(i) * We lost my way.

The problem in this example seems to lie in the sense of the idiomatic expression. It's a little like saying "I kept his shirt on" in the non-literal sense — we can no more lose someone else's orientation than force them to be patient. Compare the acceptable (ii):

(ii) We lost my watch/my dog.

(25) That man in the sunglasses resembles Lou.

This seems to have the same flavor as the example in (20); for the speaker, the two terms are not coreferential.

Another type of apparent counterexample to Principle C is exemplified in the sentences in (3):

(3) (a) Only Reagan voted for himself.

(b) Only Reagan voted for Reagan.

Here it is less plausible to claim that there is some sense in which the speaker intends two different referents for the two tokens of the name *Reagan* in (3b). Chomsky (LGB p.227, fn.27) responds to this second type of case by claiming that "Principle (C) may be overridden by some condition on discourse, not a very startling fact," and suggest the following principles:

(26) Avoid repetition of R-expressions, except when conditions warrant.

(27) When conditions warrant, repeat.

Note that (26) is independently required to account for the oddness of (28), an example pointed out by Reinhart (1983):

(28) The flowers that we bought for <u>Zelda</u> pleased <u>Zelda</u>.

Since the first instance of *Zelda* does not c-command the second, then even if they are coindexed, the second is free. (Note that either instance may be replaced by *her*, but that *herself* is infelicitous.) Hence, Principle C does not rule out this type of example, as it would (29):

(29) Zelda liked the flowers that we bought for Zelda.

(26) seems in fact to cover all the cases ruled out by Principle C, with the exception of the crossover cases. This makes the principle look suspiciously redundant.

It has been suggested by some (see, for example, discussion in Lasnik (1980)), that this and other problem cases point to the superiority of the "On Binding" (Chomsky (1980a)) system of binding, where a given NP has both a referential index and one or more anaphoric indices. Lasnik's (1980) example in (30) shows that plural pronouns with split antecedents pose a problem for the LGB Binding Theory, since coindexing they with either *John* or *Bill* would seem to exclude the other as a "partial" antecedent, yet coindexing it with neither would seem to exclude both:

(30) John_1 told Bill_2 that $\text{they}_?$ should leave.

Lasnik points out that in the "On Binding" framework, if we consider two NPs which have neither referential nor anaphoric indices in common to be referentially free, so that they may either corefer or not, then assigning a distinct index to *they*, say *3*, leaves it free to be coreferential with the two proper names as a set. But similar problems occur with conjoined NP antecedents, as illustrated in Seely's (1), and here Lasnik's solution seems inadequate:

(1) Alan and Margaret ate their dinner.

In (1), not only is there the issue of how *they* can at once refer to both *Alan* and *Margaret*, with their different indices, but of how to avoid claiming that *Alan* and *Margaret* are disjoint in reference from the NP which includes them. Surely we would not want to claim simply that the conjoined NP is free in reference and just happens to be coreferential with the set of NPs which it contains.

A different sort of problem is raised by what Saxon (1984) calls disjoint anaphors. She describes such pronouns in Dogrib, an Athapaskan language of northern Canada. These apparently have the same distribution as reflexives, and hence would seem to fall under Principle A of the Binding Theory, but a disjoint anaphor is to be interpreted as having any referent other than the NP to which it is bound. If English was like Dogrib, we might have such a pronoun, call it *herother*. Then *Mary likes herother* would be grammatical, with *herother* bound by *Mary* and meaning 'Mary likes some other person we've already mentioned.' The sentence * *Herother likes Mary* would be ungrammatical because the pronoun is not bound in its governing category. This is obviously a problem for the assumption that bound NPs are coreferential.

I note that Higginbotham's (1983) Linking framework provides a solution for the problems with split antecedents and conjoined NP antecedents, since a pronoun (or the conjoined NP) may be referentially dependent on (linked to) more than one NP. However, Higginbotham still has problems with the McCawley/Evans cases, with the disjoint anaphors, and with the sloppy identity cases we will discuss in the following section, as well as leaving unresolved the question of the relationship between referential dependence and coreference.

2.1.3 Reinhart's proposal

Here we will briefly consider Reinhart's paper "Coreference and bound anaphora" (1983). She proposes a radical revision of the Binding Theory. Instead of freely indexing structures which are then filtered by Principles A, B and C, she restricts the assignment of indices to pairs of an NP and a pronoun which satisfy the requirements on *bound anaphora.* She defines this term as follows: "I will use the term *bound anaphora* for all and only the cases where the pronoun is interpreted as a bound variable." Bound variables are interpreted in her system via lambda abstraction, so that a coindexed NP and pronoun will end up as variables bound by the same lambda operator. Her indexing procedure is as follows:[10]

(31) **(Optional)**

Coindex a pronoun P with a c-commanding NP α (α not immediately dominated by COMP or S').

Conditions:

(a) If P is an R-pronoun, α must be in its minimal governing category.

(b) If P is a non-R-pronoun, α must be outside its minimal governing category.

Since coindexation is restricted here to only one kind of anaphora, it is not a precondition for coreference. The procedure permits a derivation of examples where

[10]The requirement that α not be immediately dominated by COMP or S' is intended as equivalent to the requirement that it be in an A-position. *Minimal governing category* essentially equals *governing category* ((5) above). She uses the term *R-Pronoun* where I use *A-Pronoun* to refer to reflexives and reciprocals.

antecedents c-command anaphors, but rules out weak crossover cases like (32) automatically because the c-command condition is not met:

(32) * <u>His</u> mother loves <u>everyone</u>.

Since the only way a quantifier and a pronoun can be "coreferential" is via bound anaphora, there is no derivation for the intended reading.

One of the primary advantages of this proposal is that it can handle sloppy identity examples like (2):

(2) Mary thought she had the mumps and Alice did too.

On the sloppy, or bound variable reading, *she* is coindexed with *Mary*. The translated first conjunct then contains the lambda expression shown in (33). The lambda predicate is copied onto the second conjunct, and there *Alice* provides the value of the variable after lambda-conversion:

(33) Mary (λx(x thinks that x has the mumps)) &
Alice (λx(x thinks that x has the mumps))

Reinhart claims that disjoint reference has not a syntactic but a pragmatic basis. She points out (following others, e.g. Postal (1969)) that the disjoint reference environments, both for pronouns and for full NPs, closely mirror the environments where bound anaphora is possible. So, where a speaker may use an A-pronoun as a bound anaphor, she may not in general use a B-pronoun to refer to the same entity. And more generally, where she may use a pronoun to indicate bound anaphora, she may not use a full NP, which does not permit that interpretation, unless she has a reason to avoid a pronoun. This account of disjoint reference based on pragmatic principles has a major advantage over the syntactic accounts, in that cases such as Evans' (3), repeated here, fit in naturally:

(3) (a) Only Reagan voted for himself.

(b) Only Reagan voted for Reagan.

In (3b) there is reason to avoid bound anaphora, since the semantics of expressions containing *only* give different truth conditions in the bound and non-bound versions (a) and (b). Thus, the pragmatic disjoint reference strategy is overridden.

Reinhart's important contribution towards our understanding of anaphora lies in clearly distinguishing bound anaphora from other kinds of coreference. However, there are problems which remain unresolved here.

The first is that Reinhart does not address the "reconstruction" problems, i.e. the cases involving *wh*-movement and topicalization discussed in 2.1.1. Neither does she address the question of how to treat cases like *I like me*, where two NPs which are apparently coreferential can yet not be coindexed. As we saw in Section 2.1.2, a wide range of interpretative problems seem to be related to this question. She claims that the cases of mistaken identity fall together with the McCawley/Evans cases as exceptions to the pragmatic disjoint reference strategy, but there seems to be a missing generalization here.

Another problem for Reinhart relates to the pragmatic disjoint reference strategy, as Edwin Williams (p.c.) pointed out to me. This is that it fails to predict a difference in the weak and strong crossover examples in (34a,b):

(34) (a) His mother loves Steve.

(b) * He loves Steve.

Both constructions permit bound anaphora, as in (35) and (36):

(35) Everyone's mother loves him.

(36) Everyone loves himself.

and hence under Reinhart's proposal we would expect that (34a) would be as unacceptable as (34b). I will discuss these examples further in Section 2.2.3 below.

(35) illustrates another important problem with this approach, based on c-command at SS, the treatment of constructions where the relation between a subject-internal possessive NP and a direct object is at issue. In this example, the direct object pronoun may be interpreted by most speakers as a variable bound by the quantifier *everyone*, but there is no c-command relation between them, and hence they cannot be coindexed by (31). This type of case and related examples involving inverse linking have been taken as evidence that the Binding Theory applies at LF (cf. especially May (1977,1985). I will consider the problem of inverse linking and possessive NPs at some length in Chapter 4.

2.2 An alternative proposal

The point of departure for the proposal I will present here is the idea that pronominal elements do not have the same referential potential as full NPs. Pronominals are always referentially dependent. In this respect they are analogous to variables in the predicate calculus: they must be bound by some antecedent term in order for the utterance in which they occur to be interpreted.

But binding in natural language is a richer system than that in the predicate calculus. First, there are two kinds of structures which permit binding between an NP and a pronoun. One is established solely intrasententially, making reference in a configurational language like English to the relation of c-command. I will call binding licensed by these structural relations *c-command binding.* The other kind of structure is the hierarchical discourse structure we considered in Chapter 1, where the possibility of anaphoric relations is dependent upon the relation of accessibility. Such structures license *discourse binding.* It is important to note that c-command binding and discourse binding are not in complementary distribution: discourse binding may take place in structures where c-command binding is also permissible. We will see this in the treatment of the Reinhart examples where both sloppy and non-sloppy readings are possible.

The other central difference between binding in the predicate calculus and in natural language is that in the latter we have more than one kind of individual variable, each with different requirements on the structures in which it can be bound. English A-pronouns, like the disjoint anaphors of Dogrib, must be c-command bound in their governing category, while B-pronouns may either be c-command bound outside their governing category or discourse bound.[11] English thus seems to display a clear complementary distribution. Generally, in a given structure either an A or a B pronoun may be bound, but not both.[12] Binding A-pronouns is stronger from

[11] Again, I follow Heim (1982) in considering deictic pronouns to be discourse bound.

[12] Actually, even the English data are not so clearcut as the Binding Theory would lead us to believe. First, there are a few constructions where the complementarity does not hold. Thus, in (i), the choice of pronoun doesn't make any apparent difference in grammaticality or sense:

a communicative point of view, since there is in general relatively little confusion about their antecedents, whereas a B-pronoun often gives rise to ambiguities. This, as we shall see, is one of the sources of the apparently non-unitary character of disjoint reference.

Given this general characterization of binding in natural language, we need a formal means of encoding each of the two kinds of binding relations. Both are ready to hand: we will use indices as diacritics marking the c-command binding relation, dissociating them from any direct or uniform interpretation. These in turn will serve as guides in a mapping from the indexed S-Structure to a Discourse Representation

(i) John pulled the blanket over him/himself.

In other cases, however, although either an A or a B-pronoun is grammatical, the choice makes a subtle difference in meaning. Consider:

(ii) John saw those pictures of him yesterday.

(iii) John saw those pictures of himself yesterday.

(ii) seems to reflect the speaker's point of view of the pictures, while (iii) reflects John's. This observation seems to be verified by the contrast between (ii) – (iii) and (iv) – (v), where only the verb has been changed:

(iv) ? John took those pictures of him yesterday.

(v) John took those pictures of himself yesterday.

Here, it seems that the speaker's point of view is somehow less felicitous. Further, consider the case of (vi) – (vii), where the Binding Theory would also lead us to expect only an A-pronoun:

(vi) Al saw a vicious leopard near her.

(vii) ? Al saw a vicious leopard near herself.

I think these facts may be related to a deeper reason for the distinction between the two types of pronouns, but I will not speculate further here. For discussion of the notion of "point of view," see Mitchell (1986).

In addition, see Sells, Zaenen & Zec (1985) and Sells (1985b) for extended discussion of reflexive constructions in a variety of languages. This work indicates that the principles of the binding theory are not adequate for a universal characterization of pronominal relations.

(DR). Discourse binding will be represented in terms of the equation of the discourse referent for a free B-pronoun with another discourse referent which is accessible to it in the DR.

In order to make this discussion more concrete, let us consider a tentative indexing structure. The rule *move* α, as in Chomsky (1981), leaves the moved element and its trace coindexed.[13] Then at S-Structure, a top-down procedure assigns an index to any NP which does not have one already. Generally, indices are assigned from an ordered set of the natural numbers, and each NP receives a new index (whether assigned through *wh*-movement or the subsequent general indexing procedure). The important exceptions will be cases where a pronoun may be coindexed with a c-commanding NP in an A-position.

We might characterize the environments where coindexation is possible as follows, defined only over A-positions at SS:

(37) Coindex a pronoun α with an NP β such that β c-commands α.

Conditions:

(a) If α is an A-pronoun, β must be in its governing category.

(b) If α is a B-pronoun, β must be outside its governing category.

(Optional)

[13]In the system I am proposing here, there is a problem with the treatment of parasitic gaps. I assume that these must be coindexed, but that *wh*-movement may only leave one trace. Further, by definition there is no c-command relation between the *wh*-trace and parasitic gap, hence they could not be coindexed by the procedure I suggest. In this connection, Kayne's (1983) suggestion that parasitic gaps and *wh*-traces more generally are licensed by his connectedness principle becomes attractive. In fact, Longobardi (1985) has suggested that connectedness supercede c-command as the basis for anaphora.

Unlike Reinhart's proposal, coindexed NPs are not necessarily treated as variables bound by the same operator. In the mapping from SS to DR, an NP indexed i will generally be assigned a discourse referent x with the same index i. The exception is the case where a pronoun is coindexed with a c-commanding NP. Then, whether the two receive the same discourse referent, as in the case of English A- or B-pronouns and their c-commanding antecedents, or a different one, as would be the case with Dogrib disjoint anaphors, depends on the lexical content of the coindexed NPs. Any pronoun which is not c-command bound, and hence coindexed with an antecedent, must find a discourse antecedent, that is, a discourse referent which is accessible to it in the DR. We'll see examples of this below.

We may now reexamine some of the interpretative problems we discussed in Section 2.1.2 in the light of this new proposal.

As already suggested, the problem with Dogrib is no longer a problem when coindexation merely serves as a diacritic for binding at SS. The disjoint anaphors must be coindexed with a c-commanding NP in their governing category, just like English A-pronouns. But in the mapping from SS to DR their lexical content, perhaps in the form of a feature [+disjoint] or the like, induces us to choose any accessible antecedent except the NP with which they are coindexed.

In the sloppy identity cases, we may achieve the same results that Reinhart achieved with her distinction between the bound anaphora (sloppy) reading and the stipulated coreference (non-sloppy) reading with the distinction between a reading where the pronoun *she* in the first conjunct of (2) is c-command bound by *Mary* and one where *she* is discourse bound by *Mary*. We construct DRs for the two readings as follows:

The mapping to a DR is a top-down procedure reducing the original sentence to a structure with a discourse referent for each term and predicates over the discourse referents. We begin with the indexed SS in (38) and develop the DR in (39) in steps.

(38) Mary$_1$ thinks she$_1$ has the mumps and Alice$_2$ does too.
(sloppy reading)

(39)

(a) x_1	(e) x_2
(b)	Mary(x_1)
(c)	x_1 thinks she$_1$ has the mumps
(d)	x_1 thinks x_1 has the mumps
(f)	Alice(x_2)
(g)	x_2 thinks x_2 has the mumps

First, in step (a), we introduce a discourse referent in the DR for the subject of the first conjunct, placing on it the condition that it be Mary in any possible interpretation (b). The original sentence then becomes a condition on that discourse referent, (c). Then we reduce the condition further by finding a discourse referent for the pronoun *she*. But *she* is already indexed *1*, and hence already has a discourse referent, x_1. We reduce the condition accordingly in (d). We now reduce the second conjunct, first introducing the discourse referent x_2 for the subject *Alice* in (e) and putting the condition (f) on x_2. Since there is no VP, or predicate, on that subject, in (g) we borrow one from the preceding conjunct, replacing all instances of x_1, the discourse referent for *Mary*, by x_2, the discourse referent for *Alice*. This DR will have an interpretation along the lines of 'Mary is an x such that x thinks x has the mumps, and Alice is an x such that x thinks x has the mumps.'

In constructing a DR for the nonsloppy reading in (41), however, we begin from the SS in (40), where *Mary* and *she* are not coindexed.

(40) Mary$_1$ thinks she$_2$ has the mumps and Alice$_3$ does too.

(41)

	(a) x_1 (d) x_2 (g) x_3
(b)	Mary(x_1)
(c)	x_1 thinks she$_2$ has the mumps
(e)	x_1 thinks x_2 has the mumps
(f)	$x_2 = x_1$
(h)	Alice(x_3)
(i)	x_3 thinks x_2 has the mumps

When we reach the stage in the construction where we need to reduce the VP containing *she*, after step (c), we introduce a new discourse referent for the pronoun (d), since there is no discourse referent x_2 already in the discourse. But since *she* is a pronoun, it must be bound. We do this by equating the discourse referent x_2 with another, accessible discourse referent. The discourse referent for *Mary*, x_1, is one possible antecedent, so we equate them (f) (though, of course, there might be other readings where *she* refers to an even earlier discourse referent). In a model theoretic interpretation, the equation assures that the two terms will be coreferential. In steps (g) – (i) we treat the second conjunct as before, replacing all instances of x_1 by x_3. But the result here differs from that in (39) because x_2 is already bound to the discourse referent for *Mary*, and so we get the reading where Alice thinks that Mary has the mumps.

I said above that coindexation would not be uniformly interpreted in this approach. It now no longer means coreference, but only indicates that a pronoun is c-command bound by an NP. Notice that non-coindexation does not mean disjoint reference, either. In the case of plural pronouns with split NP antecedents, we may assign distinct indices to the individual NPs involved, then permit the discourse referent for a plural pronoun to be equated with a set of indices of other accessible discourse referents, in the spirit of Lasnik's proposal. (42) is an indexed SS for (30) above, while a partial DR is shown in (43):

(42) John$_1$ told Bill$_2$ that they$_3$ should leave.

(43)

x_1 x_2 x_3
John(x_1)
Bill(x_2)
$x_3 = \{x_1, x_2\}$

Consider again example (1), repeated here with indices:

(1) [Alan$_1$ and Margaret$_2$]$_3$ ate [their$_3$ dinner]$_4$.

Apart from the question of how to distinguish between the so-called group and distributive readings of such examples, which I will consider in detail in Chapter 3, on the approach I am sketching here there is no problem with the anaphoric relations indicated. Even though *Alan* and *Margaret* are not coindexed with the NP which contains them, this does not mean they are disjoint from it in reference. Non-coindexation does not imply non-coreference. Rather, the discourse referents for the proper names will stand in a constitution relation to the discourse referent for the whole subject NP, as shown in the DR in (44):[14]

(44)

$$\boxed{\begin{array}{c} x_1 \quad x_2 \quad x_3 \quad x_4 \\ \text{Alan}(x_1) \\ \text{Margaret}(x_2) \\ x_3 = \{x_1, x_2\} \\ x_3\text{'s dinner}(x_4) \\ x_3 \text{ ate } x_4 \end{array}}$$

Each of the proper names, as well as the full subject, induces the introduction of a discourse referent, and the condition on the discourse referent for the full subject x_3 specifies that its reference is the set of the entities referred to by the conjuncts. The plural pronoun *their*, coindexed with the full subject, then automatically receives the same discourse referent, and the truth conditions amount to 'the set consisting of Alan and Margaret ate its dinner.'

This approach to anaphora provides a means of expressing more precisely the fact that in interpreting anaphoric coreference what seems to be at issue is not coreference in the strictest sense, but something vaguely like coreference-under-a-description. It is not having the same or a different referent in the world which is at issue. Instead, the indices on two given NPs indirectly indicate whether they have the same or different discourse referents. Much here depends on the speaker's intentions. In explaining the Jesus example, (20), and example (23), *We like me*, we need only note that there is no requirement that distinct or non-overlapping discourse referents map onto distinct or nonoverlapping referents in a model. Thus *I* and *me*, *we* and *me* can have distinct indices at SS, and be mapped onto distinct discourse

[14]See Chapter 5 for a different way of representing conjoined subjects in DRs.

referents, but still be mapped onto the same referent or overlapping referents in the model into which the DR is embedded (in this case the mapping onto referents will be in virtue of the lexical content of these indexical pronouns). Similarly, in mistaken identity cases such as (25), *The man in the sunglasses resembles Lou*, two NPs may be indexed differently and have different discourse referents because the speaker does not know they actually refer to the same individual in the world.

Having sketched the basic properties of my proposal, now I will turn to consider how it might be extended to deal with three of the major issues in the theory of anaphora, reconstruction, disjoint reference, and crossover.

2.2.1 Reconstruction

We saw in Section 2.1.1 how the problem of where to apply the Binding Theory revolved around examples which seemed to require reconstruction or something like it. To summarize the problem, the example in (12), repeated below, shows that in some cases reconstruction of a moved element into its base-generated position seems necessary to account for the use of an A-pronoun. But (16b) shows that in other instances reconstruction would give infelicitous results from the point of view of Principle C. And Pesetsky's example (18a) is a case where reconstruction is both obligatory, for the binding of *himself* by *John*, and infelicitous, since then *she* would c-command *Mary*. We need to have our cake and eat it.

(12) Which picture of himself$_i$ does John$_i$ like

(16) (b) Which picture of John$_i$ does he$_i$ like

(18) (a) [Which picture of himself$_i$ that Mary$_j$ likes]$_k$ will John$_i$ give her$_j$ t_k

The crucial factor in these cases is the relation between the preposed element and its trace in the matrix clause. I propose that we use this relation without actual reconstruction. First we redefine the coindexing procedure originally given in (37):

(45) Coindex a pronoun α with an NP β such that β c-commands a node γ which contains α.

Conditions:

(a) If α is an A-pronoun, β must be in its governing category.

(b) If α is a B-pronoun, β must be outside its governing category.

Then we define *contains* as follows:[15]

(46) A node γ contains a node α *iff*

(a) γ dominates α, or

(b) γ dominates the case-marked trace of some node δ which contains α.

These definitions permit the indexing procedure to optionally treat preposed NPs as if they were reconstructed. In (12), we see that the VP node of the matrix contains *himself* via the trace of the preposed *wh*-element. Note that the definition

[15] In this definition, the specification that the trace be case-marked is designed to avoid reconstructing NP-movement cases.

of governing category given by Chomsky in LGB ((5), above) already includes the term *contain*, so in each of the cases under consideration, the governing category for *himself* is the matrix sentence. Hence, condition (a) of the coindexing procedure (45) is satisfied.

Now consider (16b). If we attempt to coindex *John* with *he*, we will fail because although *he* c-commands *John*, *John* is not a pronoun, and *John* does not c-command *he*. How then can the two NPs be coreferential? Via discourse binding. In order to see how this works, let us construct DRs for the topicalized counterparts of (12) and (16b).[16]

A preposed element is the first entered in a DR. In the case of the topicalized counterpart of (12), (47), this element contains an A-pronoun, and the mapping procedure recognizes that this must be coindexed with another NP in its governing category. Let us assume as a matter of technical implementation that the discourse referent of an A-pronoun is initially marked with a $\star$. Then, when and if another NP with that same discourse referent is located, the $\star$ is deleted throughout. For (47), we begin with the partial DR (48), ignoring the demonstrative as irrelevant to the point at hand:

(47) [That picture of himself$_1$]$_2$ John$_1$ likes t_2

(48)

x_2 $\quad$ $x_1\star$
picture of $x_1\star$ (x_2)

[16] The *wh*-examples are somewhat more complex for reasons that are irrelevant here, but would work along the same lines.

When we process the matrix sentence, the trace t_2 will also be assigned the discourse referent x_2, automatically "replacing" the preposed direct object in its argument position. The entry of a discourse referent for *John*$_1$ will then cause the removal of the $\star$ from the reflexive's discourse referent:

(49)

$$\boxed{\begin{array}{c} x_2 \quad x_1 \\ \text{picture of } x_1\ (x_2) \\ \text{John}(x_1) \\ x_1 \text{ likes } x_2 \end{array}}$$

In the case of (50), no coindexation has taken place:

(50) [that picture of John$_1$]$_2$ he$_3$ likes t_2

But we may still discourse bind *he* to *John* if the latter is accessible to the former. The discourse referents for the preposed NP and *John* are entered first. The DR after entry of the topicalized NP is shown in (51):

(51)

$$\boxed{\begin{array}{c} x_2 \quad x_1 \\ \text{picture of } x_1\ (x_2) \\ \text{John}(x_1) \end{array}}$$

x_1 is then accessible to the discourse referent for he$_3$, so they may be equated, and the resulting DR is shown in (52):

(52)

$$\boxed{\begin{array}{c} x_2 \quad x_1 \quad x_3 \\ \text{picture of } x_1\ (x_2) \\ \text{John}(x_1) \\ x_3 = x_1 \\ x_3 \text{ likes } x_2 \end{array}}$$

In any model in which (52) may be embedded, *John* and *he* will be coreferential, since their discourse referents are equated.

2.2.2 Disjoint reference

Now let us consider how to handle the disjoint reference problem illustrated by the examples in (53):

(53) **Disjoint Reference Cases:**

(a) * Zelda saw Zelda.

(b) * Zelda saw her.

(c) ? The flowers in Zelda's apartment pleased Zelda.

(a) violates Principle C of the Binding Theory, since *Zelda*, an R-expression, is not free. In (b) a B-pronoun is coreferential with an NP in its governing category, violating Principle B. (c), where repetition of a proper name seems less than perfectly felicitous even though it doesn't violate Principle C, is the type of case for which Chomsky proposed his pragmatic principle (26).

I will adopt Reinhart's general pragmatic approach to the disjoint reference problem, but note that with the distinctions I have drawn among types of binding and types of pronouns, we can develop a finer scale of binding strength than was possible in her treatment. In (54) is a list of the three pragmatic grades of binding, distinguished by the degree of ambiguity they permit:

(54) **Three Pragmatic Grades of Binding:**

(a) c-command binding of A-pronouns

ex: Zelda saw herself.

(b) c-command binding of B-pronouns

ex: Zelda thought she saw a mouse.

(c) discourse binding (of B-pronouns only)

ex: Annie told us about the surprise party.

The flowers in Zelda's room pleased her.

C-command binding of A-pronouns is the strongest, since it is least likely to be ambiguous. With c-command binding of B-pronouns we are less sure of what binds the pronoun; consider the example in (b) in a context following *The cat crept silently toward the barn*, where *she* might be taken to be discourse bound by *the cat* instead of c-command bound by *Zelda*. And discourse binding is notoriously full of potential for ambiguity, as in the illustration in (c), where *her* can easily refer to either *Annie* or *Zelda*.

One can define the binding potential of two positions in a given syntactic structure as the strongest kind of binding permitted there. Observance of the Gricean cooperative principle in conversation (Grice (1967)) leads one to use the strongest means he has to make the identity of referents unambiguous. I offer, then, a slight revision of Reinhart's pragmatic approach to disjoint reference:

(55) **Pragmatic Disjoint Reference Strategy:**

(a) *Speaker's Strategy*: Use the strongest binding potential of the structure you are using, unless you have reason to avoid binding.

(b) *Hearer's Strategy*: If the speaker doesn't take advantage of the strongest binding potential of the structure she is using, then, unless she has reasons to avoid binding, she doesn't intend her expressions to corefer.

As in Reinhart's original proposal, these pragmatic strategies contain an *unless* clause which accounts for the acceptability of examples such as (3b), despite their apparent violation of disjoint reference. Further, in this version of the pragmatic account, we might expect that the stronger the binding potential of a given structure, i.e. the greater the opportunity to avoid ambiguity, the more difficult it is to avoid binding without leading the hearer to assume disjoint reference, in line with the Strategy. We see this in the differential acceptability of (53a) and (53c). We may also use this to provide an account of the differential acceptability of (34a) and (b), an account which we noted that Reinhart's original proposal did not offer:

(34) (a) <u>His</u> mother loves <u>Steve</u>.

(b) * <u>He</u> loves <u>Steve</u>.

The structural relation between the pronoun and NP in (b) has the strongest binding potential, since c-command binding of an A-pronoun would be possible here, as in *Steve loves himself.* Hence it is a strong violation of (55). But, however we account for the possibility of anaphora in (a), c-command binding of an A-pronoun in this example is not possible (* *John's mother loves himself*), so no violation of (55) is apparent. However, note that the indexing procedure in (45) would not coindex *his* and *Steve* in this example. This leads us to discussion of the crossover problem.

First, however, I want to point out a problem with this approach to disjoint reference. In the preposed NP examples, we encounter cases like:

(56) Which picture of <u>John</u> does <u>he</u> like *t*

(57) Which picture of <u>himself</u> does <u>John</u> like *t*

The problem here is that we know that c-command binding of A-pronouns is possible between the positions indicated, as in (57). But given that the strongest binding potential of this structure is realized in (57), why isn't that sentence preferable to the one in (56), where we see only discourse binding? I believe that there may be discourse constraints on the types of binding available in such examples. This may be related to Lakoff's examples where it is claimed that for some speakers "backwards" anaphora is preferable to "forwards":[17]

(58) ? In <u>John</u>'s room <u>he</u> smokes pot.

[17] I am not able to find a reference for this contrast, although Stockwell et al. (1973, p.196) cite Lakoff (1968) on the related problem of the differential acceptability of (i) and (ii):

(i) Near <u>him</u>, <u>John</u> saw a snake.
(ii) ? Near <u>John</u>, <u>he</u> saw a snake.

I am also able to imagine appropriate discourse contexts for (ii), but as with (58), it seems far less felicitous out-of-the-blue than (i) and seems to require a contrast between John and other salient referents.

(59) In his room John smokes pot.

However, it seems to me that (58) is perfectly felicitous in an appropriate context. Consider the following, for example:

(60) I spoke yesterday with several students who have been flagrantly violating the dormitory regulations. In Mary's room there is a large refrigerator and a hot plate. *In John's room he smokes pot.* Steven ...

It would seem inappropriate in light of (60) to characterize (58) as ungrammatical. Rather, it seems that the problem here is one of how to characterize the contexts where such a sentence is felicitous and to explain why one is less likely to utter it out of the blue than (59).

2.2.3 Crossover

Consider the classic crossover cases in (61) and (62):

(61) (a) * who$_i$ does he like t_i

(b) * he likes everyone

(c) * he likes Jóhn

(d) * he líkes John

(e) he likes JOHN

(62) (a) * <u>who</u>$_i$ does <u>his</u> mother like t_i

(b) * <u>his</u> mother likes <u>everyone</u>

(c) * <u>his</u> mother likes <u>Jóhn</u>

(d) <u>his</u> mother líkes <u>John</u>

(e) <u>his</u> mother likes <u>JOHN</u>

The (a) and (b) examples for both structures are considered totally unacceptable. The reason for this in this framework is twofold. First, neither the trace t_i nor the *wh*-element which binds it, nor the quantifier *everyone* is a pronoun. Hence *they* cannot be coindexed with the c-commanding NP by the indexing procedure (45). Second, discourse anaphora is impossible because *who* and *everyone* do not actually refer, as does, e.g. a proper name, and hence it is not possible that they refer to something already salient in the discussion which might then be accessible to *he*.

Now consider the cases with proper names in (c), (d) and (e). (61c), with non-contrastive stress on *John* is just plain bad. *He* and *John* cannot be coindexed in this or any of the remaining cases, since *John* is not a pronoun. We get the same unacceptable result in the weak crossover case in (62c), as noted by Chomsky.[18] But the differential binding potential of the two structures explains the difference between the unacceptable (61d) and the acceptable (62d). In these cases, it is not that *likes* is focused. Rather, John being already salient in the discourse, the proper name *John* is unstressed, like a pronoun, and *likes* receives default stress.[19] Hence, though *he* and *John* can't be coindexed, the discourse referent for *he* in (62d) can

[18]Chomsky (1976,1980b) discusses this fact about the weak crossover cases and compares it with the acceptability of examples like (62d). His analysis, however, is very different.

[19]See Ladd (1980) for discussion of this phenomenon, wherein a pronoun or NP which would normally receive nuclear stress is unstressed (Ladd's "destressed") because it is old information, and the nuclear stress moves onto the constituent immediately to its left.

be equated with that of the previous occurrence of *John.* Though this suffices to overcome the disjoint reference strategy in the weak crossover construction, it does not in the stronger case of (61d). It is only contrastive stress, requiring a particular type of preceding discourse,[20] which overcomes the disjoint reference strategy in the strong crossover case (61e), as well as in the weak (62e). These are the types of cases Evans discussed. An appropriate discourse might be as in (63):

(63) *Speaker A*: John doesn't like anyone.
He doesn't like Al.
He doesn't like Sam.
He doesn't like Ginger.

Speaker B: But he likes JOHN.

In the DR constructed for this discourse, successive occurrences of *he* are given individual discourse referents, each of which is equated with that for the first occurrence of *John.* The final, contrastive occurrence of *John* receives a different index from that of the first occurrence and the pronouns. The two tokens of the proper name are coreferential not by virtue of anaphoric relations, but of their inherent direct reference to the individual John. The parallelism of the structures and the related strength of the contrastive focus overcomes the disjoint reference strategy which would otherwise indicate that *he* and *John* were disjoint in reference in B's utterance.

[20]By 'contrastive stress,' I mean functionally contrastive, in the spirit of Culicover & Rochemont (1983). The phonological distinction between (c) and (e) is one of pitch accents (see Pierrehumbert (1980)), not one of degree of stress. (c), for example, might end with a falling boundary tone, (e) with a rising.

Hence we see that this proposal is able to explain the facts about focus and crossover in an integral way, while the LGB Binding Theory must regard them as anomalous.

2.3 Indirect binding

Here, I will discuss in detail Haïk's (1984) proposals about the binding theory. She also argues that it should apply at S-Structure, and proposes as well that the indication of the relative scopes of quantified NPs should be represented at SS as well. She also extends the Binding Theory by means of what she calls *indirect binding* to account for some of the donkey sentences of Geach (1962), and cases of backwards bound anaphora and the Bach–Peters sentences. Although Haïk contributes to our appreciation of how surface structure may constrain the possibilities of discourse anaphora, I will argue that the proposal in Section 2.2 is superior to hers.

Haïk proposes a complex system of indices which serve both to indicate anaphoric binding and the relative scope of quantified expressions. The principal mechanisms which she develops are given in (64)–(67):

(64) SCOPE INDEXING

(a) If NP_i is to be interpreted as in the scope of NP_j, then append $/j$ to the index of NP_i; that is, a structure containing $NP_{i/j}$ is unambiguously interpreted with NP_i as in the scope of NP_j. i/j is a referential index.

(b) Scope is transitive; therefore, if NP_i is construed as in the scope of NP_j ($NP_{i/j}$) and NP_j is in the scope of NP_k ($NP_{j/k}$), then $NP_{i/j/k}$.

(65) Scope Indexing applies freely when NPs belong to the same minimal S. Otherwise, to obtain $NP_{2/1}$, NP_1 must c-command NP_2.[21]

(66) **INDIRECT BINDING**

$NP_i \rightarrow NP_{i(j)}$ iff NP_i has scope over NP_j.

(67) **CONDITION ON VARIABLES**

(a) Pro_i must be c-commanded by NP_i, if NP_i is an inherent quantifier.

(b) $Pro_{i/j}$ must be c-commanded either by $NP_{i/j}$ or by $NP_j(i)$ *(Indirect Binding)*.[22]

By (64), the scope of an NP relative to other NPs is given by the use of slash indices, subject to the constraints in (65). Consider one of her examples:

(68) (a) Two men_i wrote to a $\text{woman}_{j/i}$.

Here, *a woman* in (a) has narrow scope with respect to *two men.* The pronoun *she* in (b) cannot be coindexed j/i with *a woman* because the condition on variables,

[21]She adds (p.198), "In general, only A-positions are visible for scope indexing and binding ... Thus, the rule of Scope Indexing takes into account not the wh-word, but its trace."

[22]This version of the Condition on Variables, her (61), p.203, is later superceded by her (84), p.211, given in (67′) below:

(67′) **CONDITION ON VARIABLES**

(a) X binds Y (directly or indirectly) only if X c-commands Y at S-Structure.

(b) $Pro_{i/j}$ is licit if c-commanded by $NP_{i/j}$.

In this version, (67a) and the indirect binding disjunct of (67b) are combined into (67′a), and the remainder of (67b) becomes (67′b). I have used the earlier version (006) for expositional clarity.

(67b) requires that a pronoun with slash indices be c-commanded by its antecedent, that is, in our terms, that it be c-command bound.

Haïk accounts for universal donkey sentences by indexing them as follows:

(69) $[_{NP-1(2)}$ every farmer [who$[_S$ $t_{1(2)}$ owns

$[_{NP-2/1}$ a donkey]]]] beats $it_{2/1}$

The NP *a donkey* is first indexed 2, the subject trace in the relative clause 1. The trace takes wide scope over *the donkey*, so that the index of the latter becomes 2/1 by (64a), and the index of the former becomes 1(2) by (66). She assumes that the subject NP1 automatically receives the same index as the trace of its relative clause, so that *every farmer who owns a donkey* is indexed 1(2). The subject c-commands the pronoun *it*, and hence, by (67b), the pronoun may receive the index of *a donkey*, 2/1.

Haïk accounts for weak crossover by requiring that it is not wh-moved elements themselves, but their traces in A-Positions which count for the binding theory. Although she doesn't consider the contrast between the cases which violate weak crossover, such as *his mother loves everyone*, and cases such as *his mother loves John*, her treatment of weak crossover bears some resemblance to my proposal in Section 2.2 and could easily be extended along the lines I proposed there to account for cases with pied-piped reflexives, as well.

Haïk can also account for examples containing epithets which refer back to an NP under scope, as in (70):

(70) Some people who own a donkey like the animal.

(70) can be indexed in the same way as (69) without violating Principle C of the

Binding Theory, since *the animal*, an R-Expression, is not c-commanded by its antecedent, *a donkey.* Besides extending the descriptive adequacy of the binding theory, her account of these examples does not require a suprasentential level of representation or intermediate interpretation, unlike Discourse Representation Theory or File Change Semantics, and would thus appear to be simpler than these theories (which can, of course, account for both (69) and (70) — in the latter, the discourse referent for the epithet is simply equated with that for its antecedent in the DR or File, as with definites more generally).

Two other types of examples which Haïk discusses involve subject-object asymmetries. The first of these is illustrated by the contrast between her (71) and (72) (p.206):

(71) [Many people]$_1$ photographed [a car]$_{2/1}$ so that I could advertise it$_{2/1}$

(72) * Many people photographed [every car]$_2$ so that I could advertise it$_2$

In both of these examples, Haïk plausibly takes the *so that* clause to be a sentential adverbial.[23] Assuming it attaches to S, it is thus c-commanded by the subject NP, but not by the object. In (71), with the subject taking wide scope over the object, as indicated by the slash index on the latter, the subject may serve as indirect binder of the pronoun *it* in the rationale clause. But in (72), *every car* has wide scope over the subject, and neither the subject indirectly nor the object directly can bind *it*.

These grammaticality judgments are predicted by Haïk's system, but it is not

[23]Compare infinitival Rationale Clauses (*in order to* ...), which seem to play the same adverbial role semantically. See Jones (1985) for extensive discussion of these. Among other things, these are also sentential adverbials and require control by an agentive subject.

clear that the motivation for the ungrammaticality of (72) is correct. Notice that in similar structures, anaphoric reference to the matrix subject out of this type of adverbial clause is not in general possible where that subject is under the scope of another argument in the matrix clause:

(73) * Four people$_{1/2}$ made a tape in every language$_2$ so I could study their$_{1/2}$ dialects.

(73) is unacceptable with *every language* taking wide scope over *four people* and *their* bound by *four people*. The descriptive generalization seems to be that NPs in the matrix clause are only accessible as antecedents to pronouns in the adverbial clause when the (agentive) matrix subject has wide scope. Thus, it is not clear that these examples argue for Haïk's proposals.

Haïk points out other cases of asymmetry which involve the subject and object of the relative clause in donkey sentences:

(74) [Some people who t_1 kicked a donkey$_{2/1}$]$_{1(2)}$ hated it$_{2/1}$

(75) ?*[Some people who a donkey$_{2/1}$ kicked t_1]$_{1(2)}$ hated it$_{2/1}$

She claims that her theory predicts the difference in acceptability between (74) and (75); however, I cannot see how. In both examples, the trace in the relative clause has wide scope over *a donkey.* The 'backwards scope' we see in (75) should certainly be licit in wh-structures generally. Consider (76):

(76) Who$_1$ does every dog$_{2/1}$ like t_1

The reading indicated, where *who* has wide scope over *every man* and an appropriate answer might be "our mailman," is perfectly felicitous. Here, the indexed structure is parallel to that of the relative clause in (75). Also, in both (74) and (75), the subject, indexed 1(2) by (66), c-commands the object, indexed 2/1, and hence, by (67), the subject should be able to indirectly bind the pronoun.

Haïk points out that the explanation for the unacceptability of (75) cannot be found in the ECP (Empty Category Principle) of Kayne (1981) (presumably under the assumption that the indefinite *a donkey* would undergo QR, leaving a trace in subject position). She offers the following examples as evidence:

(77) Some people who believed that a donkey was waiting in the courtyard called to it through the window.

(78) ??Two donkeys that Mary gave a carrot to ate it.

In (77) *a donkey* is in subject position, as in (75), so if the ECP was responsible for the unacceptability of the latter, we would expect (77), on the reading with *a donkey* narrow under the subject of the relative clause, to be unacceptable as well. However, (77) seems fine on this reading. In (78), the narrow scope indefinite, *a carrot* in this example, is not in subject position, yet the unacceptability seems similar to that of (75). Haïk argues that this is due to lack of c-command of the indefinite by the trace. Note, however, that the indirect object-marking preposition *to* is the sort most plausibly treated as a case marking, rather than a true proposition, so that we might consider the trace to c-command the direct object *a carrot* after all.[24] Thus, although (77) shows that the ECP does not offer an explanation of the problem, (78) shows that c-command may not be the answer either.

[24] See Bach & Partee (1980) for discussion of how such "empty prepositions" argue for a function-argument approach to binding over structural conditions such as c-command.

Steve Berman and Karina Wilkinson (in work reported in Berman (1985)) have suggested a different view of the unacceptability of (75). They propose an account which retains the core of Heim's (1982) account in File Change Semantics, but adds to it an S-Structure constraint in terms of Kayne's (1983) Connectedness. Briefly, this constraint rules out coindexing the indefinite NP and the pronoun unless their g-projection sets form a subtree (in Kayne's (1983) sense of g-projection sets). They show how this accounts for (75) and a variety of other structures. Since something like Connectedness (or Koster's (1985) closely related Global Harmony requirement) does seem to play a role in a variety of types of structures, including also parasitic gaps, this proposal seems plausible.

A final range of examples which Haïk's proposal treats involve backwards bound anaphora. These involve "Jacobson's Sentences" (referring to Jacobson (1979)), as in (79) and (80), and the Bach-Peters (see Bach (1968),(1971)), or Crossing Coreference Sentences, as in (81) and (82):[25]

(79) Everyone$_1$ told [her$_{2/1}$ mother]$_{3/2/1}$ that [his$_1$ wife]$_{2/1}$ should get a job.

(80) * [Her$_{2/1}$ mother]$_{3/2/1}$ told everyone$_1$ that [his$_1$ wife]$_{2/1}$ should get a job.

(81) [The man who kissed her$_{2/1}$]$_{1(2)}$ loved [the woman who wrote to him$_1$]$_{2/1}$

[25]See Jacobson (1979) for extended discussion of these.

(82) [Every pilot who shot at $\text{it}_{2/1}]_{1(2)}$ hit [some MIG that chased $\text{him}_1]_{2/1}$

In (79) *everyone* c-commands, as well as taking wide scope over, both *his wife* and *her mother*. Thus, although *his wife* does not c-command *her* in *her mother*, *everyone* may indirectly bind *her*, so that *his wife* and *her* may be coindexed. But in (80) *everyone* does not c-command *her*, and hence cannot indirectly bind it.

Haïk shows that previous attempts to account for the Crossing Coreference sentences have been inadequate. Jacobson (1979) had argued that the pronoun in the relative clause of the subject of sentences such as (81) is derived by replacement of a full NP, *the woman who wrote to him*, identical to the object which seems to bind the pronoun. However, this approach could not explain examples such as (82), where the pronoun in the first relative clause is coindexed with a quantified direct object; simply replacing the pronoun with a quantified NP identical to the object would not give the same truth conditions as the bound reading. Higginbotham & May (1981) proposed to account for examples such as (82) by means of an operation called *Absorption*, where two quantifiers which have been raised at LF become one binary quantifier, with mutual c-command between the two original quantified NPs. This mutual c-command then permits each NP to bind a pronoun in the relative clause of the other. Haïk argues that Absorption is too powerful an apparatus. She points out that in the Crossing Coreference sentences, the NP which is an "inherent quantifier" generally has to c-command the other NP, as the NP with the determiner *every* c-commands the indefinite in (82). When this is not the case, as in her (83), the example is unacceptable, even though absorption would predict grammaticality:

(83) * [Some child who had heard $\text{it}_{2/1}]_{1(2)}$ believed [every story that was told to $\text{him}_1]_{2/1}$

Haïk's account of the Crossing Coreference Sentences is based on Indirect Binding. In (82), *it* in the relative clause of the subject is indirectly bound by the subject wh-trace and *him* is directly bound by NP_1, which c-commands it. She can also account for the impossibility of the binding relations shown when the object has wide scope under the subject, by the use of a principle which she calls The Extended Name Constraint, extending Gueron's (1981) Name Constraint:

(84) **EXTENDED NAME CONSTRAINT**

If NP_i is not within the scope of NP_j (that is, $\text{NP}_i \neq \text{NP}_{i/j}$), then NP_i must be closed with respect to NP_j; that is, NP_i may not contain a free variable indexed j.

This condition is intended to account for a variety of facts. Among them are that in cases such as (85), the quantified subject NP must have wider scope than an object which contains a pronoun bound by it, and that wh-extraction is not possible from a definite NP, as in (86):

(85) Everyone_i likes some film he_i saw.

(86) * Who_i did you like that picture of t_i

This constraint is plausible; however, note that it is not necessary under a Tarskian semantic interpretation. Under such an interpretation, the pronoun in the wide scope object in (85) would denote whatever was assigned to the i-th variable by the assignment function used in its interpretation. Since the interpretation of the subject ultimately does not rely on the values assigned by that assignment function, but ranges over all assignment functions just like it except for the value assigned to the i-th variable, then the interpretation of the pronoun and that of the quantified subject would be independent. In a discourse theory such as Kamp's or Heim's, one requirement on definite NPs, including pronouns, is that they have an accessible antecedent. Since the subject of (85) would not be accessible to the pronoun in a wide-scope object, the pronoun would be without an antecedent, and the example would be infelicitous.

Polly Jacobson (p.c.) points out an important problem with Haïk's account of crossing coreference examples. Haïk predicts that (87) should be fully acceptable with the coreference indicated, by the same mechanism which coindexes *it* and the direct object in (82):

(87) * Every farmer that owns <u>it</u> beats <u>a donkey</u>.

However, this example cannot be interpreted in this way. (87) shows that the binding of a subject internal pronoun by an object is far more restricted than the binding of an object internal pronoun by the subject. Although Jacobson's (1979) account is, as Haïk claims, inadequate to deal with crossing coreference under quantification, it does treat the two pronouns differently, and thus foreshadows the asymmetry which we see between (69) and (87).

I will not attempt to develop here an account of bound backwards anaphora, or of backwards anaphora more generally. I think the phenomena are complex. Peter Sells (p.c.) has noticed examples such as (88), where a wide scope object binds a pronoun inside the subject:

(88) A plaque indicating the date of <u>its</u> incorporation may be found in <u>every American city</u>.

Since this example seems perfectly acceptable, Haïk's account of the assymmetry between (83) and the acceptable Crossing Coreference sentences (81) and (82) in terms of the c-command required for indirect binding seems questionable, although I agree with her that Absorption is too strong a mechanism. Also, although many people seem to find the crossing coreference reading of (82) acceptable, none of the informants I have discussed the example with found this was the first reading (preferring one where the first pronoun is interpreted as discourse bound by some unspecified antecedent — "it, whatever it is"), and many, including the author, find the crossing coreference reading unacceptable here. When judgments are so fuzzy, it seems unlikely to me that we should use the same mechanism for binding which gives us the readily interpretable bound readings of the donkey sentences.

To summarize the discussion so far, Haïk claims that her proposal can handle donkey sentences at S-Structure without an additional level of representation or interpretation, that her account in terms of c-command predicts certain subject-object asymmetries, and that it can handle Jacobson's and Crossing Coreference sentences. We have already seen that the asymmetries and the backwards bound anaphora in the last examples seem more complex than Haïk has considered, and that although configurational characteristics of S-Structure may be involved, they seem to involve more "global" structural characteristics, in terms of Connectedness or Global Harmony, and not simply c-command. And although no further levels beyond S-Structure are required to handle the range of data Haïk considers, we saw in Chapter 1 that modal subordination in general is crucially a discourse phenomenon, involving accommodation and other pragmatic factors, and cannot be reduced to characteristics of the S-Structure of individual sentences. Thus, her approach would ultimately prove inadequate to handle modal subordination, of which the conditional donkey sentences seem to be special cases.

Other problems with Haïk's approach arise from her use of indices on NPs to indicate relative scope. How are her S-Structures, with slash indices to indicate relative scope of NPs, to be interpreted? If NPs are interpreted as generalized quantifiers, then they must take as arguments property-denoting elements. One way to do this in Haïk's framework would be to treat the complexly indexed S-Structures as indications of (possibly iterated) predications involving lambda abstractions. Where an NP *a* has wide scope over another NP *b*, then *a* would be taken as the subject of a lambda abstract which includes *b*. Thus, a simple sentence such as (89) would have an interpretation corresponding to the more abstract (90):

(89) Everyone_1 likes $\text{someone}_{2/1}$

(90) $\lambda x[x \text{ likes someone}]$ (everyone)

In a limited range of cases, such as the simple (89), the interpretations which are derived in this way correspond to the readings predicted by May (1977), or by the system of van Riemsdijk & Williams (1981) or Williams (1986), where quantifier scope is indicated at S-Structure by coindexing an NP with the higher constituent over which it has scope. However, more complex examples pose problems for this way of interpreting Haïk's system: what determines the limit of the range over which an abstraction may be formed on such an approach? In the extensive literature on quantifier scope, various arguments have been offered for quantifying in, or quantifier raising, or quantifier indexing not only at S, but at VP and NP, and perhaps even CN. (See Chapter 4 for extended discussion.) Nothing in Haïk's system gives us the means to distinguish between the various scope possibilities of a given NP in this way. Further, her generalization (65), that operator scope is clause-bound, admits of many counterexamples, including those involving NPs in the sentential complements of verbs.

But the crucial problem with her proposal for the representation of quantifier scope is that the relative scope of two NPs is not a question of a direct relation between the NPs themselves, as it appears in Haïk's system, but is indirect: if an NP *a* occurs in a property denoting constituent (syntactic or abstracted) which is predicated of another NP *b*, then we say that *a* is 'in the scope of' *b*. But anaphoric relations between NPs appear to be direct: 'is the antecedent of' is a direct relation between two NPs without the mediation of predication. Thus, the mechanism by which Haïk proposes to collapse the representation of scope with the representation of bound anaphora suffers from a fundamental conceptual confusion about the different kinds of relations involved.

Chapter 3

Distributivity

There are a variety of issues which will concern us in this chapter, but they all revolve around the phenomenon of distributivity, with special attention to how it affects the anaphoric potential of NPs. I will argue for a very simple theory of distributivity and the distributive-group distinction. Distributivity is a property of predications, combinations of a subject and a predicate. The predicate may not be the syntatic VP, but may be derived via lambda abstraction. Distributivity may be triggered either by a quantificational determiner in the subject NP or by the presence of an explicit or implicit adverbial distributivity operator on the predicate. A group reading arises when neither the subject nor an adverbial element of the predicate contributes the quantificational force underlying distributivity.

The relevance of distributivity to anaphoric potential is illustrated in the following examples:

(1) Four men lifted a piano.

(2) Bill, Pete, Hank, and Dan lifted a piano.

(3) Each man lifted a piano.

(4) Bill, Pete, Hank, and Dan each lifted a piano.

(1) and (2) are each ambiguous. For example, on the so-called 'group reading' of (1), the men in question lifted a single piano together, but it may be that none of them lifted it alone. The group reading of (2) is similar. On the distributive reading of (1) or (2) each of the men has the property of having singlehandedly lifted a piano. If we fix the scopes of the NPs in (3) so that the subject has wide scope over the object, then it is unambiguously distributive — there is no reading where the group composed of all the men together lifted a piano. Likewise, (4), with adverbial *each*, is unambiguously distributive. If the context in which (3) is uttered is such that we know that there were just four men, Bill, Pete, Hank, and Dan, then the readings of (3) and (4) with the subject taking wide scope are true in just the same situations.

Now compare the distributive readings of (1) and (2), and the readings of (3) and (4) where the subject NP has widest scope. All share this property: *a piano* may not serve as an antecedent for subsequent anaphors in discourse. This is shown by the infelicity of (5) following (1), (2), (3), or (4) (on the relevant readings), with *it* intended as anaphoric to *a piano*:

(5) It was very heavy.

But though the object in (1) – (4) behaves the same on the relevant distributive readings, there is a difference in the anaphoric potential of the subjects. The subject of (3) may not license anaphora in discourse, so that (3) followed by (6), with *he* anaphoric to *each man*, is infelicitous:

(6) He developed a crick in his back later.

This reflects a well-known property of quantificational NPs, that they only license what I have called c-command anaphora. However, the subjects of (1), (2) and even the unambigously distributive (4) may license discourse anaphora. Consider any of these examples followed by (7):

(7) They then gathered to receive the promised award.

They may refer to *four men* or *Bill, Pete, Hank and Dan.* (3) may also be followed by (7), but notice the lack of number agreement between the subject of (3) and the pronoun in (7). We most often use an NP such as *each man* where there is a group of man already salient in the discourse, and it would then be this group which served as antecedent for *they*, and not *each man*. In any case, I will argue in Chapter 5 that the use of a universally quantified NP may in general license the accommodation of a plural discourse referent. It is thus a plural discourse referent, already salient or accommodated, which would serve as discourse antecedent of *they* in this case.

Notice that the verb *gather* in (7) is generally regarded as a group predicate; that is, it is only felicitously predicated of a group. *They*, then, has a group interpretation, even when its intended antecedent, such as the subject of (1), (2), or (4), occurs in a sentence with a distributive interpretation.

There are other examples which show that the subjects of (1) and (2), under either the group or the distributive interpretation, or the subject of (4) may serve as antecedent to a plural pronoun interpreted distributively. This is the case in (8):

(8) They developed a crick in their backs later.

In general, developing a crick in one's back is something only an individual can do. The singular indefinite direct object in (8), then, leads us to the distributive interpretation: we are concerned with a property of each of the three men denoted by *they*, not of the group as a whole. Another point of interest in this example is the plurality of *their backs.* This seems to be an example of the *dependent plural* phenomenon. Note that although this complement to the head *crick* is plural, we do not understand the direct object as being about a single crick which is in all three backs. Rather, on the usual interpretation there is a different crick in each back. The dependent plural here is optional for many speakers, for whom the singular *their back* is equally acceptable.

Summarizing, it appears that (1) and (2) are ambiguous with respect to the group-distributive distinction, while (3) and (4) are not. On the distributive readings of these examples, the indefinite direct object is inaccessible to serve as a discourse antecedent. However, the subjects of (1) and (2), under either the group or the distributive reading, and the subject of (4) may serve as discourse antecedents, while the subject of (3) may not.

These facts about the anaphoric potential of the NPs in (1) – (4) will follow automatically from the theory of distributivity to be presented here. If a plural subject is itself nonquantificational, we say that it is *group-denoting.* It may serve as a discourse antecedent even when its predicate is modified by an adverbial distributivity operator, either explicit, as in (4), or implicit, as in (1) and (2). As usual, quantificational NPs such as the subject of (3) may only bind anaphors within their scope.

In developing this theory, I will begin with a detailed review of the three principal approaches to distributivity in the literature on plurality and quantification. Then I will turn to the exploration of the main aspects of my proposal, the semantics of groups and of plurality more generally, the distinction between group denoting and distributive, or quantificational, NPs, and adverbial distributivity. Then I will discuss an issue which an adequate theory of distributivity must address, the question of the analysis of dependent plurals. Finally, I will draw a few conclusions about the general character of distributivity. I will postpone offering a formal version of this theory until the following chapter, where it will be developed in relation to a theory of the representation of quantifier scope.

3.1 Previous approaches to the group-distributive distinction.

3.1.1 Distributivity as quantifier lowering/raising

Lakoff (1970a, Section III) is an early discussion in the linguistic literature of the distributive-group distinction, a distinction which Lakoff discusses in terms of a group reading vs. a 'quantifier-reading' in examples such as the following:

(9) That archaeologist discovered nine tablets.

(10) All the boys carried the couch upstairs.

(11) Every boy carried the couch upstairs.

(12) That archaeologist discovered few tablets.

Lakoff claims that (9) and (10) are ambiguous: On the group reading, the archaeologist discovered nine tablets as a group, and the boys carried the couch upstairs as a group. On the quantifier reading (what I have called the distributive reading), there are nine distinct tablets that the archaeologist discovered,[1] and each of the boys carried the couch upstairs alone. (11) and (12), on the other hand, are unambiguous, with only a quantifier reading. Lakoff (1965) had proposed that the scope of quantifiers should be indicated in deep structure by generating them as higher

[1]Lakoff's discussion of the ambiguity of (5) vaguely suggests that he views distributivity as a determinant of the number of events denoted by such sentences: "It can mean either that the archaeologist discovered a group of nine tablets or that the number of tablets that he discovered altogether totaled nine, though they may not have been in a group."

I think that the question of distributivity is logically distinct from that of the number of events denoted by a sentence. Consider the following example:

(i) John gave a whole pumpkin pie to two girls.

The sentence is ambiguous: did John give a total of one pie to a group of two girls, or a whole pie to each of two girls? On the first reading, with the group-denoting indirect object, neither of the girls by herself has the property of having been given a whole pumpkin pie by John, while they each have this property on the second, distributive reading. On the group reading of the indirect object, it seems clear that only one event is denoted, but what about the second, distributed reading? Perhaps the giving was simultaneous, in the same location. Is this one event or two? One might argue that spatio-temporal continuity is neither sufficient nor necessary to individuate events. But it is just such fuzziness in our sense of what constitutes an event, or, perhaps more to the point, of what denotes an event, that makes it difficult to find any direct correlation between the truth conditions of such sentences and the number of events involved.

In sum, I think that the semantic theory of events is not yet sufficiently well developed to permit clear claims about the number of events denoted by a given sentence. A sentence such as (9) may just be vague or noncommittal about whether or not the tablets were discovered at one time. The distinct question of which entities have a particular property, as in (i), (10) and (11), appears to have a much clearer answer for a given reading of a particular sentence.

Schein (1986) has developed a theory which is aimed at accounting for a restricted class of examples involving distributivity in terms of quantification over events. In Section 3.2.4 I will discuss the relevance of this proposal for examples involving what Link has called "plural quantification."

predicates which are then lowered transformationally in the derivation of surface structure. In his discussion of (9)–(12), he proposes that only the quantifier reading be derived by 'quantifier lowering' or, alternatively, 'quantifier raising.' He does not present a theory of the representation of the group-reading; however, from the examples and his discussion it seems that he intends *in situ* interpretation as a necessary, if not sufficient requirement. Also, although he is not explicit on this point either, presumably the rule of Quantifier Lowering is obligatory for quantifiers such as *every* and *few*, in order to account for the non-ambiguity of (11) and (12). Then either numerals and *all (the)* are ambiguous between quantifier and non-quantifier interpretations, or the rule of Quantifier Lowering only applies optionally to them. In either case, it seems that the two readings of (9) and (10) are to be distinguished by whether or not Quantifier Lowering has applied.

As further evidence for this proposal, Lakoff presents examples (13) and (14):

(13) Sam believed that that archaeologist discovered nine tablets.

(14) Sam believed that all the boys carried the table upstairs.

He claims that (13) and (14) have three readings each: both a group reading and a quantifier reading which have narrow scope with respect to the opaque verb *believe*, and a quantifier reading with wide scope. They seem to lack the wide scope group reading, where there is some group of tablets or of boys of which Sam holds some belief, although he might not describe them as such.

These judgments are not easy. Note with respect to (13) that if there is a group of tablets of which Sam holds the belief that it was discovered, then it would be true of each tablet in the group that he holds this belief about it. Hence, the truth conditions for the wide scope group reading do not differ clearly from those for the wide scope quantifier reading.[2] (15) is a better example, in that the truth conditions for wide scope group and quantifier readings differ considerably:

(15) Sam believed that the archaeologist gave nine tablets to a museum.

On the wide scope quantifier reading, each of nine tablets is such that Sam believed that the archaeologist gave it to a museum (possibly different museums), while on the wide scope group reading, the whole group is such that Sam believed that it was given to a (single) museum. In (15), I find the wide scope group reading easier to get than the wide scope quantifier reading (as is also the case with the narrow scope group reading vs. the narrow scope quantifier reading, in this particular example). In (14), I do find the wide scope group reading difficult, if not impossible, but this reading is much easier to get for the structurally similar (16):

(16) Sam believed that six boys formed a club.

Consider a situation in which the six boys in question are the Jones brothers: Sam may believe that the Jones brothers formed a club without knowing how many of them there are. If the speaker knows that there are six Jones brothers, then I think he can truly assert (16). Compare (15) also to the similar (17), where the neither the wide scope nor the narrow scope quantifier reading seems available:

(17) Sam believed that all the boys formed a club.

[2]Unless the wide scope quantificational reading is taken to indicate that there were nine distinct events of tablet discovery, as opposed to a single discovery of a group of nine tablets. See Footnote 1 above for discussion of this possibility.

I can't get a reading where it's true of each of the boys that Sam believed he formed a club.[3] I don't get a wide scope group reading of (17), either. Whatever the source of the variation from example to example, Lakoff's argument from examples (13) and (14) does not seem conclusive.[4]

Lakoff presents one further argument for the Quantifier Lowering analysis of distributivity. Since Quantifier Lowering is a movement rule, one would expect it to obey Ross' (1967) constraints on movement. In particular, it should obey the Coordinate Structure constraint. Consider Lakoff's examples (18) and (19):

(18) (a) John and nine boys are similar. *(Unambiguous)*

(b) John and all the girls are similar. *(Unambiguous)*

(c) * John and every linguist are similar.

(d) * Few philosophers and John are similar.

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[3]David Pesetsky (p.c.) suggests that the wide scope quantifier reading is possible with the similar (i):

(i) Sam has at one time or another held the belief that all the boys formed a club.

I still don't get the intended reading, though I do with (ii):

(ii) Sam has at one time or another held the belief that each of the boys formed a club.

[4]See also Hintikka's (1973) critique of Lakoff's use of examples such as (6) to argue for the ambiguity of *nine tablets*. As Hintikka points out, "from the fact that an expression exhibits an ambiguity when embedded in a certain kind of (*e.g.* opaque) context, it does not follow that it is ambiguous when considered alone."

(19) (a) John is similar to nine boys. *(Ambiguous)*

(b) John is similar to all the boys. *(Ambiguous)*

(c) John is similar to every linguist. *(Unambiguous)*

(d) Few philosophers are similar to John. *(Unambiguous)*

The examples in (18) involve intransitive, symmetric *similar*. If we assume with Lakoff that Quantifier Lowering obeys the Coordinate Structure constraint, then we expect that the quantifier reading is not possible for constituents of a conjoined NP. When an optionally quantificational NP such as *numeral CN* or or *all the CN* (cf. the ambiguous (9) and (10)) is conjoined with another NP, as in (18a) or (18b), the result is unambiguously interpreted as a group, and there is one property which makes all members of the group similar. However, quantified expressions such as *every CN* undergo obligatory Quantifier Lowering, as shown in the unambiguous example (11) above with only the quantifier reading. Such NPs are not felicitous when conjoined with another, non-quantificational NP, as in the ungrammatical (18c). The same quantificational analysis of *few* would account for (18d). In (19), with transitive *similar*, the (a) and (b) examples are ambiguous: there may be a single, shared property by virtue of which John is similar to the group of boys, or there may be a different property shared by John with each of the boys, with the direct object receiving the quantifier reading. But (19c) and (19d) are unambiguous, with only the quantifier reading of *every linguist* and *few philosophers.*

Pesetsky (1982), in a discussion of Russian constituents of the form *numeral CN*,[5] notes that within the Government and Binding framework, James Higgin-

[5]Here, I borrow the expression *CN*, mnemonic for "common noun phrase," from Montague grammar. In general I use CN instead of N″ or N′ in order to avoid questions of the number of bars involved in this immediate daughter constituent of NP (or QP). A CN may include prehead modifiers, such as adjective phrases, and posthead complements,

botham has suggested that the distinction between group and distributive readings of numeral phrases "may be traced to the optionality of QR," or Quantifier Raising. In a complex analysis, Pesetsky shows that one type of Russian *numeral CN* displays a range of characteristics typical of NPs which have undergone QR, including the ECP, or Empty Category Principle, of Kayne (1981a). He calls this the 'no agreement' *numeral CN*, because it fails to trigger agreement with a predicate. It also displays idiosyncratic case behavior, appearing in the genitive case regardless of context. This type of *numeral CN* is infelicitous with group predicates, such as the Russian counterpart of the English *disperse*, so that it may only have a distributive interpretation. It may well be correct that these Russian constituents are quantificational, thus explaining their infelicity with group predicates in general and the evidence that their behavior with respect to the ECP parallels that of other, clearly quantificational NPs. However, although this is compatible with Lakoff's view of the nature of the group-distributive distinction, it does not in and of itself argue that the group reading of NPs (with or without numeral determiners) arises due to the absence of QR. I believe that the objections which I will raise to Lakoff's proposal will also cause problems for a similar GB approach, at least for English.

Although I believe that Lakoff's proposal is correct in recognizing the quantificational character of distributivity, there are two crucial types of example which show that it is inadequate. First, there are distributive readings of sentences with nonquantificational subjects. Consider the following:

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adjuncts and, according to some analyses, relative clauses.

Pesetsky argues that these constituents in Russian are not NPs but Quantifier Phrases, or QPs.

(20) Mary, Susan, and Kathy have broken their leg at one time or another while learning to ski.

The only pragmatically plausible reading here is where each of the individuals in the group denoted by the subject has the property denoted by the predicate. Although many similar examples are not as acceptable to those (like me) who prefer the plural form of direct objects in such cases (the 'dependent plural'), the existence of such examples shows that conjoined proper names, which are not regarded as quantificational in any theory I am aware of, can have a distributive interpretation. This interpretation has very similar truth conditions to those of closely related examples with clearly quantificational subjects, as in (21):

(21) Each girl has broken her leg while learning to ski.

The anaphoric potential of the two types of subjects in (20) and (21) differs, demonstrating the "referential" character of the conjoined proper names and the quantificational character of *each girl*. There are two tests for this difference. The first is the possibility of discourse anaphora. Consider:

(22) (a) <u>Mary, Susan, and Kathy</u> have broken their leg at one time or another while learning to ski.

(b) <u>They</u> had to wear a cast for a long time.

(23) (a) <u>Each girl</u> has broken <u>her</u> leg while learning to ski.

(b) # <u>She</u> should have stayed on the practice slopes longer.

While the anaphoric link between the pronominal subject of (22b) and the subject of (22a) is felicitous, this is not the case in (23). This is exactly what we would expect if *Mary, Susan, and Kathy* is nonquantificational, and hence available as a discourse antecedent, while *each girl* is quantificational, and hence only able to serve as antecedent in c-command anaphora.

The other test for the distinction is their behavior in sloppy identity constructions such as (24) and (25):

(24) Mary, Susan and Kathy love their mother and Bob does too.

(25) Each girl loves her mother and Bob does too.

(24) is ambiguous between the sloppy reading, where Bob loves his own mother, and the nonsloppy reading, where he loves the mother of Mary, Susan and Kathy. But (25) has only the sloppy reading. As discussed in Chapter 2, Reinhart (1983) argues that the sloppy reading requires bound anaphora, and I argued there that the nonsloppy reading arises due to discourse binding. Thus, the two NPs appear to have a different binding potential.

Lakoff's account, distinguishing between the distributive and group readings according to whether an NP has undergone a rule of Quantifier Lowering or Quantifier Raising, cannot capture the truth conditional parallels between the clearly quantificational cases such as (21) and cases like (20), while at the same time accounting for the anaphoric facts.

The second type of problem is more serious, since it shows a contradiction in Lakoff's basic assumption about the relation between distributivity and quantifier scope. Example (26) shows that the function of Quantifier Lowering/Raising as an indication of the scope of an NP is incompatible with the proposal that it is restricted to distributively interpreted NPs:

(26) Five insurance associates gave a \$25 donation to several charities.

(26) is multiply ambiguous. The reading which interests us is where a single group of five insurance associates gave a donation of \$25 to each of several charities. On this reading, *five insurance associates* has a group reading, while *several charities* is distributive over *a \$25 donation*, so that it has a quantifier reading. *Five insurance associates* has wider scope than *several charities*; i.e. the relative scopes of the NPs in (26) are as in (27):

(27) 5_{group} - $several_{distr}$ - \$25

If the distributivity of *several charities* and its scope over *a \$25 donation* are to be represented in a logical form by Quantifier Lowering or Raising, then *five insurance associates* would have to undergo that rule as well, despite its group reading.

Note that one could not account for the reading indicated in (27) by maintaining that all group denoting NPs interpreted in situ automatically have wide scope.[6] On this view, the wide scope of the subject of (26) would not entail that it had been moved. But this approach would also predict that the subject of (26), on its group interpretation, could not have narrow scope with respect to the quantificational

[6]In a similar move, Aoun, Hornstein, & Sportiche (1981) argue that *any* is interpreted in situ but has a special logical translation which always, in effect, gives it wide scope. This is based on the claim that *any* always has a wide scope universal interpretation, though it does not display the properties associated with QR'd NPs. However, they do not note that the examples they consider all permit a different logical form — where *any* is interpreted as an existential which has narrow scope with respect to a downward entailing operator, such as negation (cf. Ladusaw (1979)). Their argument is seriously undermined by their failure to address this possibility.

(and hence raised) *several charities.* However, there is such a reading of (26), where each charity was given $25 by a possibly different group of five insurance associates. Therefore, the scope of the group-denoting subject with respect to the quantificational indirect object is free, demonstrating that the assumption that distributive NPs undergo quantifier movement while group-denoting NPs are interpreted in situ is inadequate.

Finally, even if the Quantifier Lowering/Raising approach were adequate descriptively, we would still need an account of how the different readings were derived from the raised and non-raised structures. Would the interpretive differences arise entirely from the structural differences, or would lexical differences between NPs make a contribution as well? The different potential for distributivity of different types of NPs suggests the latter; however, if lexical factors are involved in interpretation, it is unclear why the movement rule would be a necessary component in the explanation of distributivity (though, of course, it might play another role — the indication of the scope of NPs).

3.1.2 The distributive-group distinction as a function of predicate type

Some lexical items have been held to permit only a group or a distributive reading of sentences in which they occur. The examples in (28) – (31) illustrate this:

(28) (a) * John disperses.

(b) The committee disperses.

(29) (a) * John walks together.

(b) The men walk together.

(30) (a) * Mary is among John.

(b) Mary is among the unicorns.

(31) (a) John, Paul, George, and Ringo are pop stars.

(b) Paul is a pop star.

In (28)–(30), from Bennett (1974), are a number of lexical items which require a group-denoting subject or complement. *Disperse* seems to require such a subject; hence (28a) is unacceptable, since *John* does not denote a group. But (28b) is fine; it seems that *the committee* denotes a group. The fact that it is syntactically singular shows that the group/nongroup distinction is not directly tied to syntactic number. As (29a,b) shows, adverbial *together* seems to turn the predicate which it modifies into one which takes only a group denoting subject. And (30a,b) show that *among* seems to require a group-denoting complement.

In (31), from Link (1983), there doesn't seem to be a group reading as distinguished from a distributive reading — the predicate *be a pop star* seems to be true only of individuals. So, if (a) is true, then it entails (b) automatically. Thus, *be a pop star* is said to be a distributive predicate. In this class are often included verbs such as *walk*, *eat*, *talk*, and others which seem to be related to personal identity or individual will.

It is these types of examples which inspire the second general approach to the distributive-group distinction, which emphasizes the contribution of particular lexical predicates. Following Montague (1973), both CNs and VPs are predicates, so on this approach the lexical entries of such elements might contain information about which class (or classes) they belong to. This type of approach was originally investigated by Bennett (1974), who distinguished two classes of predicates, those which contain individuals in their extension, and those which contain groups. More recently, the distinction between distributive predicates such as *be a pop star* and other, non-distributive predicates has provided the foundation of Link's (1983) theory of distributivity. In this section, I will review in detail Bennett's theory, and compare it briefly with Link's. I will postpone a more detailed consideration of Link's theory until Section 3.2, where I will discuss his theory of the semantics of groups.

Bennett (1974) proposes a treatment of plurality, including the distributive-group distinction, by an extension of the fragment of English treated by Montague (1973). The central feature of his analysis is the use of two different classificatory distinctions. The first is a syntactic number distinction: CNs may be either singular or plural. Pluralization is accomplished by a rule which does not affect the semantic type of the CN involved. Besides affecting its morphology, the syntactic number of a CN restricts the determiners with which it can combine and the number of the resulting NP; and the syntactic number of a subject NP triggers number agreement in the verb of its predicate. NPs themselves may be plural as well without having plural CN heads. For example, *John and Mary* is plural. Agreement in number of pronouns with their antecedents is also syntactic.

The other distinction is manifested in both the syntax and the semantics: there are two kinds of CNs, individual level and group level. Bennett distinguishes these in the categorial syntax by the use of 'CN' as the category for the individual level CNs and the same symbol with a bar over it for the group level. For typographical convenience, I will use 'CN_g' for the group level CNs. The categorial difference between CN and CN_g is reflected semantically in different types: the denotation of individual level CNs is a function from individuals in the universe of discourse to truth functions, type $\langle e,t\rangle$.[7] But the denotation of group level CNs is a function from sets of individuals (the groups) to truth functions, type $\langle\langle e,t\rangle,t\rangle$. There is also a new basic category for group level verbs such as *gather*, *riot*, and *disperse*: IV_g, interpreted by the same type as CN_g. This distinction in basic categories and types effects a split in derived categories as well: for example, at every level where a CN_g may enter into a larger constituent, the categories of any elements it combines with and of the resulting constituent, and the semantic type of their interpretations must be lifted as well. The inventory of basic categories must be expanded to include a group level NP, T_g ($= t/IV_g$), and group level pronouns it_g and $they_g$ to permit quantifying in group level NPs; Bennett also needs various verbal categories such as TV_g ($= IV_g/T_g$), which takes a group level object NP to form a group level predicate; IV/T_g, which takes a group level object NP to form an individual level predicate; and IV_g/T, which takes an individual level object NP to form a group level predicate. There is also a category for adverbial *together*, IV_g/IV, which takes an individual level predicate to form a group level predicate; and a category for prepositions such as *among* which take group level complements, AJ/T_g. Thus, because of the individual-group type distinction in Bennett's system, NPs may only combine with VPs on the same level, whether group or individual, and the same constraint is found in other rules of function-argument application as well.

The two kinds of distinctions cross-cut each other: there are both singular and plural individual level CNs, e.g. *man* vs. *men*, as well as singular and plural group level CNs, e.g. *committee* or *mob* vs. *committees*, *mobs*. There are two main classes

[7]Bennett departed from Montague in this regard; CN in PTQ (Montague (1973)) was intensional, of type $\langle\langle s,e\rangle,t\rangle$. Bennett's treatment of CN has been widely adopted among Montague grammarians; see Dowty, Wall & Peters (1981) for discussion, Janssen (1984) for arguments that Montague's CN type is preferable in some cases.

of determiners, one class combining with singular CNs or CN_gs, the other with plural CNs and CN_gs. Some of the most common determiners and their classification by Bennett are shown in (32):

(32)

	Singular	Plural
a	•	
every	•	
one	•	
two,three...		•
the	•	•
no	•	•
few		•
some		•
many		•
most		•
all		•

There are a variety of rules (S12–S17, S21, S22) which form NPs from these determiners in combination with CNs and CN_gs. Singular CNs on the individual level may only feed individual level NPs, of category T. Plural CNs may combine to form either an individual level NP, T, or a group level T_g. Singular CN_g may either form part of singular T_g or plural T; the latter possibility permits the derivation of sentences with semantic, but not syntactic, number agreement between subject and predicate, such as *The committee walk.* Plural CN_g always combines with a determiner to form a T_g; however S22 (optionally) changes a plural T_g to a plural individual level T, so that, in effect, a plural CN of either type may enter into a NP of either type.

Because there is no direct mapping from singular T to T_g, and only singular CN_g and plural CN or CN_g can feed rules forming T_g, certain readings are ruled out. These involve singular, individual level NPs of category T in combination with group level predicates or prepositions, as in (28)–(30), repeated from above:

(28) (a) * John disperses.

(b) The committee disperses.

(29) (a) * John walks together.

(b) The men walk together.

(30) (a) * Mary is among John.

(b) Mary is among the unicorns.

John, of type T, can never be the subject of a group level predicate such as *disperse*, of type IV_g, or of any predicate modified by the group predicate-forming adverb *together*, nor can it be the complement of a group level preposition such as *among*. A singular CN such as *man* can never form a group level NP either. Since *committee* is of type CN_g, it forms an NP of type T_g, which can combine with such predicates. Similarly, the plural CN *men* can combine with *the* to form a group level NP of type T_g.

Because Bennett's theory locates distributivity in properties of predicates, rather than in a scope rule such as Quantifying In, he predicts some readings which Lakoff cannot derive in his theory, where quantifier movement determines both distributivity and scope. This is illustrated in the readings which each theory predicts for

Bennett's example (33):

(33) Ten men applauded two women.

Bennett permits a large number of different analyses of (33), depending on the group vs. individual level of the NPs, whether or not they are quantified in, and the relative order of their scopes. However, several of these analyses yield logically equivalent interpretations, and the total number of distinct readings he derives is seven. These are shown informally in (34), where only the relative scope of the two NPs and their types is given. Subscript '*d*' indicates an individual level, or distributive reading. Subscript '*g*' indicates a group reading:

(34) **Bennett's readings of (33):**

(i)	$[10 \text{ men}]_d$	$[2 \text{ women}]_d$
(ii)	$[2 \text{ women}]_d$	$[10 \text{ men}]_d$
(iii)	$[10 \text{ men}]_g$	$[2 \text{ women}]_d$
(iv)	$[2 \text{ women}]_d$	$[10 \text{ men}]_g$
(v)	$[10 \text{ men}]_d$	$[2 \text{ women}]_g$
(vi)	$[2 \text{ women}]_g$	$[10 \text{ men}]_d$
(vii)	$[10 \text{ men}]_g$	$[2 \text{ women}]_g$

The readings in (ii), (iv) and (vi), where *2 women* has wide scope over *10 men*, must involve Quantifying In because of the inverse scope; however, all of the other readings can correspond to analysis trees which do not utilize Quantifying In.

Lakoff only predicts five readings of (33), as shown in (35). The readings are numbered as they are in (34), in order to make clear how the two theories compare.

Here, they are followed by the logical form which derives the reading for Lakoff:

(35)	**Lakoff's readings of (33):**		
(i)	[10 men]$_d$	[2 women]$_d$	$(10x2y[\text{applaud}(x, y)])$
(ii)	[2 women]$_d$	[10 men]$_d$	$(2y10x[\text{applaud}(x, y)])$
(iii)		*not available*	
(iv)	[2 women]$_d$	[10 men]$_g$	$(2y[\text{applaud}(10\text{men}, y)])$
(v)	[10 men]$_d$	[2 women]$_g$	$(10x[\text{applaud}(x,2\text{women})])$
(vi)		*not available*	
(vii)	[10 men]$_g$	[2 women]$_g$	$(\text{applaud}(10\text{men},2\text{women}))$

The two readings which are not available in Lakoff's theory are those in which an NP interpreted as a group has wide scope over an NP interpreted distributively. These readings don't make a great deal of difference for the truth conditions of (33), but recall that in Section 3.1.1 we found that the lack of such a reading was a problem in representing the reading of (26) indicated in (27):

(26) Five insurance associates gave a $25 donation to several charities.

(27) 5_{group} — $\text{several}_{\text{distr}}$ — $25

Bennett's proposal would permit us to derive the reading in (27), and is thus an improvement over Lakoff's.

However, there are several problems with Bennett's approach. One kind of problem arises with coordinate VP structures. Consider (36), after an example from Karina Wilkinson (p.c.):

(36) John and Mary won a lottery drawing and then developed insomnia worrying about the money.

The most prominent reading of (36) is one in which John and Mary jointly won a lottery drawing, then each developed insomnia. Bennett's approach to what are often considered the inherently distributive predicates, such as *eat* and *walk*, treating them as predicates on the individual level only, suggests that he intended to derive the distributive entailments of such verbs from their type, so we might assume that he would have regarded *develop insomnia* as a predicate on the individual level only. We thus appear to have conjoined VPs of different types — one on the group level, the other on the individual level. Under the usual assumption that only constituents of the same type may be conjoined, this is a problem for Bennett's approach.

But perhaps the most obvious problem with Bennett's approach is the proliferation of types which it entails, as Bennett himself points out.[8] Some predicates must be treated as several ways ambiguous. For example, *applaud* in this fragment is a member of four different categories, with four corresponding translations, IV/T (*John applauded Mary*), IV_g/T_g (*The committee applauded the mob*), IV/T_g (*John applauded the mob*), and IV_g/T (*The committee applauded Mary*).

A related problem involves group level CN_gs such as *committee.* Since plurality in this system is distinct from the group vs individual level distinction, there is no way to form a group of groups reading for plural group nouns such as *committee*, a type of reading necessary for examples such as (37):

[8]For extensive discussion of the problem of proliferation of types in Montague Grammar, see Parsons (1979).

(37) The committees met last week.

where the committees may have met all together. Bennett himself noted the existence of CNs such as *federation* denoting groups of groups, and observed that an adequate treatment of such CNs would involve further type lifting across the board, resulting in an even more embarrassing array of types.

Link's (1983) general approach to distributivity is that it is a lexical property of one-place predicates, but unlike Bennett, he doesn't reflect this in a type distinction; thus he avoids the problems with VP conjunction and the proliferation of types. As we will consider in more detail in Section 3.2, a group in Link's system is just another kind of individual, so that predicates such as *disperse* are of the same type as Bennett's individual predicates. Link does not consider such group predicates, focusing instead on predicates such as *be a pop star* in (230). He defines a special class of *Distributive Predicates* (which I will abbreviate as "DistrPs"); these DistrPs are those which do not contain groups in their extension, but only single ("atomic") individuals (see his definition D19, p.314). He then defines a meaning postulate for this class of predicates which guarantees that whenever one of them takes a plural subject, it holds of all the individuals which make up the group denoted by the subject. From this, Link is able to guarantee the valid inference from (31a) to (b), repeated below, on the assumption that the predicate *be a pop star* is a DistrP:

(31) (a) John, Paul, George, and Ringo are pop stars.

(b) Paul is a pop star.

Though Bennett's and Link's theories differ in many respects, they are alike in locating the distributive-group distinction primarily in lexical characteristics of predicates. But building this view of the distinction into the formal structure of a semantic theory is, on the one hand, unnecessary because it is redundant, and, on the other hand, it fails to capture some important generalizations about the nature of distributivity. First, the fact that a particular lexical item is a group predicate or a distributive predicate doesn't really need to be specified independently: it follows from the sense of the predicate itself.[9] What does it mean to gather or to disperse? By virtue of the meaning of such a predicate, its subject must denote a group of individuals (or a mass of some substance), performing in a way peculiar to a group (or mass). Viewed in this way, these verbs are no more special than a verb such as *grasp*, which, on one of its senses, can only be true of an individual with a certain type of movable thumb. What is it to be a pop star or to walk or to die? The actions or states denoted by these verbs can generally only be performed or endured by an individual with a single will and consciousness. It is for this reason that we think of them as distributive. Although it may well be that only atomic individuals are in the extension of such distributive verbs in their strict sense, this follows from our knowledge of what is required for them to be true of an individual.

Note also that many of the predicates which might be considered group predicates or distributive predicates are not composed of single lexical items. For example, it seems that only a group can *make a good team.* Under standard assumptions about the lexicon, there would be no entry for such a predicate, since its meaning could be compositionally determined on the basis of the meaning of its parts. But, given what it means to make a team, we would naturally assume that its extension contained only groups. The same is true of *win a relay race* but not of *win a 100 meter dash*, the latter presumably a distributive predicate. These classifications are a question of world knowledge about the denotations of the terms involved.

[9] I have been influenced in this discussion by Dowty (1986). See Section 3.4.1 below.

The other kind of problem with founding a theory of the group-distributive distinction on the properties of predicates alone is that it does not take into account the important and systematic contributions of determiners and adverbial elements like floated quantifiers to distributivity. By restricting our attention to predicates alone, it seems that we are missing an important generalization about the unity of the contribution made by these various elements. This problem leads us naturally to consider the third major approach to the distributive-group distinction, wherein it is viewed as a property of determiners.

3.1.3 Determiners and the distributive-collective-cumulative distinction

In this section, we will consider an approach to the distributive-group distinction which focuses on the contribution of determiners. First, we will review an influential proposal in this vein by Remko Scha (1981). Then we will consider Scha's claim that there is a third kind of reading, the cumulative reading; the evaluation of this proposal involves exploring more generally what it means for a relation to hold between two groups, and leads us into a brief consideration of the semantics of reciprocal sentences.

3.1.3.1 Determiners as the locus of the distinction

Remko Scha's "Distributive, Collective and Cumulative Quantification" (1981) locates the kind of distinction we are concerned with in the semantics of determiners, instead of in the distinction between distributive and group (or "collective") verbs and CNs which was the basis of Bennett's approach. In addition, he contends that a two-way distinction between distributive and group, or "collective" readings is not sufficient: there is a third kind of reading, which he calls the "cumulative," and his proposal is aimed at accounting for these as well.

For Scha, all CNs, whether singular or plural, denote sets of singleton sets of individuals, rather than sets of individuals.[10] The advantage of this is that it permits distributive and collective predicates to be of the same type: When a distributive determiner is combined with a CN by function-argument application, the result is a function from one place predicates to truth values, as in Montague's system. For example, the determiner *all*, on its distributive interpretation, when combined with the plural CN *boys*, yields the interpretation indicated by the logical form in (37):[11]

(37) $\lambda\, \mathrm{P}\, [\forall\{x\}(\underline{\mathrm{boys}}\ (\{x\}) \rightarrow \mathrm{P}(\{x\}))]$

($\{x\}$ is the set containing x.) This resembles the standard interpretation of such an NP, as in Montague's treatment; however, here *boy* denotes a set of singleton sets, and quantification binds a special variable over singleton sets.

All also has a collective interpretation.[12] This sense of *all* forms the union of the singleton sets in the extension of the CN, as in the logical form for *all boys* in (38):

(38) $\lambda\, \mathrm{P}\, [\mathrm{P}(\cup(\underline{\mathrm{boys}}))]$

---

[10]Stein (1971) also interprets individuals as singleton sets in a fragment of Thai.

[11]This is not the type of logical form Scha uses. In fact, the type of Scha's verbs and his rule for predication differ considerably from Montague's, as we shall see below, but these logical forms convey the intuitive idea behind his approach to abolishing Bennett's type distinctions.

My use of such logical forms in first order predicate calculus here, and in general in the following examples, is intended to be theory-neutral, and is used only to clarify the truth conditions under discussion. I do not mean to imply that such a logical formula should be part of the derivation or representation of the relevant sentence.

[12]Actually, Scha gives two different interpretations for any collective determiner, so that if it has a distributive reading as well, it has a total of three readings.

A one-place predicate P in such a system need only be a function from sets to truth values. It will then combine with either (37) or (38), since in each case its argument is a set.

This predicts that any subject-predicate combination should be grammatical, regardless of whether the verb would be individual-level or group-level on Bennett's approach. Scha, indeed, says that his grammar is "more tolerant," accepting sentences such (39) as grammatical, although the quantifier *each* is unambiguously distributive:

(39) Each boy gathers.

Further, since he regards *all* as ambiguously either a group or a distributive quantifier, (40) is ambiguous, yielding both the expected collective reading and an implausible distributive reading:

(40) All boys gather.

Scha regards (39) and the distributive reading of (40) as "semantic anomalies," of the same kind as the famous *colorless green ideas sleep furiously*, that is, presumably, as cases which violate selectional restrictions.

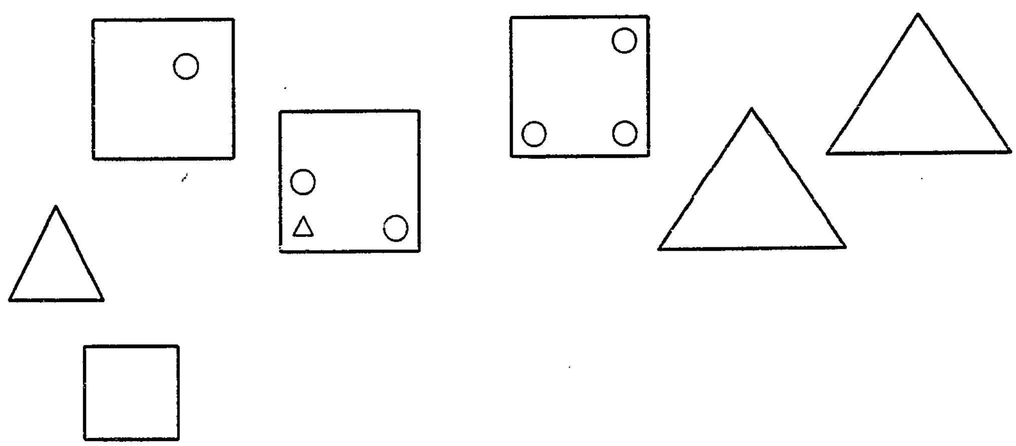
The table in (41) presents Scha's classification of the determiners he treats:

(41)	**Distributive**	**Collective**
	each	
	every	
	a	
	both	
	∅	∅
	all	all
	$\text{some}_{\text{sing/pl}}$	some_{pl}
	$\text{no}_{\text{sing/pl}}$	no_{pl}
	2,3,4 ...	2,3,4 ...
	the_{sing}	the_{pl}

A number of determiners in this taxonomy are considered unambiguously distributive — all the singular determiners and *both*. The null determiner, *all*, plural *some* and the numerals are ambiguous; only the plural definite article is unambiguously a group determiner.

Scha notes that Bennett (1974) and Hausser (1974) both treat plural *the* as ambiguous, with a distributive reading as well. He presents examples such as the following as evidence that the only correct reading of plural *the* is the group reading:

(42) The squares contain the circles

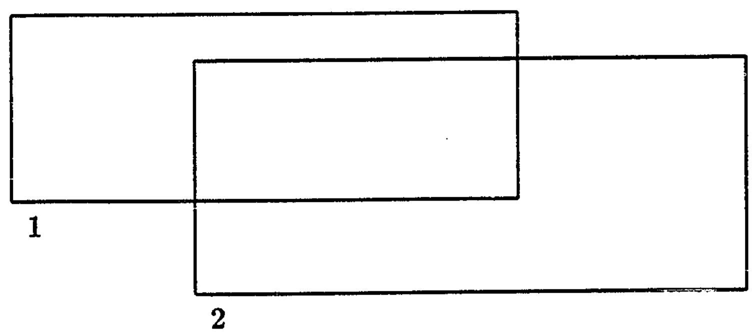


(42) has a reading which is true in the situation shown in his figure. However, Link claims that the Bennett/Hausser approach could not generate this reading, which has truth conditions something like (43):

(43) $\forall y[\text{circle}(y) \rightarrow \exists x(\text{square}(x) \; \& \; \text{contain}(x, y))]$

None of Bennett's types for *contain*, IV/T, IV/T_g, IV_g/T_g, or IV_g/T, yields (43). Anytime the subject is treated as distributive, this has the effect of universal quantification; but in (43) it is as if existentially quantified. One might try treating the subject NP as a group but the object as distributive, with the V type IV_g/T. This gets the correct, universal quantification over the circles and gives a sense 'each of the circles is contained in the group of squares,' very close to (43). But other examples are even more complex, as in (44), with truth conditions something like (45), so that it may be true in the situation shown in the accompanying figure:

(44) The sides of rectangle 1 cross the sides of rectangle 2



(45) $\exists x \exists y[\text{side-of-R1}(x)\ \&\ \text{side-of-R2}(y)\ \&\ \text{cross}(x,y)]$

Scha then proposes to account for (42) and (44) by treating all the definite NPs as group-denoting, then applying meaning postulates on the verbs *contain* and *cross*, as in (46) and (47):[13]

(46) $[\underline{\text{contain}}(u,v)] \rightarrow [\forall y(y \epsilon v \rightarrow \exists x[x \epsilon u\ \&\ \underline{\text{contain}}(x,y)])]$

(47) $[\underline{\text{cross}}(u,v)] \rightarrow [\exists x \exists y(x \epsilon u\ \&\ y \epsilon v\ \&\ \underline{\text{cross}}(x,y))]$

I agree that the truth conditions of sentences with plural definite articles should involve groups. However, I don't feel that these particular examples constitute by themselves a sound argument against treating the definite article as ambiguously distributive or group-denoting. Note that Bennett could also derive the meanings in (43) and (45) by treating all the definite NPs in these particular examples as group-denoting and the verbs of type $\mathrm{IV}_g/\mathrm{T}_g$, then adding the meaning postulates

[13] Again, Scha's logical forms are somewhat different; however, I believe (46) preserves the main intended truth conditional effects of his (5) in Section 6. His logical form also includes a requirement that the set denoted by the subject be non-empty, but I have omitted that as unessential here.

(49) and (50). Of course, he would also predict other readings with the distributive sense, but even if this seems infelicitous in these examples, is it in general impossible for plural definites to have a distributive interpretation, or is this interpretation only marked?

Under the assumption that definite plurals are unambiguously collective, Scha follows Bartsch (197?) in using meaning postulates on verbs such as *walk* and *eat* to derive distributive readings when these combine with definite plural subjects. For example, in order to derive the appropriate truth conditions for (48), Scha proposes a meaning postulate such as (49):

(48) The boys walk.

(49) $[\text{walk}(x)] \rightarrow [\forall y(y \epsilon x \rightarrow \text{walk}(y))]$

One final aspect of Scha's analysis which is of interest here is his treatment of what he calls 'cumulative quantification,' describing the most plausible reading of examples such as (50):[14]

(50) 600 Dutch firms have 5000 American computers.

He claims that this example has the reading in (51), a reading which could not be obtained from any combination of group and distributive readings of the two NPs:

[14]The following example, from Partee (1975b), illustrates the cumulative reading more vividly:

(i) (A total of) three women gave birth to (a total of) five children.

She calls the intended reading of (i) the 'total-total' reading. The example improves on Scha's because although a conglomerate or group of companies could jointly own one or more computers, no two women can give birth to the same child.

(51) $[\text{Cardinality } (\{x|\text{DuF}(x) \ \& \ \exists y[\text{AmC}(y) \ \& \ \underline{\text{have}}(x,y)]\})$

$= 600] \ \&$

$[\text{Cardinality } (\{y|\text{AmC}(y) \ \& \ \exists x[\text{DuF}(x) \ \& \ \underline{\text{have}}(x,y)]\})$

$= 5000]$

The type of reading Scha has in mind here also seems to be what Lauri Carlson (1980) and Schein (1986) call the "sum of the plurals" reading. It is in order to obtain this reading for (50) and similar examples that Scha invents a new mechanism for combining verbs with their arguments. Instead of taking n arguments one at a time, his n-place predicates take a single argument: an n-tuple consisting of n NPs. In addition, for examples with cumulative quantification, pairs of NPs of the form *numeral CN* may be generated by a special rule as a single "compound noun," with a meaning which is the cartesian product of the meanings of the two NPs individually:

(52) DuFs X AmCs

There are also compound numerals, and one of these may combine with a compound noun of the same arity n to form an NP which is a function from n-place relations to truth values. When such a compound NP combines with an n-place verb, a sentence results. In the case of (50), the truth conditions which result are equivalent to those in (51).

The Scha/Bartsch approach to the treatment of distributive verbs via meaning postulates retains some of the good features of Bennett's theory, while improving on it in other respects. The main advantage of the approach Scha advocates over earlier approaches is that he is able to predict readings of examples such as (26), *five insurance associates gave $25 to several charities*, where a group NP has wide scope over a distributive NP, without the type proliferation of Bennett's fragment. He achieves this by regarding distributivity as a lexical property of determiners, rather than as a function of scope or of the type of CNs and VPs.

But this same aspect of Scha's theory has some disadvantages, as well. He restricts the contribution of predicates to the distributive-collective-cumulative distinction to meaning postulates and selectional restrictions. One problem arises with the class of mixed verbs whose subjects sometimes appear to be distributive, at other times collective. *Lifted*, as in examples (1)–(4) above, is one example of this very common class, which also includes *bring*, *carry*, *give*, *take*, *own*, and many others. The group reading of definite plural NPs is strongly preferred with mixed predicates. For example, (53), with the mixed predicate *bring (something)* is generally considered quite ambiguous. As we might expect, (54), with a distributive-only subject, has only a distributive reading, but (55), with a definite plural subject, strongly suggests a group reading:

(53) Four women brought a salad to the potluck.

(54) Every woman brought a salad to the potluck.

(55) The women brought a salad to the potluck.

Yet in some contexts (55) can have a distributive reading. Consider the following discourse:

(56) Every woman brought a dish to the potluck. The hostess asked those from Acton to bring a casserole. The women from Boxborough brought a salad, and those from Littleton a dessert.

The subject of the underlined sentence is interpreted distributively.

The problem here is that the markedness of the distributive reading of the definite plural subject in (55), as opposed to the distributive potential of the subjects of (53) and (54), seems to support Scha's classification of plural *the* as unambiguously collective, as does the accessibility of the subject of the underlined sentence in (56) to serve as a discourse antecedent, as in (57), with the distributive reading of (56):

(57) The women from Boxborough brought a salad, and they came early to help set up.

If *the* is not the source of the distributivity here, then it must lie elsewhere. If the only other source of distributivity were meaning postulates on predicates, then examples such as (55) would force one to claim that meaning postulates could be optional. But this seems incoherent.

Alternatively, one might claim that the verbs under consideration are ambiguous, with both a distributive and a collective sense which are otherwise identical in their entailments. This is undesirable, since it would require a proliferation of ambiguity which would parallel Bennett's proliferation of types for verbs like *applaud.* And in any case, it would still leave the markedness of the distributive reading of (55) unexplained. Although I think Scha is correct in claiming that the distributive-group distinction rests in part on the nature of the determiners involved, there is a broader characterization of distributivity which will permit us to avoid this type of verbal ambiguity.

The other aspect of Scha's theory which bears close examination is his claim that there is a third kind of reading, the cumulative, and the way in which he proposes to account for such readings. We will consider the cumulative reading in more detail in Section 3.1.3.2. Here, however, I want to point out problems with Scha's formal account of how these readings are derived. Recall that Scha treats n-place verbs as functions taking a single argument, an n-tuple of NPs, and that the principal motivation for this unusual feature of his grammar appeared to be the treatment of cumulative readings of sentences such as (50). This approach is not well motivated syntactically, and in a more complex fragment I believe it would encounter serious problems with island constraints, conditions on bound anaphora, control, and other complex syntactic issues. Here, I will only illustrate my contention with another kind of problem: VP ellipsis. In Scha's fragment, there is no VP constituent syntactically or semantically. Hence, some of the standard approaches to the problem of VP ellipsis, such as Sag (1976) and Williams (1977), which state constraints on ellipsis in terms of VP constituents could not be translated into this framework. A phonological copying rule would not suffice, since issues of scope and anaphora (including sloppy identity) are involved. There are a number of other syntactic constructions which involve constituents such as VP or the notion of subject (whether basic or configurationally defined), and these all present problems for an approach which simultaneously inserts all the arguments of the verb.

3.1.3.2 Cumulative readings

Here we will consider Scha's claim that there is a third type of reading, the cumulative. I will first review earlier work by Langendoen on reciprocals and their relation to other sentences with multiple group-denoting plural NPs. Langendoen's insights will then prove useful in developing an analysis of Scha's collective and cumulative readings. I will adopt a suggestion of Barbara Partee's, and treat sentences with cumulative readings as a subclass of the class of sentences with two or more collectively interpreted NPs. I will argue that such sentences merely denote relations between as many groups, and that, as with reciprocals, any further details about the nature of the involvement of individual members of the groups in that relationship, which might be suggested by the particular lexical items involved, ought not to play a part in the truth conditional interpretation of the sentence. Finally, I will briefly review work by Gil (1982) which tends to support this view.

In "The Logic of Reciprocity" (1978), Langendoen attempted to discover an analysis of reciprocals such as *each other* and *one another* in which they make a unified, compositional contribution to the logical form of sentences in which they occur. In addition, he related the interpretation of sentences with reciprocals to that of a more general type of sentence involving relations between plural NPs. He calls sentences of the form *subject-verb-reciprocal object* "Elementary Reciprocal Sentences" (ERSs), and those of the form *plural NP-verb-plural NP* "Elementary Plural Relational Sentences" (EPRSs). While he does not specify exactly the class of NPs he permits in EPRSs, all of his examples use plural definite descriptions. Thus, I take it that he is interested in nonquantificational, group-denoting NPs.

Langendoen considers in detail six possible schemata for the truth conditions of ERSs; the strongest, Strong Reciprocity (SR), is given in (58), while the weakest, Weak Reciprocity (WR), is given in (59); in each, A stands for the set denoted by the subject, R for the relation denoted by the verb:

(58) **Strong Reciprocity:**

$$(\forall x, y \epsilon A)(x \neq y \rightarrow xRy)$$

(59) **Weak Reciprocity:**

$$(\forall x \epsilon A)(\exists y, z \epsilon A)(x \neq y \ \ \& \ \ x \neq z \ \ \& \ \ xRy \ \ \& \ \ zRx)$$

In SR, a given member of A must stand in the relation specified by the verb with each other member of A; while in WR, a given member of A need only play each of the two roles specified by the arguments of the relation with some other member of A. Langendoen argues in detail that any schema stronger than WR is too strong for the general case. The crucial kind of example, illustrated by (60), involves an asymmetric, disconnected relation on an unfounded set, since only WR, and none of the stronger schemas which Langendoen considers, can assign the value *true* to such an example:

(60) The integers succeed one another.

Langendoen then turns to consider EPRSs such as (61):

(61) The women released the prisoners.

He considers the schematic representation of the truth conditions for such sentences given in (62), where A represents the set denoted by the subject NP, B the set denoted by the object, R the relation denoted by the verb:

(62) $$(\forall x \epsilon A)(\exists y \epsilon B)(xRy) \ \& \ (\forall w \epsilon B)(\exists z \epsilon A)(zRw)$$

He notes that we can deduce WR, (59), from (62) if we i) set $A = B$ in (62), and ii) add the condition that R not be reflexive ($x \neq y$, $x \neq z$ in (59)). "That is, WR follows as the truth conditional-schema for ERSs from the truth conditional-schema for EPRSs by substitution of the interpretation of the reciprocal element for the object phrase." (p.187) He takes this as additional evidence for the claim that reciprocals make a uniform, compositional contribution to the sentences in which they occur, and for the correctness of WR, and therefore as evidence against the contention of Fiengo & Lasnik (1973) that the logical form of ERSs depends on properties of the relation R denoted by the verb.

In fact, as Langendoen points out, even the truth conditions for (61) which would be derived from the schema (62) may be too strong. "There remains ... the possibility that two or more of the women may have acted in the release of one or more of the prisoners in such a way that none of those women can be said to have individually released any of the prisoners." (p.186) Langendoen claims that the same kind of problem arises in deriving a logical form for the ERS *The women released one another* from WR, (59). He then proposes to weaken WR and the corresponding schema (62) for EPRSs to (63), Weak Reciprocity for Subsets (WRS), and (64), respectively, where $\subseteq$ stands for the 'subset of' relation:

(63) **Weak Reciprocity for Subsets (WRS):**

$$(\forall x \epsilon A)(\exists X_1, X_2, Y \neq \emptyset, Z \neq \emptyset \subseteq A)(x \epsilon X_1 \;\&\; x \epsilon X_2 \;\&\; \neg(x \epsilon Y) \;\&\; \neg(x \epsilon Z) \;\&\; R(X_1, Y) \;\&\; R(Z, X_2))$$

(64)
$$(\forall x \epsilon A)(\exists X \subseteq A,\ Y \neq \phi \subseteq B)(x \epsilon X \;\&\; R(X,Y)) \;\&\; (\forall w \epsilon B)(\exists W \subseteq B,\ Z \neq \phi \subseteq A)(w \epsilon W \;\&\; R(Z,W))$$

(64) specifies that each individual in the set A denoted by the subject must be a member of a subset of A which fulfills the role denoted by the first argument of the verb, and each individual in the set B denoted by the object must be a member of a subset of B which fulfills the role denoted by the second argument. (63) again

follows from (64) on setting $A = B$ and requiring non-reflexivity of the relation.

But even these schemata are too strong for some ERSs and EPRSs. The range of types of relations between individual members of the groups involved has been discussed at some length in the literature on reciprocals. Consider the following:

(65) The plates were stacked on top of one another.

(66) The leaves touched each other.

(67) The men knew each other.

(68) The men touched each other.

(69) The men killed each other.

(70) John's grandparents hate one another.

Langendoen's (65) is one of a group of exceptions to his WR/WRS. The problem with such examples, in contrast to (60), is the fact that the sets of individuals involved are well-founded with respect to the asymmetric relation — there is a first plate. He shows that such exceptions are systematic, in that they all involve restrictions on the spatial or temporal relations that order the elements of the set denoted by the subject, so that the order must go from top to bottom, outside to inside, front to back, left to right or right to left, or from earlier to later. Thus, while (65) is acceptable, (71) is not:

(71) the plates are stacked underneath one another.

L. Carlson's (1980) (66) can be true in a situation where the leaves are all on a tree and most of them touch one or more other leaves. Thus, WR/WRS is too strong for it.[15] But Fiengo & Lasnik's (1973) (67) seems to require that all the men knew all the others, i.e. Strong Reciprocity, (58). They show that weak reciprocity alone would permit (67) to be consistent with both (72) (where a cyclic or infinite asymmetric relation held between the men) and (73):

(72) No two men knew each other.

(73) Many of the men did not know each other.

This seems undesirable, and thus suggests that WR is too weak. However, Colin Gordon's (p.c.) very similar (68) is weaker than (67), in that not all the men have to touch all the others for the sentence to be true, and stronger than (66). And the counterparts of (72) and (73) do seem to be consistent with (68). Finally, in (69), also due to Gordon, it seems that only some of the men (but not just one or two) must have killed some of the others (but not just one or two) for the sentence to be true, and here again the sentence is consistent with counterparts of (72)–(73). These

[15]Carlson uses this example to argue for a slightly weaker, game theoretical version of WRS as one version of his rule for the interpretation of sentences containing plural NPs; this rule treats sentences including reciprocals, but also those with nonreciprocal plural NPs, whether strictly quantificational, as with *few*, or not, as with plural definite descriptions or *numeral CN*s. He then develops a theory of the distributive-group distinction which relies on three kinds of game theoretical rules: counterparts of Langendoen's SR and WR as alternative clauses in a rule for the interpretation of plural NPs, rules for specific determiners, and ordering rules which put restrictions on the relative scopes of NPs with different types of determiners. Like Scha, he recognizes the contribution of the lexical properties of determiners to the distributive-group distinction. In addition, he purports to derive the branching quantifier readings of Hintikka (1974). The overall system is rather complex and unclear on several points. The result tends to blur the distinction between group and distributive readings, making it more a question of vagueness than of ambiguity.

examples show that neither the semantic characteristics of the predicate alone, nor of the arguments alone, suffice to determine the strength of the reciprocal relation denoted. Chomsky's (1975) (70) is a case where several different interpretations are possible: perhaps each couple is involved in mutual hatred, or perhaps both members of each of the two couples hate both of the members of the other couple, or perhaps there is just a lot of hatred among the four people. These are the kinds of examples which have been used to claim, for example by Fiengo and Lasnik (1973), that a uniform, compositional treatment of sentences containing reciprocals is not possible.

There is another approach to the problem. Emmon Bach (UMass. colloquium, 1980) has suggested that the reciprocal can contribute uniformly to a compositional derivation if we include in its translation a context sensitive quantifier ENOUGH. Like *few*, *many*, and *most*, as well as adjectives like *big*, etc., what is enough depends on lexical properties of the relation involved, as well as characteristics of the individuals involved and elements of the context. Bach proposes that reciprocals be treated along the same lines as reflexives are treated in Bach & Partee (1980), that is, as causing the introduction of an argument-reducing function over predicates. For example, if a two-place predicate takes a reflexive object in Bach & Partee (1980), it becomes a one-place predicate, but its single argument, the subject, fills both places of the original two-place predicate. In sentences with transitive verbs, this is accomplished formally by introducing a variable meaning into the translation in the object position of the reflexive and simultaneously introducing an operator *SELF 1* into a Cooper Storage device (see Cooper (1975)). The operator is taken out of store at the VP level and takes the two-place relation as its argument; Bach & Partee (1980) describe *SELF 1* as "a function which turns a two place relation R into a one-place predicate *SELF1*(R), which is true of an individual x just in case

R holds between x and x." Thus, there is no direct translation for *himself* in Bach & Partee (1980), since the effect of a reflexive is partly syncategorematic. Since Bach (p.c.) envisions a similar treatment of reflexives, I will not offer a schema for their direct translation into intensional logic. However, incorporating the use of Bach's ENOUGH, we might develop a Langendoen-type schema for the logical form of reciprocal sentences in line with Bach's suggestion, as in (74):

(74) $$\exists A(\text{ENOUGH}_1 x \epsilon A)(\text{ENOUGH}_2 y, z \epsilon A)(x \neq y \;\&\; x \neq z \;\&\; R(x,y) \;\&\; R(z,x))$$

In other words, 'there is a group A enough of whose members stand in the roles specified by the relation with enough other members of the group.' Note that, if we add existential quantification over the set A, both (58), Langendoen's SR, and (59), Langendoen's WR, are subcases of (74), Bach's reciprocity:

(58) **Strong Reciprocity:**

$$(\forall x, y \epsilon A)(x \neq y \rightarrow xRy)$$

(59) **Weak Reciprocity:**

$$(\forall x \epsilon A)(\exists y, z \epsilon A)(x \neq y \;\&\; x \neq z \;\&\; xRy \;\&\; zRx)$$

A version of Bach's proposal which uses subsets, paralleling WRS, could be formulated to account for the relevant readings. Thus, Bach's proposal provides for flexibility in the strength of reciprocals, at the same time permitting a compositional treatment in which the limited distributivity involved in ERSs derives from the lexical contribution of the reciprocal itself, constrained by other pragmatic and lexical factors in the context.

Another way of expressing Bach's insight might be even less explicit about the precise nature of the reciprocal relation: the truth conditions for an ERS would be something like 'the group A (denoted by the subject) has the property of reciprocally R-ing itself (where R is the relation denoted by the verb).' What it means to bear some relation reciprocally to oneself could vary quite a lot, depending on the particular lexical items and contextual factors involved. The one factor which all such reciprocal relations would have in common would be the anti-reflexive condition which we see in both Langendoen's (59) and Bach's (74), which does somehow seem central to the idea of reciprocity. Reciprocity, then, reduces to an restricted type of relation between a group and itself.

Although Langendoen is not entirely explicit on this point, I think that his central insight is that EPRSs display the same wide range of relations between two (or more) groups as ERSs display between a group and itself. I think this is essentially correct, and that it is noncoincidental, but I think his suggested logical form for such sentences, (62) (and the subset version (64)), is not quite right for two reasons: first that there is no way to compositionally derive instances of this schema from actual EPRSs and, second, as we saw with ERSs, the schema is too strong to capture all of the types of relations which may be involved in our understanding of such sentences. With respect to the first problem, in order to compositionally derive a logical form for a sentence such as (61) which instantiates the general schema (62), one of two possibilities must be the case:[16] i) One of these is that one or both of the group-denoting NPs contributes some quantificational force to the logical form. But neither the universal quantification nor the existential quantification in (62) can be lexically inherent in one or the other of the two NPs in a sentence such

[16]I assume that such a schema could not be realized as a function of the verb, since, given the idiosyncrasy of verbal meanings, there would then be no reason to expect the general form of (64).

as (61) — if they are switched a very similar meaning results. ii) Alternatively, the quantificational force would have to arise syncategorematically; but it is very difficult to see how this could be handled in a compositional fashion. The rule would have to have access to information about the two NPs to the effect that both were group-denoting, and thus simultaneously to information about two constituents, one of which is embedded in a VP which acts as argument to the function denoted by the other (or as function to the argument denoted by the other — which is preferable is immaterial here).

To give just a brief example of how (64) is too strong to capture the range of relations in EPRSs, compare Langendoens' (61) with (75) and (76):

(61) The women released the prisoners.

(75) The guards released the prisoners.

(76) The parole commissioners released the prisoners.

Each of these involves the same verb and direct object, but they have different group-denoting plural definite subjects, with very different connotations. While (62), the schema for EPRSs, or (64), its counterpart in terms of subsets, may be adequate for the most salient interpretation of (61), both (75) and (76) have readily available readings for which both of these schemas are too strong. For example, in order for the guards to release the prisoners, it may not be necessary for each of the guards to be personally involved with the release of one or more prisoners. The release may involve distinct, routine tasks which differ from guard to guard, for example, filling out forms or taking over from another guard while he releases the prisoners. And for the commissioners to release the prisoners it needn't be the case that any of them be directly involved in the release; they simply initiate it.

These examples also bear on Scha's proposal for the treatment of his EPRSs (42) and (44) — that is, that the correct truth conditions depend on meaning postulates on their verbs. They show that this proposal is inadequate because the precise nature of the relations between the two groups may depend not only on the verb, but on its arguments. It may even depend on context: if we are reading a story about how guards joined in a prisoners' revolt, then we might take (75) in the same way in which many of us originally read (61), where the women, or guards, personally went around releasing the prisoners.

Bach's approach to reciprocals views them as a relation between a set and itself. Preserving Langendoen's insight, I will assume that EPRSs are a superset of the ERSs, relations between two (or more) sets. Then, the schema for the logical forms of EPRSs is more or less as in (77):[17]

(77) $R(A, B)$

Here, the set denoted by A and the set denoted by B stand in the relation R. For (61), the group denoted by *the women* and that denoted by *the prisoners* stand in the *release* relation. But of course, *release* has certain presuppositions, such as that the entity released was formerly in captivity; also, given our real world knowledge about such things, there are certain subtasks related to releasing someone.[18]If the agent in this relation is a single individual, we generally assume that this individual performed all the subtasks (though even this is not necessarily so; compare *the governor released the prisoners*, which is similar in this respect to (76)).

[17]Actually, (77) is just the simplest logical form for the reading I intend. Either NP may be quantified in or quantifier raised, though in cases where both NPs are group-denoting, this will not make a difference in truth conditions.

[18]Again, I have been influenced in this discussion by recent work by Dowty (1986) on the relation between distributivity and what he calls the lexical 'subentailments' of particular verbs.

On the other hand, when we assign agentivity to a group, as in (61), we may make certain assumptions about the roles of the individuals in the group. G. Carlson (1977, p.61ff.) discusses the relation between a collective entity and its members, in connection with the following examples with the singular definite subject *the battalion*:

(78) (a) The battalion was wiped out.

(b) The battalion is quite tired now.

(c) The first battalion handles ammunition.

(d) The battalion shifted its position slightly.

(e) The first battalion has served its country for 200 years.

(f) The battalion has been dismantled.

As he points out, in these sentences there is a wide range of types of entailments concerning the individual members of the battalion. He writes (p.62),

> In place of searching for some quantifier that ranges over members of the battalion, the question becomes one of discovering how it is that we recognize as true or false certain things said about the battalion. In this process of recognition, we bring with us a whole set of assumptions about the world and how real armies work in the world. In many cases, we can infer what sort of quantification would be appropriate. But this process of inference, I believe, should be viewed as an extra-grammatical process, and hence beyond the scope of semantics (as the area of semantics is conceived here).

How do we individuate groups? Consider L. Carlson's (1980) discussion of what it is to be a "set theoretical individual:"

> A plurality can always be identified by identifying each of its members individually. But significantly, there are other means in use too. One can identify a plurality with the same or similar means with which one identifies singular objects: by space-time localization, and by functional considerations (describing the internal organization and external function of the plurality).

In some cases, the functional cohesion of a group may be a question of socially defined roles. Consider (79), similar to G. Carlson's examples, but with a plural definite subject:

(79) The Marines invaded Grenada.

(79) is true, although not all members of the U.S. Marine Corps went to Grenada. We think of the Marines as an organized body by virtue of their official function as a military body, waging war. The entire body cooperates in a venture such as an invasion, but this may entail subtasks which are not directly involved, including maintaining proper functioning of bases in home territory, getting money from Congress, and the like. (75) is another case where we are likely to view the subject as such an organized body.

In (61), however, we have no basis for considering the group denoted by the subject to be cohesive, apart from their sex, except on the assumption that they all participated directly in the release. This combination of lexical information and world knowledge thus suggests inferences about the members of the group which are not licensed by the truth conditions of (61) alone.

Now let us return to reconsider Scha's claim that there is a cumulative reading which is distinct from the collective. Note that both Scha's examples of collective quantification, as in (42) and (44), and his example of cumulative quantification, (50), have truth conditions which are subsumed under Langendoen's schema for the truth conditions of EPRSs, (64), as well as my schema (77):

(42) The squares contain the circles.

(44) The sides of rectangle 1 cross the sides of rectangle 2.

(50) 600 Dutch firms have 5000 American computers.

(64) $$(\forall x \epsilon A)(\exists X \subseteq A, Y \neq \phi \subseteq B)(x \epsilon X \ \& \ R(X,Y)) \\ \&(\forall w \epsilon B)(\exists W \subseteq B, Z \neq \phi \subseteq A)(w \epsilon W \ \& \ R(Z,W))$$

(77) $R(A,B)$

Further, Scha's cumulative readings arise with precisely the same determiners which give rise to the collective readings, so there seem to be only two classes of determiners, the distributive and the collective-cumulative.

Barbara Partee (1985) has proposed that there is no fundamental semantic distinction between Scha's collective and cumulative readings. In each case, the group denoted by the subject, whether the NP is definite or indefinite, simply bears the relation denoted by the verb to the group denoted by the object. It is this generalized reading, subsuming the cumulative readings of Scha as well as those where two plural arguments each receive a collective interpretation, which I will refer to as the *group-group* reading. Depending on the lexical characteristics of the particular verb and NPs involved, our real world knowledge about their denotations, and other contextual factors, we may draw further implications from such a sentence about the nature of the involvement of individual members of the groups denoted, including (64) as one subcase, but these implications are not themselves a part of the semantic representation of the sentence. Link (to appear) makes a similar proposal about cumulative readings, assigning them a group-group interpretation (which he terms 'CC,' for 'collective-collective') in the model. He notes that such an approach raises the question: "where does the line of demarcation run between proper readings and mere models realizing a reading?"

David Gil (1982) argues (on the basis of questionnaires administered in several languages) that what I have called the group-group reading is very common. He distinguishes four types of readings of sentences which contain two plural NPs: two readings where the NPs are interpreted distributively (with either relative scope); a reading which he calls the "strong symmetrical," which corresponds to Langendoen's SR; and the "weak symmetrical," which corresponds to Langendoen's WR. He doesn't discuss the clear group-group readings, but he notes (p.453) that all the readings, including both kinds of symmetrical readings, can be easily represented by quantification over sets.

Gil's findings indicate that the symmetrical readings are strongly preferred over the asymmetrical readings by those who filled out his questionnaire, and, in addition, that the strong symmetrical reading is preferred over the weak. I think this result is interesting in that it shows clearly the availability of symmetrical, or group-group readings. However, I have some reservations about accepting his conclusions. Unfortunately, Gil includes only a few of the examples which he used in his questionnaire. I note that those he does mention are all of the form *numeral* CN_{pl}*-verb-numeral* CN_{pl}. Thus, although he wants to use his results to make claims about general features of the representation of quantified NPs, he seems to have restricted himself to a class of NPs which may all be group-denoting indefinites.[19]

If his examples were, in fact, all of this form, the results favoring the symmetric interpretations would provide further evidence that NPs with numeral determiners are unambiguously group-denoting, since the distributive reading appears to be highly marked, but would say nothing about the readings available for distributive NPs. Further, the only verbs which he uses in his examples are *read*, *see*, and *run*, verbs which Bennett and others have called distributive-only. Thus, the preference for the strong symmetrical reading over the weak may have to do with lexical entailments of these particular verbs, rather than a global preference for strong over weak symmetry.

3.1.4 Summary

In this section, we have considered three kinds of approaches to the distributive-group distinction. One type of theory, represented by Lakoff's proposal, bases the distinction on whether or not an NP has undergone quantifier movement. This approach correctly identifies distributivity in the quantificational force of certain NPs, but confuses distributivity with the NP's scope. Another approach, represented by Bennett's theory, sees the distinction principally in the lexical characteristics of predicates; but this tends to encode too much lexical and pragmatic information in the formal compositional semantics, and, in addition, fails to recognize the more systematic contribution of determiners and adverbial elements to distributive readings. The third approach, represented by Scha's theory with its emphasis on the contribution of determiners to distributivity, also fails to account for the full range of distributive readings, since it seems that even those plural NPs which are most clearly group-denoting, those with a definite determiner, may sometimes occur with a distributive reading.

[19]This has been argued by various authors, including Hoeksema (1983), Kadmon (1984) and Link (1986).

Finally, I reviewed a range of examples involving group-denoting NPs, including Langendoen's reciprocal sentences, those with multiple definite plural NPs, and Scha's cumulative examples, and argued that they all receive a group-group reading. Except for the possible exception of the reciprocal sentences, where the reciprocal itself may contribute a distributive element to the truth conditions of the sentences, the apparent quantificational element in our understanding of many of these examples is not a part of their truth conditions, but is only implied on the basis of various types of pragmatic factors, including lexical and contextual elements and world knowledge.

3.2 Groups as individuals

One of the central requirements for an adequate theory of distributivity is a theory of the semantics of group-denoting expressions. In Bennett's (1974) theory of plurality, groups in the model were sets of individuals. This led to problems because of the difference in the types of individual and group level NPs. Scha (1981) overcame this problem by making both singular and plural NPs denote sets, the former singleton sets. In a series of recent papers (1983,1984,1986,to appear), Godehard Link has developed a semantics of plurality which treats groups as distinct individuals in a model, instead of sets. I believe Link makes two important contributions to our understanding of plurality. One is his emphasis on the interpretation of groups as individuals in their own right, and the other is his exploration of the relation between the count and mass domains by the use of a lattice structured domain. In this section I will explore some of the consequences of Link's view of groups for a theory of distributivity.[20] First I will consider Link's proposal in detail. Then I will turn to a more general discussion of three topics central to the semantics of plurality, in

[20]See also Landman (1986b) for further discussion of the semantics of groups.

light of Link's theory: the interpretation of conjoined NPs, the relationship between syntactic and semantic plurality, and the phenomenon which Link has called "plural quantification." The view of the semantics of groups and plurality which emerges will lay the foundation for much of the discussion in subsequent sections.

3.2.1 Link's use of lattice structures

The central hypothesis of Link's (1983) "The Logical Analysis of Plurals and Mass Terms: A Lattice-Theoretical Approach" is that plural NPs denote individuals, just like singular NPs, rather than sets of individuals. He is able to accomplish this while obtaining the proper truth conditions for sentences in which plurals occur by giving the domain of individuals in his model the complex organization of a complete join semi-lattice. Before I consider his proposal in detail, I will briefly describe the mathematical structures called lattices, for those who are not familiar with them.

A lattice is a partially ordered set in which each two-element subset has both a supremum and an infimum.[21] A partially ordered set is an ordered pair consisting of a set and a relation over its members. Typically, this relation is symbolized by '$\leq$'; this translates informally as 'is less than (or equal to).' In a partially ordered set $\langle X, \leq \rangle$, the relation has three properties:

[21]This definition is drawn from the first chapter of Bell & Slomson (1969), on which this discussion of lattices is based.

(a) it is reflexive, so that for any member x of X, $x \leq x$,

(b) it is antisymmetrical, so that for any two members of X, x and y, if $x \leq y$ and $y \leq x$, then $x = y$, and

(c) it is transitive, so that for any members of X, x, y, and z, if $x \leq y$ and $y \leq z$, then $x \leq z$.[22]

The definition of a lattice also involves the terms *supremum* and *infimum*. These may be defined as follows: If A is a subset of X, an *upper bound* for A, call it x, is an element of X such that for any element of A, say a, $a \leq x$. Similarly, a *lower bound* is any $x \epsilon X$ such that for all $a \epsilon A$, $x \leq a$. The *supremum*, or *least upper bound*, of some subset A of a partially ordered set X is an upper bound of A which is a lower bound for the set of all upper bounds for A in X. Similarly, the *infimum* of A is the *greatest lower bound* of A in X, that is, a lower bound of A which is an upper bound for the set of all lower bounds for A in X. Intuitively, the supremum of some subset A of X is the smallest thing in X which is greater than (or equal to) all the elements of A. It can be shown that any finite non-empty subset of a lattice, and not just those with two members, has both a supremum and an infimum. Furthermore, we say that a lattice is *complete* iff any (possibly infinite) subset of the lattice has both a supremum and an infimum.

A number of structures with which most of us are familiar are instances of lattices. For example, if X is any set, $\mathcal{P}(\mathcal{X})$ denotes the power set of X, and $\subseteq$ is the relation of set inclusion, then $\langle \mathcal{P}(\mathcal{X}), \subseteq \rangle$ is a lattice. For any two sets A and B in $\mathcal{P}(\mathcal{X})$, the supremum of $\{A, B\}$ is $A \cup B$ and its infimum is $A \cap B$. A Boolean algebra is also a kind of lattice.

[22] If the set were totally ordered, then the relation would also have the property of dichotomy, that is for any two members x and y, either $x \leq y$ or $y \leq x$.

The structure which Link uses to organize E, the domain of individuals in his model, is a complete join semilattice. This is a partially ordered set in which any (potentially infinite) subset has a supremum, but there is no guarantee that each subset has an infimum. The semilattice on E is determined by the i-sum operator, $\vee_i$, which induces a part-whole ordering, $\leq_i$, on the individuals in the domain. $\vee_i$ has a syntactic counterpart, $\oplus$. The i-sum of two individuals is their supremum in the lattice. Informally, what this means is that for any atomic individuals in the domain, say Annie, a, and Bernard b, there is another individual, c which is the i-sum of a and b, that is, which is the denotation of "Annie and Bernard," $a \oplus b$. a and b both then stand in the i-part relation, $\leq_i$, to c. Furthermore, if there is another individual Danny d in the model, then there is a further individual e which is the i-sum of c and d, and the denotation of $d \oplus [a \oplus b]$. For convenience, I will sometimes call an individual such as c an *i-sum* and talk about its *i-parts* a and b. Because it is a distinct individual, c may have properties which neither a nor b have; for example, c may have the property of being a couple, though neither a nor b does.

Since the semi-lattice is complete, Link can also define an abstraction operator σ, which forms an individual term of the form $\sigma x P x$, where P is a one-place predicate. Such a term denotes the i-sum of all individuals that are Ps, which is an individual itself. In Link (1986), he points out that σ is actually a generalization of the iota operator: "If the extension of P is a singleton set then $\sigma x P x$ and $\iota x P x$ denote the same thing, viz. the unique element in this set."

E has a subset A which contains all the atoms of E, where an *atom* is a singular object. In A, in addition to individuals which correspond to objects in the ordinary sense of that word, Link includes as atomic individuals all "individual portions of matter." These form a subset D of A. The elements of D are ordered by another relation, the material part-whole relationship denoted by '$\leq$,' which induces another complete join semilattice, though this one is not necessarily atomic. There is also an order-preserving semilattice homomorphism from $E \backslash \{\emptyset\}$ onto D; essentially, this maps any (atomic or plural) individual in the domain onto its corresponding portion of matter. Hence, we can talk about the material correlate of a particular individual without identifying the two. Link claims that this offers some interesting insights into longstanding puzzles, such as how (80) can be given a consistent interpretation:[23]

(80) This ring is new, but the gold which constitutes it is old.

As I discussed briefly in Section 3.1.2, Link's general approach to distributivity is that it is a lexical property of one-place predicates. He defines a special class of *Distributive Predicates* (*DistrPs*), which includes any predicate whose extension contains only atomic individuals (see his definition D19, p.314). His syntax guarantees that DistrPs are combined with the a special '*' operator when they are predicated (via his rule T4) of a plural subject. This operator works on one-place predicates to generate all the i-sums of members of the extension of P, $^*P$. Formally, the extension of $^*P$ is the complete join semilattice generated by the extension of P, i.e. all the individuals in the extension of P and their closure under the i-sum operator (all the groups which they form). He then offers special axioms and meaning postulates for DistrPs. His theorem (T.10), p.316, guarantees that a starred DistrP will be distributed over the i-parts of the extension of any individual it is predicated of:

T.10 $\text{Distr(P)} \rightarrow \forall x \forall y[^*P(y) \;\&\; \text{i-part-of}(x,y) \rightarrow {}^*P(x)]$[24]

[23]But see Bach (1986) for discussion of a problem with Link's treatment of this example.

From all this, Link is able to guarantee the valid inference from (31a) to (31b), on the assumption that the predicate 'be a pop star' is a DistrP:

(31) (a) John, Paul, George, and Ringo are pop stars.

(b) Paul is a pop star.

The denotation of *Paul* is an i-part of the denotation of *John, Paul, George, and Ringo*, the DistrP in (31a) carries '*' and is subject to the distributivity theorem T10 on DistrPs, and hence what is predicated of the i-sum is predicated of the i-part.

Predicates other than DistrPs may have mixed extensions, including both atomic and i-sum individuals, but they cannot be starred when predicated of a plural subject, since * only applies to DistrPs. Some nonDistrPs may occasionally have a distributive meaning, but this requires the use of another operator, to be discussed below.

Among the non-distributive predicates are the mass terms (MTs). The denotation of a MT is a complete subsemilattice of the subdomain D, that is, it includes some set of atomic portions of matter and all their i-sums.

Both plural count nouns and mass nouns have what Link calls the *cumulative reference property*:

(81) If a is water and b is water then the sum of a and b is water.

(82) If the animals in this camp are horses and the animals in that camp are horses, then the animals in both camps are horses.

---

[24] *i-part-of*(x, y) is to be read 'x is an i-part of y.'

This property is encoded in theorems (T.11) and (T.12):

T.11 $\quad \forall x \forall y({}^{*}Px \;\&\; {}^{*}Py \;\rightarrow\; {}^{*}Px \oplus y)$

T.12 $\quad \forall x \forall y(Px \;\&\; Py \;\rightarrow\; Px + y)$ for $P \epsilon$ MT[25]

As Link notes, "The set approach to plural objects does not carry over to the case of mass terms, thus missing the structural analogy between the two cases. Inherent in the notion of a set is atomicity which is not present in the linguistic behaviour of mass terms." (1983,p.305)

There is another group of predicates which are neither DistrP nor MP. Among these are what he calls "mixed predicates" — those which sometimes receive a distributive interpretation, other times collective. As with other nonDistrPs, these may have mixed, atomic and nonatomic denotations. In Link (to appear) and Link (1986), he introduces an adverbial operator, D, which serves to introduce distributivity in the cases where such predicates receive the distributive interpretation:[26]

(83) $\quad {}^{D}\mathrm{VP} := \lambda x \forall y[\text{atomic-i-part-of}(y, x) \;\rightarrow\; \mathrm{VP}(y)]$

---

[25] '$a + b$' is the material fusion of a and b, a single individual.

[26] In Link (to appear), which was written before Link (1986), D seems to play a slightly different role than the simple, general operator I describe in the text. For example, it is defined only over DistrPs; and transitive verbs may be marked with a double D preceding, indicating that they are distributive over both arguments. The way I use the operator here, it may apply to any predicate whatsoever, DistrP or not, syntactic or derived by abstraction, whether the subject is singular or plural. This seems to be closer to its character in Link (1986), where he mentions its use with mixed predicates, on complex VPs and as the translation of floated quantifiers; however, he does not compare its use in the two manuscripts. Below we will see examples where so-called collective predicates are interpreted distributively over subjects which denote groups of groups. This supports the more generally applicable operator I discuss here. I will assume that D may apply trivially to predicates which have only atomic elements in their extensions.

D serves the same function in two other kinds of cases. First, Link adopts Dowty & Brodie's (1984) thesis, which we will consider in Section 3.4.1, that floated quantifiers such as *each* are adverbials which induce distributivity. He uses D to translate these adverbials. (84a), with a mixed predicate, has a collective interpretation which does not imply (84b), but if an adverbial applies to the predicate, implicit D as in (a′), or the explicit *each* as in (a″), the result does imply (b):

(84) (a) Bill, Pete, Hank, and Dan lifted a piano.

(a′) Bill, Pete, Hank, and Dan ^{D}[lifted a piano].

(a″) Bill, Pete, Hank, and Dan each lifted a piano.

(b) Pete lifted a piano.

Also, D may apply to a VP derived by lambda abstraction, so that, for example, the indirect object in (85) below may be interpreted distributively. A (simplified) logical form for (85) which incorporates D is shown in (86):

(85) John gave a pumpkin pie to two girls.

(86) (two girls) ${}^{D}[\lambda x(\text{gave}(j,\text{a pie},x))]$

Here, the property of having been given a pie by John is predicted distributively of two girls. When we apply the translation of D in (83) to the predicate it operates on in (86), the result is as in (87a), which reduces by lambda conversion to (87b):

(87) (a) $[\lambda x \forall y[\text{atomic-i-part-of}(y, x) \rightarrow$

$$(\lambda z(\text{gave}(j,\text{a pie},z)(y))]](\text{two girls})$$

(b) $\forall y[\text{atomic-i-part-of}(y,\text{two girls}) \rightarrow \text{gave}(j,\text{a pie},y)]$

so that each of the two members of the group denoted by *two girls* (atomic i-parts of the plural individual) has the property of having been given a pie by John.

In Link (1986), he extends and revises his (1983) theory of the logic of plural and mass terms to make it compatible with the generalized quantifier framework. Recall that in this framework, an NP does not denote an individual (whether atomic or plural), but a set of properties; for example, *a woman* denotes the set of all properties which some woman has, while *John* denotes the set of all the properties which John has. The conjoined NP *John and Mary*, i.e. the term *John*$\oplus$*Mary*, denotes a third set of properties, those which the individual $john' \vee_i mary'$ has. Since this individual may have properties which neither John nor Mary has, e.g. that of being a couple, then this set of properties is not just the intersection of the properties which John has with those which Mary has. This translation of *Mary and John* into a generalized quantifier assumes that *and* translates as $\oplus$. There is another type of *and*, the distributive or Boolean *and*, and we will consider this and related issues pertaining to the semantics of conjunction in Section 3.2.2.

Finally, Link (1984,to appear) introduces a function h from i-sums in the domain E onto what he calls "impure atoms." Thus, every nonatomic i-sum has an impure atomic correlate. Though the impure atoms are a subset of the atomic subdomain A, they are distinct from the "pure atoms," such as the denotation of *John*. When a syntactically plural term, such as *the Beatles*, is enclosed in angled brackets, as in $\langle$*the Beatles*$\rangle$, the result denotes an impure atom. Link's motivation for this device seems to lie principally in the analysis of examples involving NP conjunction and distributivity, and we will review these in the following section.

3.2.2 NP conjunction and distributivity

In this section, I will review some existing analyses of NP conjunction in its relation to distributivity. This is not intended to be a complete theory of conjunction, which involves a number of difficult questions which are beyond the purview of this work.[27] Rather, I will focus on three aspects of conjunction which are directly relevant to the question of distributivity and the semantics of groups. The first is the existence of (at least) two types of NP conjunction, collective vs. intersective, or Boolean, conjunction; I will give a preliminary characterization of the two types of conjunction and point out the types of examples which argue for the distinction. The second issue which I will briefly consider involves the conjunction of quantificational with nonquantificational NPs, and in particular whether some unacceptable examples of this may be taken to argue for a movement analysis of distributivity. Finally, I will look at examples which Link (1984) takes to motivate the mapping from i-sums onto impure atoms.

Several authors have recognized that there are two basic types of conjunction, though terminology and formal analyses differ. Hoeksema (1983) calls the two kinds of conjunction, "collective" and "intersective"; these are exemplified in (88) and (89), along with Hoeksema's proposed syntactic and semantic schemas for each type:[28]

[27]See, for example, Gazdar (1980), Rooth & Partee (1982), and Partee & Rooth (1983) for more general discussion of conjunction. See Link (1984) for discussion of a particular type of conjoined NP, the hydras.

[28]The syntactic and semantic schemas in these examples are not Hoeksema's, but I think they preserve the spirit of his proposal. $[x]$ means 'the denotation of x,' as does x'.

(88) Joe and Ellen have a new dog.

COLLECTIVE CONJUNCTION:

$$NP_{[\pm pl]} \;\&\; NP_{[\pm pl]} \rightarrow NP_{[+pl]}$$

$$\lceil [a \&_{coll} b]\ \ VP \rceil \;=\; VP'(a' \oplus b')$$

(89) Each man and each woman has a new dog.

INTERSECTIVE CONJUNCTION:

$$NP_{[-pl]} \;\&\; NP_{[-pl]} \rightarrow NP_{[-pl]}$$

$$\lceil [a \&_{int} b]\ \ VP \rceil \;=\; VP'(a') \;\&\; VP'(b')$$

In (88), the conjoined NP is plural, regardless of the plurality of the conjuncts. This in turn determines the plural number of the verb, by agreement. The truth conditions of collective conjunction are such that the predicate is true of the i-sum of the denotations of a and b, though it may not be true of either conjunct individually. Hoeksema claims that intersective conjunction, which might also be thought of as a "conjunction reduction" interpretation of conjunction, only occurs with singular conjuncts, as reflected in the syntactic schema in (89). The semantics are intersective in the Boolean sense. There is no group denotation.

I think things are a bit more complex in the case of intersective conjunction than Hoeksema's (89) would indicate. Note that the number of either or both of the conjuncts in this type of conjunction may be plural. (90) is a case where the conjuncts are of mixed number:

(90) Every man and most women prefer the all-expense-paid vacation (as a prize) over the fur coat.

Hence, I would suggest a syntactic schema for intersective conjunction as in (91), retaining the interpretation given in (89). I have used 'α,' 'β,' and 'γ' as variables over '+' and '−':

(91) **INTERSECTIVE CONJUNCTION:**

$$NP_{[\alpha pl]} \ \& \ NP_{[\beta pl]} \ = \ NP_{[\gamma pl]}$$

$$\text{where: } (\alpha = \beta = -) \rightarrow (\gamma = -)$$

$$[(\alpha = +) \text{ or } (\beta = +)] \rightarrow (\gamma = +)$$

$$[[a \&_{int} b] \ VP] \ = \ VP'(a') \ \& \ VP'(b')$$

Van Eijck (1983) discusses the same two types of conjunction in terms of what he calls "the scope of *and*." For him, in the collective interpretation *and* has narrow scope, while in the intersective interpretation, it has wide scope. Van Eijck treats these cases in the context of Discourse Representation Theory, though I won't go into the details of his proposal here. He also points out that there is another type of conjunction, "appositional coordination," illustrated by (92):

(92) His aged servant and the subsequent editor of his collected papers was with him at his death-bed.

The two conjuncts of the subject of (92) are just two different descriptions of the same person, with the result that the conjunct is singular in number, as is the verb. When *was* is replaced by *were*, a different, collective interpretation results. Van Eijck treats appositive conjunction with "wide scope *and*" as well. This amounts to the truth conditions of 'his aged servant was with him at his death-bed and the subsequent editor of his collected papers was with him at his death-bed.' But this conjunction reduction paraphrase may be true where the servant is not the same person as the editor, whereas (92) does not seem felicitous in that case. The singular verb seems to introduce a presupposition in this case that the two NPs denote the same individual, i.e. that the conjoined subject is pragmatically singular. This would account for the apparent difference between (92) and the conjunction reduction paraphrase.

Massey (1976) gives the following contrasting examples (slightly modified by me):

(93) Gerald Ford and Pierre Trudeau weigh over 270 lbs.[29]

(94) Joe Green and The Refrigerator weigh over 270 lbs.[30]

The preferred interpretation in (93) is one where the i-sum of Gerald Ford and Pierre Trudeau weighs over 270 lbs. (94) would generally be taken to mean that each of the two individuals denoted weighs over 270 lbs. These readings are strongly preferred on pragmatic grounds alone. Note that, though (94) on this interpretation has the same truth conditions as the conjunction reduction paraphrase, 'Joe Green weighs over 270 lbs. and The Refrigerator weighs over 270 lbs,' the number of the verb in this example doesn't warrant the intersection interpretation of *and*. But, as Link (1986) points out in conjunction with a similar pair of readings, the intersective interpretation isn't necessary in (93) in order to derive the correct truth conditions. Rather, the conjunction may be interpreted collectively, but then the predicate is interpreted distributively, using the D operator. The truth conditional result is the same as that of intersective conjunction. Thus, it seems that the

[29] The subjects denote an ex-president of the United States and an ex-prime minister of Canada, respectively.

[30] American football players, with the Pittsburgh Steelers and the Chicago Bears, respectively.

crucial examples which argue for intersective conjunction are those which involve (a) nonplural agreement on the verb, as in (89) and (92), and/or (b) distributive (non-group-denoting) NPs as conjuncts, as in (89), (90) and (92).

Consider again (90). Collective conjunction is not possible in this example because it involves forming i-sums of individuals in the domain and distributive NPs do not denote such individuals. Recall that Lakoff (1970a) offers examples which purport to show that only individual or group-denoting NPs may coordinate with proper names; compare (95a) and his (18d):

(95) The philosophers and John are similar.

(18) (d) * Few philosophers and John are similar.

As discussed in Section 3.1.1, Lakoff attributes the unacceptability of (18d) to the inability of Quantifier Lowering to operate into coordinate structures, since this would violate the Coordinate Structure Constraint. We have seen that a descriptively adequate theory of quantifier movement must, like Bennett's (1974) theory, permit the lowering, raising, or quantifying In of group-denoting, as well as quantificational NPs, since the former may take scope over the latter. One might, however, claim, that the movement of group denoting NPs is optional, whereas quantificational NPs have to move, as in May (1977). This difference, then, would be taken to account for the difference between (95) and (18d), since *few philosophers* would have to be lowered, raised or quantified in, violating the Coordinate Structure Constraint. However, such a theory would predict that quantificational NPs may never occur in coordinate structures; but we have examples where they do, as in (89) and (90) above, and (96) and (97):

(96) Both apartments and most of the mobile homes have a fire extinguisher in the kitchen.

(97) Few tv comedies and even fewer children's shows have any redeeming content.

(96) may only mean that both apartments have a fire extinguisher in the kitchen and most of the mobile homes have a fire extinguisher in the kitchen, an intersective interpretation of the conjunction. (97) has a similar intersective interpretation. It is generally conceded that *both* is strictly distributive, and *most* and *few* seem to be as well. Hence, it seems that distributive NPs may occur in coordinate structures so long as the conjunction is interpreted intersectively. The unacceptability of (18d), then, would arise from the fact that one of the conjuncts in the paraphrase of its conjunction reduction interpretation, 'John is similar,' is uninterpretable, since *similar* requires a group subject.

What then of the conjunction of quantificational and nonquantificational NPs? Many examples of this sort seem odd to me, but they may be grammatical. Most of them seem to have only intersective readings, which is what one would expect given the above discussion. Consider the following:

(98) John and every kid on the block ate an ice cream cone last night.

(99) The members of the drama club and every visiting director sent a press release to the local paper.

(100) The members of the drama club and every visiting director will attend a banquet Thursday evening.

All these seem a bit awkward to me, but I think they may be grammatical. (98) has only an intersective reading, where John ate an ice cream cone and each kid ate an ice cream cone. (If this example is acceptable, it is a direct counterexample to Lakoff's claim that proper names and quantificational NPs may not be conjoined.) Likewise, I think that (99) has only the intersective reading, where the directors, for whatever reason, sent different press releases from the one sent by the members of the club. (100) may have two readings. One is an intersective reading, where there will be one banquet attended by the members of the club and a possibly different banquet attended by each of the directors. But there may also be a reading where all of the members and the visiting directors will attend the same banquet; I suspect that this reading is forced by the pragmatics of the predicate — i.e., the likelihood that these people might have something in common to celebrate and the unlikely nature of a situation where each had different banquets to attend on the same Thursday night.

Mats Rooth (p.c.) has pointed out another sort of example where the quantificational conjuncts do not have a straightforward intersective reading:

(101) Each professor and some student of his are writing a paper together.

The most likely interpretation of (101) in a null context might be paraphrased, 'for each professor x, x and some student of x are writing a paper together.' Thus, the first conjunct appears to have wide scope over the entire sentence. Under the scope of this operator, a group formed by collective conjunction, and consisting of x and

x's student, has a property which may only be true of groups. Prima facia, this sort of example appears to be a violation of the coordinate structure constraint of Ross (1967). However, an adequate assessment of its import would require a deeper investigation into the semantics of conjunction and, in particular, its relation to quantifier scope, than I am prepared to undertake here.

Finally, let us turn to the example which motivates Link's (1984) mapping from i-sums onto impure atoms:

(102) The Leitches and the Latches like each other.

On the assumption that there are two Leitches and two Latches, Link claims that there are three ways to interpret this example. One reading results from treating each of the conjoined NPs as denoting a nonatomic i-sum, so that the whole subject denotes a single i-sum with four atomic i-parts. As we discussed in Section 3.1.3.2, a reciprocal predicate is collective; the reciprocal itself *each other* then suggests or entails that the relation of liking hold between atomic i-parts of the group denoted by the subject. This is the reading which is prominent if we introduce floated *all*:

(103) The Leitches and the Latches all like each other.

However, there are two other readings of (102) which cannot be obtained if each of the conjuncts of the subject denotes an i-sum. Link uses these readings to argue that the conjuncts may each denote an impure atomic individual, or couple.

When the plural conjuncts of the subject of (102) are interpreted as impure atoms, the logical form of the entire subject is as in (104):

(104) $\lambda P P(\langle \sigma x \text{Leitch}'(x)\rangle \oplus \langle \sigma x \text{Latch}'(x)\rangle)$

Now the predicate may be interpreted in two ways: If it is collective, the group denoted by (104), which contains just two atomic i-parts, has the property of *liking each other*. On this interpretation, each couple likes the other couple. If the predicate itself is interpreted distributively with the D operator, then the *like each other* property will be predicated of each couple. The further lexical distributive effect of the reciprocal then appears to be able to act on the individual members of each couple, even though the couples are themselves atomic individuals. Think of this reading in discourse as a retort to someone else's utterance of *I don't know of any couples where the husband and wife like each other*. In this respect, the distributivity of the reciprocal seems stronger than that of the D operator, in that it can entail relations among subparts of an atomic individual.

Given this approach to conjunction, we can analyze another type of example:

(105) The pitchers and catchers were practicing their signals.

Suppose we regard the plurality which is morphologically realized on both of the two CN heads of the subject as a single operator having wide scope over the whole conjunct, and treat the denotation of *pitcher and catcher* as an impure atomic individual. Then by interpreting the predicate distributively, we are able to derive a reading of (105) where each pitcher/catcher pair has the property of practicing their own signals (i.e., the signals are not common to the entire set consisting of all of the pitchers and all of the catchers).

There are other CN conjuncts, such as *husband and wife*, which also seem to have this atomic pair interpretation, perhaps even as a convention on their use. Note the fixed order of the conjuncts. Also, there is a possible interpretation of examples such as (106) where normally distributive predicates may be said to hold only of the ordered pair individual:

(106) The husband and wife ate an ice cream cone/smoked a cigarette.

It seems that the couple may have shared an ice cream cone or cigarette, though it is also possible to get a distributive interpretation, where each ate a cone or smoked a cigarette.

3.2.3 Syntactic vs. semantic plurality

There are a variety of ways in which the general notion of number is reflected in the syntax of natural language. In English and related languages, two of the most important are morphologically realized: the number of nouns and that of verbs. Here I want to discuss the relation between these syntactic reflexes of number and the semantics of plurality. First I will discuss verb agreement, beginning with a review of Hoeksema (1983), where an intimate relation is posited between the number of a verb and semantic interpretation. I will argue that this view is incorrect, and that instead we should view verbal number as a purely syntactic agreement phenomenon. Then I will turn to consider plurality in CNs. There, in contrast to verb agreement, I believe that syntactic number is directly reflected in semantic interpretation, and I will show how this might be reflected in a Link-type semantics of plurality.

Like Link, Hoeksema (1983) uses a structured domain and views distributivity as a property of predicates. However, his structured domain contains two kinds of entities, individuals and groups. In his theory, singular nouns and VPs denote sets of individuals, while plural nouns denote sets of groups, and plural VPs denote mixed sets containing both individuals and groups. Syntactic number is taken to be directly related to semantic number ("number concord is analyzed as a semantic phenomenon," p. 71), and thus the requirement of subject-verb agreement acts as a semantic filter as well. Distributivity is a regarded as a property of one-place predicates, introduced by means of meaning postulates.

There are several problems with Hoeksema's approach which make Link's preferable. Hoeksema himself points out that there is often a disagreement in number between subject and predicate. Some examples involve *there* insertion constructions, as in his (107); others, such as (108), involve nouns which are syntactically singular in number, but plural in the sense that their singular extension usually contains groups in some pretheoretic sense:

(107) There's all sorts of explanation.

(108) The committee gather. *(British English)*

Jespersen (1911,Vol.II,Chap.6) offers a large number of examples which display a lack of number concord, from which the following are drawn:

(109) *from Defoe (p.170):* Not one in ten of them write it so bad.

(110) *from Wells (p.172):* Do you mean to say, neither of you know your own numbers? [cf: neither of them know(s)]

(111) *from Shaw (p.174):* Public and private life become daily more theatrical.

(112) *from Norris (p.180):* incoherences, to which nobody, not even themselves, were listening

Finally, Barbara Partee (spring 1985 lecture, University of Massachusetts, Amherst) has pointed out that VP ellipsis presents a problem for this approach when the subject of one VP is singular, the other plural, since for Hoeksema, singular and plural VPs have different types of denotations:[31]

(113) John bought a house, and Bill and Mary did, too.

These problems with Hoeksema's approach suggest that it is a mistake to posit a direct relation between the syntactic number of a verb and its semantic interpretation. Rather, the morphological number on a verb is the outcome of an agreement phenomenon, with all the conflicting demands of syntax and pragmatics which so often plague agreement (cf. problems with gender).

Notice that Link (1983) also posits a relationship between syntactic and semantic number in his use of the $\star$ operator. This is true for both CNs and VPs, but the motivation for its use differs in the two cases. In VPs, $\star$ marks DistrPs (and only DistrPs) with plural subjects. Unlike Hoeksema's use of the number of the verb to trigger semantic plurality, Link's use of $\star$ on VPs does not depend solely on verbal number, for not all verbs of plural subjects receive the $\star$. But still, on this proposal a semantic characteristic of a particular kind of verb or predicate is determined by the syntactic number of its subject. I think this is questionable, and

[31]Recall the similar problem which faced Bennett's theory when, as in examples such as (36), two VPs of different types were conjoined. There, however, the types were not defined in terms of syntactic number, but of the individual/group-level distinction. A VP on the individual level could have either a singular or plural subject. For Hoeksema, the problem is both syntactic and semantic, since the two are interdependent.

that verbal number is solely a question of agreement, with no direct consequence for semantic interpretation apart from its role in indicating intersective conjunction. In addition, I argued in Section 3.1.2 that it is not necessary to build aspects of the lexical content of predicates into our semantics, so that $\star$ is not necessary or desirable for the characterization of distributivity in predicates.

However, Link (1983) also uses $\star$ on morphologically plural CNs, and I think that this use may be desirable, although its applicability needs to be clarified. Recall that he defines $\star$ as an operator over one-place predicates, which would automatically suggest its use with CNs. As with its use on VPs, a starred CN denotes the elements of the semilattice generated by its singular counterpart. However, unlike the use of $\star$ with VPs, Link offers no rules for its use with CNs, nor any discussion of the relationship between syntactic (or morphological)[32] and semantic plurality.

Let us simply correlate syntactic plurality in CNs with the application of the $\star$ operator. We then posit a direct relation between syntactic and semantic plurality, and define the semantic plural of a CN denotation in terms of the $\star$ operator, as the semilattice generated by its singular denotation. Note that under this definition the extension of a syntactically (and, hence, semantically) singular CN will be a subset of the extension of its plural counterpart. And if the extension of a singular extension contains only one individual, the extension of its plural counterpart will be identical (see below for discussion).

[32]I prefer to use the term 'syntactic plurality' for two reasons. First, although plurality in nouns is marked morphologically in English, this is not the case universally. In Haitian Creole, for example, plurality is marked with an enclitic particle, -*yo*, which follows the entire NP, including postnominal adjectives and deictic particles. This raises a number of questions about the locus of plurality and its compositional treatment. And, second, it reminds us that although the plural morpheme in English almost always occurs on the head noun, the CN so marked may be a larger constituent, including adjectives and/or complements to the head. We will consider such examples in conjunction with the discussion of Rooth (1986a,b) in Section 3.4.3.

The question of the syntactic number of an NP is a complex one. An NP might be considered syntactically plural when its head (or N′ or N″ constituent) is syntactically plural. But there is often some question about what the head is in a particular NP. Barbara Partee (p.c.) points out examples like the following:

(114) (a) Are the students or the teacher in the classroom?

(b) Either the students or the teacher is in the classroom.

(115) The majority of men is/are eligible to vote.

(116) None of my friends is/are going to the party.

In cases such as (114) where the conjuncts themselves differ in number, the number of the whole conjoined NP is in question, and resolution for some speakers often depends on proximity of the verb to one or the other conjunct. In the cases in (115) and (116), there is some question whether the construction is a partitive or a pseudopartive,[33] and the number of the verb vacillates accordingly. In addition, there is the question of the number of disjuncts such as *John or Mary*, compared with that of *John and Mary*. These problems with the definition of syntactic and semantic plurality of NPs suggest that the approach I have taken to nominal plurality in terms of CNs is preferable.

Despite such problems, most approaches to semantic plurality seem to focus on the NP level, instead of the CN. One such approach to nominal plurality is that of Van Eijck (1983), who offers the following formal definition of *semantic number*, where $\lceil a \rceil$ means 'the denotation of a,' $P(U)$ means 'the power set of U.'

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[33]See Selkirk (1977) for discussion of the distinction.

Call a NP-denotation $\lceil a \rceil$ *proper* iff $\lceil a \rceil$ is defined and $\lceil a \rceil \neq \emptyset$ and $\lceil a \rceil \neq P(U)$. [Then]

(i) semantic number(a) $=$ 1 iff in every model where $\lceil a \rceil$ is proper, $\neg(\emptyset \in \lceil a \rceil)$ and $\lceil a \rceil$ contains at least one singleton set.

(ii) semantic number(a) $=$ 2+ iff in every model where $\lceil a \rceil$ is proper, $\lceil a \rceil$ has only sets as its elements that contain at least two members.

(iii) semantic number(a) is undefined in all other cases.

First, note that this definition has nothing to do with CN number; for example, it makes *more than one man* plural. Furthermore, this definition does not make clear what the semantic number of syntatically plural NPs is to be. Is a plural NP such as *some girls* supposed to be undefined if there are less than two girls in a model in which it is evaluated? Note that if this is not the case, then the semantic number of *some girls* would be *1*, which doesn't seem to make a useful distinction between *a girl* and *some girls*. But if *some girls* is not defined in such a model, then van Eijck's definition makes different predictions than the definition of nominal plurality I have proposed in terms of properties of CNs, where the denotation of *some girls* in such a case would be the same as that of *a girl*.

The predictions of semantic plurality as I have defined it do not always correlate with our initial judgments in particular examples. For example, note the contrast between (117) and (118):

(117) There is a girl who is a good pitcher.

(118) There are some girls who are good pitchers.

We expect that the speaker of (117) only has evidence that there is a single girl who is a good pitcher, but in (118) we might expect that he has evidence that there is more than one girl who has this property. Yet, on the approach to plurality I have sketched, the extension of *girls* contains atomic individuals as well as i-sums of girls. This predicts that the utterance of (118) is true if there is only one girl who is a good pitcher.

I think this prediction is correct, but that, although the sentence is true in this situation, it is misleading by virtue of Gricean conversational principles. This is so because a plural CN is not only semantically plural, but in cases such as (118) implies that more than one girl has the properties in question. The singular NP *a girl* in (117) would be less likely to mislead in such a situation, since it has only atomic individuals in its extension. Then, by the Gricean cooperative principle, if I know that only one girl has the property, I should, in general, use the singular CN.

However, consider a situation where a bunch of boys are talking together about playing baseball with girls:

(119) A: I can't believe girls can be good pitchers.

B: Wrong! There are some girls who are good pitchers — Nina pitched a no-hitter last year.

I think that in this context, where the question of whether girls can be good pitchers is already salient, B's utterance can be true and felicitous when he only has evidence that there is one girl who has the property, and in fact, where there is only one such girl.

Another type of example, involving VP ellipsis, also argues that the relationship between semantically singular and plural CNs which I have argued for is appropriate:

(120) Al and Steve hurt their backs and so did Mary.

Even though the direct object in the first conjunct is plural, the ellipsis here seems perfectly felicitous. This also seems to indicate that *their backs* must have atomic individuals in its extension, so that Mary need have hurt only one back for (120) to be true.

Because of a limited number of nouns such as *scissors* and *pants* (*pluralia tantum*), which require classifiers such as *pair of* to be countable, and nouns which show no morphological distinction between singular and plural, such as *sheep* and *fish*, syntactic plurality does not always correlate directly with morphological form. However, apart from these exceptions, we recognize a fairly regular correlation between morphological form and syntactic number (and hence between morphological form and semantic interpretation) in CNs. In particular, in English the plural morpheme *-s* generally correlates with syntactic plurality.

Further, it seems that in the majority of cases the extension of a syntactically singular count CN contains only atomic individuals. The candidates for exceptions to this correlation include nouns such as *committee*, *police*, *legislature*, *nobility*, *audience*, and the like. (108) above exemplified a tendency to number agreement problems with these nouns, due to a tension between their syntactic singularity and our feeling that they denote groups. This particular example seems to be British in flavor, but there is a similar lack of agreement in American English with *police*, *nobility*, and other such 'group' nouns. Do the denotations of these singular CNs include nonatomic i-sums, or do they contain only atomic individuals, with the pragmatic implication of plurality arising from the general facts about what these things are?

In the framework we are considering here, there is a sense in which any expression whose denotation contains nonatomic i-sums also denotes atomic individuals. This is because of the mapping which Link (1984) posits from i-sums onto their impure atomic correlates. We might say that the denotation of the singular noun *committee* contains i-sums, each of which has a number of i-parts, the members of the committee. But due to the mapping onto impure atoms, *committee* would also denote impure atoms, the correlates of the i-sums in the first denotation under the mapping from i-sums to impure atoms. This would reflect our sense that a committee is more than its individual members, that it has its own being; and because of the correlation between an impure atomic element in the extension and its i-sum correlate in the mapping, we could still speak of the committee's members, interpreting this expression in terms of i-parts of the i-sum correlate of the impure atom.

I don't think there can be a pretheoretic answer to the question of the denotation of group nouns. Bach (1981a,1985) argues, correctly I believe, for a "natural language metaphysics;" we are not to bring to our semantics preconceptions of the way the world is, but instead to let language direct us in the construction of our models. In arguing for his view of groups as individuals, Link takes a similar position, with a call for "ontological agnosticism." In the discussion of adverbial distributivity in Section 3.4.1, I will point out certain technical consequences of giving group nouns atomic or nonatomic denotations, and suggest that within the framework I am assuming it is preferable to assume that they denote atomic individuals.

3.2.4 Plural quantification

Link (1986) claims that there is a phenomenon which he calls "plural quantification," in which we quantify over i-sums rather than atomic individuals in the denotation of a CN. He illustrates this by examples such as the following:

(121) (All) competing companies have common interests.

(122) No two competing companies have common interests.

(123) Two's company, three is a crowd.

There seems to be a reading of (121) in which *all* quantifies not over individual companies, but over groups of competing companies. The interpretation may be paraphrased, 'Any given i-sum of competing companies has mutual interests.' This is the only type of reading we can get for (122), with the further restriction that the i-sums of competing companies under consideration have only two i-parts each. And (123) seems to mean something like 'a group of two is company, while a group of three is a crowd.'

As further evidence of this phenomenon, consider NPs containing obligatorily collective predicates, such as the following:

(124) twin babies
feuding neighbors
opposed forces
matching towels

It seems that the extensions of such modified CNs can only contain i-sums.[34] [35] [36] So, in examples such as (125) and (126), the plural quantification reading is strongly preferred:

(125) Most twin babies love each other.

(126) Many feuding neighbors war constantly (on each other).

In both examples, the predicates are collective, so that only groups, or plural individuals, are in their extensions. Since twin babies only come in pairs, as do the *two competing companies* of example (122), in order to determine the truth of (125) we simply partition all the i-sums consisting of twin babies into two classes, those who love each other and those who don't; we then compare the cardinalities of the two classes, and if the former class is larger than the latter, (125) is true. Like twin babies, we generally think of feuding neighbors as coming in pairs — the expression is likely to connote the Masons and the Dixons, for example. In (126), if

[34]Or i-sums ('sets') of i-sums: note that these derived CNs may in some sense be semantically singular — for example, *opposed forces* may only refer to the i-sum of those forces which are opposed on a single issue. But one may want to talk about the characteristics of more than one such group, that is, the semantic plural of this CN. Since syntactic plurality in English only appears morphologically on the head noun, and since even the "singular" sense of this CN requires it, there can be no syntactic distinction between *opposing forces* as denoting an i-sum or an i-sum of i-sums.

[35]*Feuding* and *twin* may occasionally be used as attributions of a single individual, meaning 'one who is having a feud with someone else' and 'one who has a twin,' respectively. I don't think this kind of reading is available for *opposed* or *matching*, though there is another intransitive, non-reflexive use of these adjectives, where the opposed or matching party is already contextually salient. In these cases, the adjective is a function, 'opposed to x' or 'matching x,' which is referentially dependent on a contextually salient argument. I will not be concerned with these readings here. I think it is uncontroversial that the adjectives do have the plural-individual-denoting sense.

[36]Barbara Partee (p.c.) points out that the plural forms of all symmetric or non-asymmetric relational nouns seem to have such readings: cf. *friends*, *sisters*, *relatives*.

we only consider all the i-sums of pairs of neighbors who are feuding, and compare the number of pairs which war constantly with the number of pairs that don't, then I think we capture our intuitive sense of the sentence. *Many* may either have a proportional reading, where we compare the number of i-sums which have the property with the number which do not and decide if the proportion is adequate, or a context dependent cardinality reading, where we have some vague idea of how many we consider 'many' and determine whether the cardinality of the class of pairs which are feuding is equal to or greater than this number. But in either case, plural quantification seems to give the right results.

Now consider (127):

(127) Few people agree (with each other) on this issue.

The determiner *few* is strongly distributive, but *agreement* can only take place between individuals in a group. It does not make sense to say of an individual that she agrees with each other. So one is tempted to claim that *few* here quantifies over i-sums, groups of people; then the sentence would have the paraphrase 'there are few groups of people who agree with each other on this issue.'

But Angelika Kratzer (p.c.) has pointed out that there is a problem with the plural quantification approach to the truth conditions of (127). Consider a situation in which there are four people, call them *a*, *b*, *c*, and *d*, such that three of them, *a*, *b*, and *c*, agree on the issue at hand, while the fourth, *d*, doesn't agree with any of the others. Now consider the sublattice of E which is generated by these four people; in addition to the four atomic individuals, this sublattice contains all possible nonatomic i-sums of those atomic individuals, eleven in number. Then, Kratzer points out, if we partition these eleven i-sums into two classes, those whose members are all in agreement and those whose members are not all in agreement, we get the following result: the class of i-sums which agree will include the four individuals denoted by $a \oplus b$. $a \oplus c$, $b \oplus c$, and $a \oplus b \oplus c$,[37] but the class of those whose atomic-i-parts are not all in agreement includes the seven individuals denoted by $a \oplus d$, $b \oplus d$, $c \oplus d$, $a \oplus b \oplus d$, $a \oplus c \oplus d$, $b \oplus c \oplus d$, and $a \oplus b \oplus c \oplus d$. Thus, the number of plural individuals who are not in agreement is greater than the number of those who are, despite the fact that three out of four atomic individuals agree. This does not reflect our intuitive understanding of the proportion of agreement among the group of four atomic individuals. And if seven out of ten people agree on the issue, then there are only 120 i-sums of agreers, but 381 non-agreers, so that (127) might be (counterintuitively) true in such a situation.

Generalizing, consider any set of m atomic individuals. For any subset of m consisting of n atomic individuals which all agree in some way, there will be a total of $2^n - (n+1)$ nonatomic i-sums all of whose i-parts agree (the cardinality of the power set of a set of n individuals is 2^n, from which we subtract $\emptyset$ which is not in the lattice, and the number of singleton sets, since these are atomic). In order to find the i-sums whose members do not all agree in this way, we take each member of the set of non-agreers, of cardinality $m-n$, and add it to each element of the lattice generated by the agreers. That is, the number of non-agreers will be $(m-n)(2^n-1)$. And if we take into account the fact that in a given group, there may be subgroups of people which agree in different ways and do not agree with one another, then the number of i-sums which agree with each other must be calculated as follows: if there are k groups of people which agree in some way, each of some cardinality n, we must determine for each group the number of i-sums which agree in that way, and then sum together the agreeing i-sums for all the groups. And we must similarly

[37]Strictly speaking, $\oplus$ is an operation over pairs; however, $a \oplus [b \oplus c]$, $[a \oplus b] \oplus c$, and $[a \oplus c] \oplus b$ denote the same individual in the lattice, and I have used $a \oplus b \oplus c$ here to denote this individual.

determine the number of i-sums all of whose members are not in agreement. The number of agreers will be $\sum_{i=1}^{k} 2^{n_i} - (n_i - 1)$ and the number of disagreers will be $\sum_{i=1}^{k}(m - n_i)(2^{n_i} - 1)$. No matter what the number of atomic individuals of the relevant sort who agree with each other in some way, the number of i-sums whose members are not all in agreement will always be equal to or greater than the number of i-sums whose members are all in agreement. Kratzer calls this the *proportion problem* for plural quantification. The problem would appear to arise not only with *few*, but with *many* and *most*, which also have proportional readings.[38]

The proportion problem shows that in order to obtain the correct truth conditions in cases such as (127), not all i-sums are relevant. Rather, what seems to be at issue is the cardinality of the maximal collection of people who agree on the issue. For example, consider a situation in which there are twenty people and some burning political issue. Suppose that two of them agree on one potential solution to the problem, while three others agree on a different solution, and none of the others agrees with anyone on any solution. I think the relevant question is 'what's the largest number of people who agree?' Given the answer to this question, in this case 'three,' then we must determine, by some pragmatically given measure, whether or not this number is 'few.' One way to represent this intuition might be via a logical form such as (128):

[38]The situation doesn't improve if one compares the number of pairs of individuals who agree with that of those pairs who don't (for example, in this way, if out of a set of 10 people, 7 all agree with each other and 3 disagree with everyone, then only 21 pairs agree, whereas 24 don't), or if one compares the number of agreeing i-sums with the number of i-sums all of whose members disagree (then the problem works the other way: for example, if there are 20 people and 15 agree, but 5 disagree, then the number of agreeing i-sums is 32,756, while the number of i-sums all of whose members do not agree is 491).

$$(128) \qquad \text{FEW}(\sigma x[\exists y({}^*\text{person}(y)\ \&\ \text{agree}(y)\ \&\ x = |y|) \\ \&\ \forall z({}^*\ \text{person}(z)\ \&\ \text{agree}(z)\ \rightarrow\ x \geq |z|)])$$

where $|y|$ means 'the number of atomic i-parts of y,' and *agrees*(y) means that all i-parts of y agree in the same way. (128) means that the cardinality of the largest i-sum of people who agree in the same way is FEW. Though (128) does involve plural quantification, it is over a restricted type of i-sum, those which are a group of people who agree in the same way, and not over all i-sums which are in the lattice **person*.

A general truth conditional schema for *few* which would derive (128) for the sentence in question is given in (129):

$$(129) \qquad \lambda\text{CN}\ \lambda\text{VP}\ \text{FEW}(\sigma x[\exists y(\text{CN}(y)\ \&\ \text{VP}(y)\ \&\ x = |y|) \\ \&\ \forall z(\text{CN}(z)\ \&\ \text{VP}(z)\ \rightarrow\ x \geq |z|)])$$

The schema in (129) is of type $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$ (a relation between one-place predicates), the usual type of determiners. There are two ways in which the 'fewness' of the maximal collection may be determined, corresponding to two readings of *few*: on the cardinality reading, we simply have some number in mind, which isn't very large, and we check to see if the number of people who agree (the number of atomic i-parts of x) is less than or equal to this number. On the highly context sensitive proportional reading of *few*, we have some idea of what constitutes a small proportion of agreers relative to some other set, e.g. the set of all people in the situation. In either case, the operator *FEW* may be seen as a predicate which takes the cardinality of a maximal collection, or i-sum, as argument.

Note that a parallel reading is available for cases with *many*, as in (130), with truth conditions given by the logical form in (131):

(130) Many people agree on this issue.

(131)
$$\text{MANY}(\sigma x[\exists y({}^*\text{person}(y)\ \&\ \text{agree}(y)\ \&\ x = |y|)$$
$$\&\ \forall z({}^*\text{person}(z)\ \&\ \text{agree}(z)\ \rightarrow\ x \geq |z|)])$$

This means 'the maximal collection of experts who agree in some way is many.' (132) gives the appropriate logical translation for *many*, parallel to that for *few* in (129):

(132)
$$\lambda\text{CN}\ \lambda\text{VP}\ \text{MANY}(\sigma x[\exists y(\text{CN}(y)\ \&\ \text{VP}(y)\ \&\ x = |y|)$$
$$\&\ \forall z(\text{CN}(z)\ \&\ \text{VP}(z)\ \rightarrow\ x \geq |z|)])$$

(129) and (132) give the proper truth conditions for a variety of examples, and in addition bring out the intuitive parallel between *few* and *many*.[39] Their monotonic characteristics (see Barwise & Cooper (1981)) would be attributed to the lexical character of the particular operators *FEW* and *MANY*. However, I am not certain of the status of these logical schemas in the grammer. Note that they will not suffice as the translation of *few* or *many* in all examples. Angelika Kratzer (p.c.) points out that to utter *Few people are wearing matching sweaters* in a situation where ther are 100 people and 50 pairs of matching sweaters would be true on the "predicative" translation of *few* in (129), since the maximal collection of people wearing matching sweaters would be two. However, this is unintuitive. In this example, we seem instead to want to quantify over i-sums which are pairs of matching sweaters, with

[39]It was in order to bring out this parallel that I translated *few* as (129), rather than the simpler (i), which would not have generalized over *many*:

(i) $\forall x({}^*\text{person}(x)\ \&\ \text{agree}(x)\ \rightarrow\ \text{FEW}(x))$

a cardinal, rather than a proportional interpretation of *few*. It is possible that *few* (and *many*) are ambiguous, or it may become apparent that the truth conditions which these schemas aim to derive are actually subcases of a more general treatment of *few* and *many*.

Schein (1986) addresses a group of related examples, (133)–(136):

(133) (a) Few experts agree.

(b) Few experts ever agree.

(134) (a) Few Democrats vote with the President.

(b) Few Democrats ever vote with the President.

(135) (a) Few good students are unprepared.

(b) Few good students are ever unprepared.

(136) (a) Few advanced students collaborated on three problems.

(b) Few advanced students ever collaborated on three problems.

Schein claims that all these examples have what he calls an "event dependent" reading, indicated for (133a) and (133b) by a paraphrase like 'whenever there is an event of agreeing, it involves few experts.' He claims that the same reading is available for both versions of (134)–(136), as well; in fact, as I understand his theory, he predicts the availability of such a reading for all sentences with plural NPs. The schema behind these paraphrases might be given as in (137):

(137) $\forall x(\text{event}(x)\ \&\ \text{VERBing}(x) \rightarrow \text{FEW}y(\text{CN}'\text{–in–}x(y)))$

Schein uses the thematic role of a particular argument of the verb in these cases to further restrict the nature of the involvement of its denotation in the event, so that in (133), we might specify that the elements of the CN denotation are not involved in just any way in the event, but are involved in ways conventionally attached to the subject argument position of *agree* by the lexical specification of the verb.

(127) seems to have at least one reading with truth conditions in line with Schein's event dependent paraphrase, meaning something like 'few people ever agree on this issue.' I also agree that the event dependent paraphrase which Schein suggests comes close to the truth conditions for the examples in (133) and (136) and for one reading of (134b) and (135b), but there are a number of problems with his proposal.

First, I question whether such readings are available for (134a) or (135a). Consider (134a). This seems to be a statement about the voting tendencies of individual Democrats. But I do not get a reading of this example which reflects the event-dependent paraphrase 'whenever there is a voting with the President, it involves few Democrats.' This paraphrase is not about tendencies of individuals; it is about tendencies of overall voting patterns in Congress. (The paraphrase does reflect the "event dependent" reading of (134b). Of course, there is another reading of (134b) where there aren't many Democrats who vote with the President at any time in their careers.) If there are not many Democrats who habitually vote with the President, it still might be true on several occasions that many Democrats vote with the President (perhaps different Democrats on each of these occasions), so that (134a) would be true, but (135b) false. The type of paraphrase which Schein suggests fails in (135a) for the same type of reason — it fails to reflect the fact that generalizations are being made over individuals of a certain character.

Further, there does not seem to be a reading of (130) which instantiates the schema in (137), i.e., 'Whenever there is an event of agreeing on this issue, it involves many people.' For example, in a situation where 80% of the people agree on solution A and only 3% agree on solution B, the sentence is probably true; but within that situation there is a sub-situation (or subevent) involving the agreement of the 3%, and that group of agreers is not many in number. Schein's paraphrase would predict, incorrectly, that the sentence was false. Again, the truth conditions for (130) seem to hinge on maximal collections of people-who-agree, and not on just any collection of agreers. Compare this with a sentence which is slightly more generic in feeling, such as (138):

(138) Many people agree on such matters.

Here, there does seem to be a reading which might be paraphrased 'typically, when there is discussion of such matters, *the maximal set* of people who agree is many.' However, this is still not Schein's paraphrase.

Furthermore, note that the adverb of quantification *ever* occurs in the (b) version of each of the examples (133)–(136). This is surely not a coincidence. In fact, in all these event dependent readings there is a generic feeling which might be traced to either the explicit generic adverb of quantification or an implicit counterpart. Schein assigns universal or existential quantification over events freely, as an "aspectual difference" between sentences, but this fails to address the relation between the presence of adverbs of quantification and the possibility of quantification over events.

Moreover, *ever* is a negative polarity item, which means, following Ladusaw (1979), that it must be under the scope of a downward entailing operator. Monotone decreasing *few* is such an operator, and it seems that in these examples it is the only such operator. Comparison of (133)–(136) with examples which differ only in the presence of *many* instead of *few*, shows that it is indeed *few* which licenses *ever*:

(139) * Many experts ever agree.

(140) * Many Democrats ever vote with the President.

(141) * Many good students are ever unprepared.

Hence, *ever* must have scope under that of *few*. In view of this scope relation, a paraphrase of (134b)) which would be more in line with a compositional interpretation of the examples would be 'the number of Democrats who ever (on some occasion) vote with the President is few.' Instead of wide scope universal quantification over events, we have narrow scope existential quantification. This does indeed seem to be one available reading for (134b), but it is not the only one. There also seems to be a reading closer to Schein's event-dependent paraphrases: 'on each occasion, the number of Democrats who vote with the President on that occasion is few.' But it remains to be seen how this reading could be compositionally derived while respecting the negative polarity of *ever*.

Thus, while I agree that some of the examples Schein treats involve quantification over something like events (perhaps situations along the lines of Kratzer (1986)), his proposal seems too general, since it predicts event dependent readings where they do not seem to occur, and he misses the role of adverbs of quantification in deriving the sort of reading he is interested in.

In summary, neither quantification over i-sums in the denotation of the CN nor Schein's approach in terms of quantification over events appears to provide a general account of examples such as (127). But we may avoid Kratzer's proportion problem for such examples by means of the treatment of *few* and *many* suggested in (129) and (132). I believe that these logical forms may themselves ultimately yield to a deeper explanation, which may very well involve quantification over situations, but this will have to await a better understanding of the nature of situations, and how they are individuated and denoted.

Having addressed the proportion problem, let us return to the general question of plural quantification. There are some cases involving *few* which seem amenable to treatment with simple plural quantification over i-sums in the denotation of the CN:

(142) Few twin girls have the same taste in clothing.

Notice, however, that (142) involves the type of CN which may only denote an individual with exactly two i-parts. The proportion problem does not arise because in the extension of *twin girls* none of these dual individuals may combine to form more inclusive i-sums; such combinations would no longer be twins. Also, note that we tend to think of these individuals as units — a unit of twins. This is also the case with the CNs in our original examples, units of competing companies or of two competing companies in (121) and (122), of couples or trios in (123). What this suggests to me is that we don't need to posit plural quantification in order to account for examples such as (121)–(123) or (142). We never quantify over all i-sums in a plural CN lattice. Rather, we quantify over units of a certain sort. In the default case, these are atomic individuals — companies or girls. But when the minimal units which satisfy a CN are composed of more than one individual, we look at all units of the required sort, groups of competitors or sets of twins or groups of experts who agree in some way. We then quantify over units of this sort, rather than over all i-parts in the lattice of **company* or **girl* or **expert*.

The appropriate type of unit may even be suggested by the context, as in (143):

(143) Between many houses, there stood a picket fence.

This means that between many pairs of adjacent houses there was a fence. Since something may in general only stand between two things, we assume that the quantification is over pairs.

As Barbara Partee (p.c.) points out, natural units are often defined by events, so that in cases such as (133), the natural unit might be taken to be any group of experts engaging in debate on a subject of their expertise. But however the units are defined in a particular case, we only quantify over homogeneously defined unit i-sums. Recall that Link posits a mapping h from nonatomic i-sums onto impure atoms, so that we may either think of an NP such as *the Leitches* as denoting an i-sum or denoting an impure atom, a couple. Then thinking of the i-sums involved in the cases of apparent plural quantification as units, we might consider the quantification to be over their corresponding impure atoms, rather than over the nonatomic i-sums themselves. I believe that this possibility casts doubt on the existence of true plural quantification.

3.3 Determiners and distributivity

In the preceding sections, I have frequently assumed a classification of NPs into two types, according to properties of their determiners, the individual (or group) denoting NPs and the distributive, or quantificational NPs. Here I will address the question of the classification of determiners into the two classes.

Kamp (1981) and Heim (1982) both claim that there are two kinds of NPs, those, such as singular indefinites, which are interpreted as variables and those, such as universally quantified NPs, whose determiner sets up a relationship between the denotation of the CN and that of the predicate of which the NP is subject. The first type of NP I will call an *individual denoting NP*. The *group denoting NPs* are a subset of the individual denoting NPs, those whose denotations include nonatomic elements of the lattice-structured domain. The second type of NP I will call the *quantificational NPs*. These are the NPs which introduce a distributive element into the interpretation of a sentence in which they occur.

By the criteria I will discuss below, the individual denoting NPs include proper names and pronouns, as well as those with indefinite or definite determiners. Among the indefinite determiners are *a*, singular and plural *some*, and the numerals. The definites include singular and plural *the* and the demonstratives (*this* and *that*, *these* and *those*). There are a number of modified versions of these which are also individual denoting, such as a definite or indefinite determiner followed by a numeral, *few*, or *many*. I will not attempt to argue for the status of bare plural NPs, since this would involve considerations beyond the scope of this work.[40]

Quantificational determiners include the universals *each* and *every*, both singular and plural *no*, and the plurals *most*, *few*, *many*, *both*, and *neither*. There are a number of other quantificational determiners, simple or complex, which I have not considered here. See Bennett (1974) for an extensive list. As in Bennett's treatment, most of these can be handled as synonyms of the determiners I treat here.

The proposed taxonomy is summarized in the following chart:

[40]See G. Carlson (1977,1986), Wilkinson (1986) for discussion.

(144) **CLASSIFICATION OF DETERMINERS**

Individual Denoting	Quantificational
a	each
some$_{sg/pl}$	every
1,2,3 ...	no$_{sg/pl}$
the$_{sg/pl}$	most
this,that	few
these,those	many
both	
neither	

Implicit in this taxonomy is the hypothesis that determiners are unambiguous. There are a few cases, notably the numerals and *many*, where it is not yet clear if this hypothesis can be maintained. More investigation into the behavior of these determiners will be required before this matter can be settled. In the meantime, I have adopted the stronger hypothesis in the interest of making clear predications about the nature of distributivity.

One problem which complicates the issue here to some extent is that many of the lexical items frequently referred to as determiners (e.g. in Bennett (1974), Barwise & Cooper (1981), Scha (1984), among others) may actually be adjectival. For example, Hoeksema (1983) argues that the numerals are adjectives, and Link (1986) argues that they may in some cases be postmodifiers of determiners. Besides the numerals, *many* and *few* display adjectival properties: they take degree modifiers such as *as* and *so*, (compare with *almost* and *nearly* before numerals) and frequently occur in superlatives and comparatives, as predicate adjectives or after a definite or demonstrative determiner. *Most* also occurs after definites, though it doesn't display the other adjectival characteristics. Thus, the distribution of these possibly adjectival elements is in contrast to that of the true determiners, whether quantificational or group, since the latter occur only in SPEC position. Semantically, all but the numerals are non-logical, that is, their definition may vary from model to model, and their interpretation is often context dependent, like scalar adjectives such as *big* or *small*. The true determiners, on the other hand, are logical, not varying from model to model. I am not convinced that the group vs. distributive character of these lexical items is contingent on their categorial status, and in what follows, I will assume they are determiners for the sake of simplicity.

Other theories have recognized a split into two types of determiners, but the split is not made in the same way as I propose. For example, May (1977,1985), along with other theorists in the Government and Binding framework, assumes that there are two kinds of NPs, the referential and the quantificational, only the latter undergoing Quantifier Raising at LF. However, he would classify a number of NPs as quantificational which Heim and Kamp (and I) consider individual denoting. For example, *some CN* is quantificational in his theory. His criteria for what is quantificational are unclear; in May (1985), he claims that even plural pronouns may at times be quantificational.

As we saw in Section 3.1.3, Scha (1981) also has two classes of NPs, the collective and the distributive. But again, his taxonomy, repeated here, does not coincide with mine:

(41) **SCHA'S TAXONOMY OF DETERMINERS**

Distributive	**Collective**
each	
every	
a	
both	
$\emptyset$	$\emptyset$
all	all
$\text{some}_{\text{sing/pl}}$	some_{pl}
$\text{no}_{\text{sing/pl}}$	no_{pl}
2,3,4 ...	2,3,4 ...
the_{sing}	the_{pl}

For example, the term *collective* suggests plurality, so only determiners which take plural CNs are included in this class. Singular indefinites and definites are considered unambiguously distributive.

Since the treatment of the singular determiners which I assume here has been argued elsewhere (see, especially, Heim (1982)), I will focus on the classification of the plural determiners. The general rule of thumb in classifying plural determiners as group-denoting or quantificational is that group denoting NPs can appear to have a distributive reading, by virtue of adverbial distributivity (see Section 3.4 below), whereas plural NPs with quantificational determiners do not have group readings. It thus appears that the crucial factor in classifying a particular determiner is whether or not it may have a group reading.

There are a number of other tests for group readings. One of the most important is whether the NP formed by the determiner may serve as an antecedent for discourse anaphora. Quantificational NPs may only bind anaphoric elements within their scope. As we saw in Chapter 1, that scope may in some cases seem to be extended by telescoping; but strictly speaking, an NP only has scope over material in a predicate (syntactic or formed by abstraction) with which it combines. I will discuss this in detail in Chapter 4. For now, it suffices to note that this scope restriction is the basis of the frequently made claim that the scope of an NP is restricted to the sentence in which it occurs, since subject/predicate combination is always intrasentential.

Individual denoting NPs, in contrast, are treated as variables in the Kamp/Heim theory of discourse, and, if they are not under the scope of another operator, they are bound by an existential operator over the entire discourse in which they occur. Suppose an individual denoting NP maps onto a discourse referent x_i, and later the discourse referent for a pronoun is equated with x_i, as we have seen in numerous examples above. Then both discourse referents will be bound by the same existential operator over the discourse in which they occur, and, since the assignment function will recognize them as the same variable, the NPs themselves will be coreferential. This accounts for the anaphoric potential of individual denoting NPs in discourse, in contrast to that of the quantificational NPs.

Above we have seen a number of examples of the availability of conjoined proper names, definites, and numeral NPs to serve as discourse antecedents. And we have seen that in general NPs with singular universal determiners may not license discourse anaphora. There are, however, complications in demonstrating the unavailability of plural quantificational NPs to serve as discourse antecedents. Consider:

(145) (a) Many men lifted a piano.

(b) They got a crick in their back later.

Although *many* was classified above as a quantificational determiner, here it seems to serve as discourse antecedent for *they* in (145b). However, I believe that *many men* is not the antecedent of *they*. Rather, the search for an antecedent for *they* triggers the accommodation of a plural discourse referent 'the men who lifted a piano,' an accommodation licensed by the existential implications of *many CN*. As evidence for this, notice that there is no group reading of (145a). Even if the indefinite *a piano* has wide scope, the truth conditions of the sentence require that each man has the property of having lifted the piano. (Compare *many men got together to lift a piano*, where there may only have been a group lifting.) If *many men* were individual denoting, then such a group reading should exist, as it does in (1) and (2):

(1) Four men lifted a piano.

(2) Bill, Pete, Hank and Dan lifted a piano.

Thus, I take it that *many* is unambiguously distributive, but its existential implications often lead to accommodation. See Chapter 5 for some discussion of the phenomenon of accommodation in plural anaphora.

There is another test for whether an NP is group-denoting which is also based on the differential anaphoric potential of the two types of NPs. This is the NP's behavior in sloppy identity constructions. Recall that in Chapter 2 I agreed with Reinhart that the sloppy reading of such examples is due to c-command anaphora, and argued that the nonsloppy reading arises when the object in the first conjunct is discourse bound to its subject. Consider:

(24) Mary, Susan and Kathy love their mother, and Bob does too.

(146) Many girls love their mother, and Bob does too.

(24) is ambiguous between the sloppy reading, where Bob loves his own mother, and the nonsloppy reading, where he loves the mother of Mary, Susan and Kathy. But (146) has only the sloppy reading. These examples seem to support the classification of *many* as quantificational. However, I find the nonsloppy reading harder to get with an indefinite subject in the first conjunct:

(147) (a) Some girls like their teacher, and Bernie does too.

(b) Four girls like their teacher, and Bernie does too.

I believe I can get a nonsloppy reading of (147a) if *some* is unstressed.[41] But it is harder with (147b), and I am not sure of the source of the problem. Note that (147b) may occur with an unambiguously group reading:

(148) Four girls like <u>their teacher</u>. <u>She</u> encourages them.

If *four girls* were quantificational and bound *their*, then *their teacher*, which is referentially dependent on *their* and hence on *four girls*, would not be accessible as a discourse antecedent. Since it is in (148), we can be sure that the first sentence has a group reading.

Frey & Kamp (1986) note that in general indefinites are more likely to have distributed readings than definites. This seems to be true, and, whatever the explanation, it may be the reason why (147b) does not seem to have a nonsloppy reading. But generally, this test reinforces the results of the anaphoric potential

[41] In fact, in general, *some CN* seems more likely to have a distributed reading when the determiner is stressed. This may be due to the fact that a contrast is being made between two classes of entities in the denotation of *CN*, on the basis of whether or not they have some property. Also, stressed *some* in particular has a scalar implicature *not every*. Since *every* is purely quantificational, the implicature may introduce distributivity by association.

test and the others below, so that in most cases all and only those examples with individual denoting NPs may have the nonsloppy reading.

Another test, as we will discuss in Section 3.4.1, is whether an NP occurs felicitously as the subject of a predicate with a floated quantifier:[42]

(149) (a) The students all left.

(b) # Few students all left.

As discussed there, it is not clear that examples such as (149b) are ungrammatical — the contrast in (150) is not one of grammaticality:

(150) (a) The students were all wet.

(b) Few students were all wet.

In (150), only in the (a) sentence is ambiguous, meaning either that each student was wet through and through or that each student was wet. But (b) is unambiguous, meaning only that each of a small number of students was wet through and through. The unacceptability of (149b), then, seems to arise from the lack of a plausible 'through and through' meaning addition to the verb *to leave.*

Bennett (1974) points out that the prepositions *among* and *between* take a group-denoting complement:

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[42]This is related to Dowty & Brodie's (1984) pair in (i), showing that control structures display the same properties:

(i) (a) The students appeared to have all left.

(b) # Many students appeared to have all left.

(151) (a) Ellen found a thistle among some roses.

(b) # Ellen found a thistle among few roses.

(152) (a) Jonathon found a poem stuck between (the) pages of logical formulae.

(b) # Jonathon found a poem between both pages of logical formulae.

Finally, we may test the behavior of an NP in coordinate NPs, to see whether the conjoined whole may have the nonintersective reading which only group NPs license. (96), repeated here, has only an intersective reading, whereas (153) may have a group reading:

(96) Both apartments and most of the mobile homes have a fire extinguisher in the kitchen.

(153) Two movers and some neighbors carried the piano into the house.

Another kind of test which has frequently been used in the literature to gauge whether an NP is quantificational is the possibility of combining it with a so-called group predicate, such as *gather*, *be numerous*, the like. In particular, the possibility of predicating *gather* of *many CN*, as in (154) has been taken as further evidence that that determiner may be ambiguous between an individual denoting and a quantificational reading:

(154) Many people gathered in the square to protest.

This kind of test is questionable. First, with respect to *many* and *few*, I argued in Section 3.2.4 that there is a predicative reading of these lexical items which would give (154) the meaning roughly 'the cardinality of the maximal group of people who gathered in the square to protest is many.' This restricted version of Link's plural quantification thus accounts for (154) without the assumption that the subject is group-denoting. Note further, that the group predicates do occur with quantificational NPs, where the CN denotes groups, as in (155) and (156):

(155) All the different species of insects were numerous that summer

(156) Most church congregations gather to worship on Sundays.

(155) means that each species was numerous, (156) that the individual congregations in question gather to worship. If such group nouns as *congregation* denote atomic elements in the domain, then the subject of *gather* need not be a nonatomic i-sum. It is our world knowledge about what it is to be a congregation and what it is to gather which tell us that (156) is plausible, while John gathered is not.

3.4 Adverbial distributivity

I have claimed that the distributivity in examples with a group-denoting subject arises due to an adverbial distributivity operator. In this section I will explore the character of adverbial distributivity in a variety of constructions. First I will consider examples which contain explicit "floated" quantifiers, which Dowty & Brodie (1984) have analyzed as adverbial. This includes examples such as (157), with adverbial *each*:

(157) The men each lifted a piano.

As Dowty & Brodie point out, such examples seem to be related to partitive constructions, and I will briefly explore this relationship. In both of these constructions some explicit element serves to assure a distributive reading of a group-denoting NP.

Then I will turn to consider related examples such as (56) with a definite plural subject and a distributive reading but no explicit adverb:

(56) The women from Boxborough brought a salad.

I will discuss the motivation for positing an implicit adverbial in such cases. I will also consider examples involving what Choe (1985) calls "antiquantifiers," and show how these may be related to adverbial distributivity. Finally, I will examine a type of example which Rooth (1986a) calls "numeral based donkey sentences," as in (158):

(158) (a) Seven fathers with <u>two children</u> send them to Montessori School.

(b) They think it's a good investment.

These sentences display the same structure and anaphoric relation between a complement in the subject and a pronoun outside its scope as the classic universal donkey sentences of Geach (1962), but here the subject is not quantificational, and may itself serve as a discourse antecedent, as in (158b). I will argue that these are also cases involving implicit adverbial distributivity.

3.4.1 "Floated" quantifiers

Dowty & Brodie (1984) discuss "The Semantics of "Floated" Quantifiers in a Transformationless Grammar." These involve examples such as (159a) and (160a), which in earlier accounts were derived transformationally from the (b) examples:[43]

(159) (a) The students each left.

(b) Each of the students left.

(160) (a) The students all left.

(b) All of the students left.

They focus their attention on the examples with *all*, and develop an account in which these quantifiers are base-generated adverbials. The synonymy between (160a) and (160b)[44]is explained by the relationship between the semantics of constructions with adverbial quantifiers and the semantics of partitive constructions. In this theory, VP denotations are third-order, where a third-order VP denotes a function from generalized quantifiers to truth values (i.e. of type $\langle\langle\langle e,t\rangle,t\rangle,t\rangle$), instead of a function from individuals to truth values (type $\langle e,t\rangle$). That is, where in Montague (1973) NPs are functions which take VPs as arguments, here the VPs are the functions,

[43]See Dougherty (1968, 1969, 1970) for the earliest arguments I am aware of that floated quantifiers are moved from quantified subjects; he posits the transformations of 'Quantifier Postposition' and 'Quantifier Movement.' Chomsky (1971) uses Dougherty's analysis to argue for interpretation from Surface Structure, instead of Deep Structure; Partee (1971) argues against Dougherty and Chomsky in her Section 3.1.1 on '*each*-hopping.' I am not sure of the origin of the term 'floated quantifiers.'

[44]Dowty & Brodie do not directly address examples like (115b); however, they do discuss the partitive construction, and I believe that the comparison I am making here is implicit in their theory.

the NPs arguments.[45] This is necessitated in their account by the logical translation of *all* as a function from third-order VPs to third-order VPs:

(161) $$[\![[\underline{\text{all}}\ \text{VP}\ _{\text{VP}}]]\!] = \{\mathcal{P} \epsilon \text{D}_{\text{NP}} | \cap \mathcal{P} \subseteq \{y | y^* \epsilon [\![\text{VP}]\!]\}\}$$

(p.76, where $\cap\mathcal{P}$ = the intersection of all the sets in $\mathcal{P}$; "y^*" = $\{X|y\epsilon X\}$ (i.e. the maximal filter generated by y); and "D_{NP}" = the domain of NP-denotations. What this says is that every individual that is a member of the intersection of all the sets in the NP-denotation has the property denoted by the VP. What it means intuitively (and loosely) is that each individual in the extension of the subject has the property denoted by the VP. Dowty & Brodie argue that it isn't possible to have VPs be of the usual type, $\langle e,t\rangle$, and make *all* a function from type $\langle e,t\rangle$ to type $\langle\langle\langle e,t\rangle,t\rangle,t\rangle$, because of the interaction of *all* with verbal auxiliaries, including modals. Depending on their order, *all* and a modal auxiliary may have different relative scopes. If these elements are to be of uniform type, surely desirable on the grounds of uniform semantic and syntactic contribution, then both VPs with and without *all* should be of the same type.

As we saw, Link (1986) adopts Dowty & Brodie's general view of such adverbials and incorporates their insight about their semantic contribution without lifting the type of VPs. He uses his D operator as the logical translation of *all*:

(83) $${}^{D}\text{VP} := \lambda x \forall y[\text{atomic-i-part-of}(y,x) \rightarrow \text{VP}(y)]$$

Because plural individuals are of the same type as atomic individuals, he doesn't define D in terms of set inclusion, but uses instead the two-place i-part relation

[45]Montague (1970), Keenan & Faltz (1978), Bach (1980a) and Bach & Partee (1980) also treat VPs as functions which take NPs as their arguments, each offering independent reasons for this move.

between individuals of the same type.

Dowty & Brodie also discuss a restriction on the type of NP which can serve as subject in such a construction. They note that this restriction parallels that on the complement NP in partitive constructions, such as *the books* in *each of the books*. Jackendoff (1972) called this the "Partitive Constraint," claiming that it requires such NPs to be definite. Barwise & Cooper (1981) redefine the partitive constraint as a requirement that a partitive complement be interpreted as a principal filter (this is what constitutes definiteness, in their view). However, since NPs with any of the universal quantifiers are principal filters but are not acceptable as complement NPs in partitives, Barwise & Cooper must add the stipulation that the principal filter be proper, that is, generated by a nonempty set in all worlds. Although this eliminates the universal quantifiers, it also weakens the intuitive value of their version of the constraint.

Ladusaw (1982) notes that there is one remaining counterexample to Barwise & Cooper's constraint: *both CN* is always a principal filter where defined, and yet such NPs are clearly unacceptable as partitive complements. Ladusaw then provides a characterization of the constraint which rules out both the universal quantifiers and *both*. (In what follows, I am abstracting away from Ladusaw's particular formulation.) He observes that if we adopt the idea that a group may be semantically an individual, then, roughly, group NPs denote individuals, or, more precisely, they denote principal filters generated by an individual. Then we can state the partitive constraint as a requirement that the complement NP denote such a filter. Since *both* and the universal quantifiers are unambiguously distributive, never group-denoting, Ladusaw assumes that their denotations are not generated by an individual, and hence that they are ruled out.[46]

[46]Hoeksema (1985) presents an interesting compositional analysis of the syntax of partitives in which he claims that they are headless NPs with prepositional complements. Among

It is appealing to claim, as Dowty & Brodie do, that this generalization applies to the subjects of floated quantifiers as well: they must denote a principal filter generated by an individual, where groups are individuals in the model. There are, however, a couple of ways in which the requirements on partitive complements differ from those on the subjects of predicates with floated quantifiers.

One way in which they differ is that in general definiteness, in the sense of Heim (1982) and Kadmon (1986), seems to be a requirement on partitives,[47] but not on the subjects of predicates with floated quantifiers. Compare the unacceptable partitives in (162) with the floated quantifier constructions in (163):

(162) (a) # all of some men

(b) # most of four girls

(c) # few of sixty diplomats

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other things, he claims that they are related to comparative and superlative NPs of the form exhibited in (i) and (ii), where the complement NP may contain *all*:

(i) the most beautiful of all

(ii) the best of all pupils

I have no idea at present of how to analyze these, or what they say about the analysis of partitives Ladusaw proposes.

[47] In some cases, the requirement that partitive complements be definite in this sense seems too strong. Ladusaw notes the existence of examples like the following, with "specific" indefinites:

(i) one of <u>three people</u>

(ii) one of <u>several students who arrived late</u>

However, though such examples cast doubt on the generalization that partitive complements must be definite, the issue of "specific" indefinites is a much broader problem, and its resolution may make it possible to retain such generalizations about definiteness, or recast them in a form which accommodates these examples.

(163) (a) Some men each lifted a piano.

(b) Four girls each presented a science project.

(c) Sixty diplomats all presented the President with letters from their heads of state.

(162a–c) are unacceptable due to the indefinite nature of their complements, but these same indefinites are acceptable in (163a–c).

Besides the definiteness requirement, it seems that conjoined NPs are not generally acceptable as the complement NP in a partitive, although they are acceptable in cases involving floated quantifiers:[48]

(164) (a) # All of John, Mary and Susan ate pizza.

(b) John, Mary and Susan all ate pizza.

(165) (a) # Each of the bicycle, the tool kit, and the oven sold for $10.

(b) The bicycle, the tool kit, and the toaster oven each sold for $10.

Summarizing the discussion of partitives so far, we may conclude that they require their complement NP to denote an individual, in the extended sense of Link where we have plural individuals as well as singular, and also that they require their complement to be definite in the sense which concerns Heim (1982) and Kadmon

[48]Angelika Kratzer (p.c.) has pointed out to me that *among*, which also takes group-denoting complements, does not seem acceptable with conjoined NPs either:

(i) # Mary was among John, Susan, and Ellen.

(1986). However, these requirements do not suffice to rule out conjoined NPs, and thus it seems that some further constraint remains to be discovered. In contrast, subjects in floated quantifier constructions do not obey the definiteness restriction, and they permit conjoined NPs.

Ladusaw also notes the existence of examples with singular complement NPs, such as the following:

(166) some of the book

(167) most of the oatmeal

Proper names and pronouns also occur as complement NPs in these mass partitives:

(168) all of John

(169) all of me

First note that these are all definite, individual denoting NPs, and thus obey Ladusaw's partitive constraint — they each denote the principal filter generated by an individual. But here they are singular. These mass partitives demonstrate an unexpected bonus of couching Ladusaw's insight in the context of a theory such as Link's. Since the class of individuals in Link's structured domain includes not only objects, but also individual portions of matter, we can make sense of mass partitives by giving the complement NP its marked, but readily available, mass interpretation. Link (1983) argues at length for the mass denotation of CNs and NPs which are generally count, through examples such as:

(170) There is apple in this salad.

(171) The apple in this salad is mealy.

where the portions of apple in (170) and (171) need not come from or constitute one piece of fruit. In the mass partitives above, the book may be viewed as its contents, the oatmeal as a mass, me as my physical mass or, more abstractly, the mass of my consciousness.

Recall that the elements of the atomic subdomain D of individual portions of matter are also ordered by a relation of material part/whole. The lattice which is formed by this relationship is nonatomic, but in other respects it is like the lattice on the count domain. Suppose that in (167) we consider the material correlate of the oatmeal, say the individual portion of matter a_m in the model. We then find a way of characterizing a level of homogeneous material i-parts of a_m. For example, in *most of the oatmeal got wet*, we might consider a partition of the mass of oatmeal into equal portions of matter. These will also be atomic individual portions of matter on the count lattice, but they will be related to the entire mass of the oatmeal by the material part relation on the nonatomic mass lattice. Then we compare the proportion of those portions of oatmeal which are wet to those which are dry. Again, as we saw with the plural quantification examples, the quantification here is not over all parts of the denotation of *the oatmeal* (in fact, in a nonatomic lattice, there may be infinitely many parts of a given individual), but over parts homogeneously characterized in some appropriate fashion.

Note also that there are floated quantifier constructions which are counterparts to the mass partitives:

(172) John was all tired out.

(173) The dog was all wet.

Again, if we partition the mass correlate of the dog (or its surface) into relatively homogeneous portions, and then determine whether each is wet, we seem to get the right truth conditions for (173).

These mass partitives and floated quantifier constructions support Ladusaw's characterization of the constraint on these constructions in terms of groups as individuals, especially in a framework such as Link's which has a built in relationship between individuals in the count and mass domains. The individual denoted by a partitive complement or by the subject of a predicate with adverbial *all* need not be nonatomic. In the cases examined above where the individual is atomic on the count domain, we simply shift to its counterpart in the mass domain, and the distributivity over parts of the individual proceeds in analogous fashion in the two domains.

What does the constraint on the subjects of adverbially distributive predicates, parallel to that on partitive complements, amount to? Is it a formal prohibition of non-individual denoting subjects in such cases? Dowty & Brodie argue that there is no syntactic or semantic prohibition against combining a quantificational subject with a predicate modified by a floated quantifier. For example, they claim that the use of adverbial *all* with the subject *all (of the) CN*, as in (174) below, is infelicitous due to "the repetition of a homophonous word which contributes nothing new to the meaning of the sentence" (p.81). One reason they argue for the lack of a formal prohibition of such combinations is that they get better with length. Compare their examples:

(174) ? All (of) the students have all left.

(175) All of the students in the phonology class that I taught at the 1973 Linguistic Institute have all gone on to become well-known linguists.

(175) does seem to be more acceptable than (174), but this may be due to the "forgetful speaker" effect — in other words, we may accept (175) as a case where by the time she got to the predicate, the speaker forgot that the subject was a partitive, instead of just a definite, and repeated the distributive operator. Contrast (175) with (176):

(176) # Most of the students in the phonology class that I taught at the 1973 Linguistic Institute have all gone on to become well-known linguists.

I'm not sure what (176) could mean. It seems to me to make conflicting claims about the proportion of the speaker's students who are successful, given that the use of *most* generally implicates *not all*. The illformedness of (176) is in contrast to (177):

(177) Most of the people who came in from the storm were all wet.

I think we need to explain not only why cases such as (174) are unacceptable, but why (177), unlike (176), is acceptable.

Dowty (1986) offers an discussion of the nature of *all* which sheds light on this problem. He points out that it is difficult to ascertain whether this determiner is distributive or collective. (Recall that for Scha (1981) it was ambiguous.) Examples such as Dowty's (178), with collective predicates, seem to argue that *all* is collective and that it only has what Dowty & Brodie (1984) called a "maximizing effect," so that the CN and all the CN are truth conditionally equivalent:

(178) (a) John, Mary, and Bill are all alike.

(b) All (the) students gathered in the hall.

But (179), due to Bill Ladusaw, and (180), due to Barbara Partee, show that *all* can change truth conditions:

(179) (a) The students voted to accept the proposals.

(b) All the students voted to accept the proposals.

(180) (a) The trees are denser in the middle of the forest.

(b) All the trees are denser in the middle of the forest.

Thus, *all the CN* does not seem synonymous with group-denoting *the CN*. And Dowty's (181b), with another collective predicate, is unacceptable, in contrast to the version in (a) without *all*:

(181) (a) The students are numerous.

(b) # All the students are numerous.

As a point of departure in explaining these facts, Dowty argues that although the so-called collective predicates, such as *gather*, can only be true of a group qua group, many also have entailments about the individual members of their group subjects. He calls these the *distributive subentailments* of such verbs. For example, in order for a group to gather, most of its members must undergo a change in location, just as when a group disperses all must be in some central location to begin with and then leave; in order to disagree, the members of a group must each have opinions on some issue, etc. There are some predicates, he notes, which do not seem to have such subentailments, verbs like *numerous* which refer only to some characteristic of the group as an individual, but these are just the predicates which cannot take a subject with the determiner *all*, as in (180). Unless, of course, the subject is a group of groups, as in (182), and the collective predicate *numerous* is distributed over each of the member groups:

(182) (a) The different species of insects were all numerous that summer.

(b) All the different species of insects were numerous that summer.

Given this fact about collective predicates, Dowty then characterizes the effect of *all* with such predicates, as follows:

> **Hypothesis:** the effect of *all* on a collective predicate is to fully distribute the predicate's sub-entailments to every member of the group argument: Instead of merely holding of some (proper) subset of these members, as required by the predicate by itself, *all* requires that these sub-entailments hold of every member of the group.

To see how this works, consider again Ladusaw's (179). Dowty notes that in order for a group to vote for a proposal, it is necessary that a certain percentage of the members of the group have the property of voting for the proposal. In general, it isn't necessary that all members have the property, but when *all* modifies the subject in (b), then the subentailment must be distributed over the entire group; each member must have the property. This explains the different truth conditions of (179a) and (b).

Just as many "collective" predicates appear in this light to have a distributive aspect, Dowty points out that often the "distributive" predicates have a reading in which they do not distribute over all the members of a group denoted by their subject. He offers the following examples:[49]

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

(184) A: What was that noise?

B: Oh, I'm sure it was only the children getting up to watch cartoons. Go back to sleep.

Dowty argues that these examples may be literally true even though not all the reporters asked questions or one of the children is still in bed. He points out that, as with G. Carlson's *battalion* examples cited in (78) above, the number or percentage of the members of the group denoted by the subject which must have the property denoted by the predicate varies according to the sense of each. So, it may be that (183) is true although only a few of the reporters at the press conference, say one in four, got to ask questions, but if only one of four children is watching television, it seems false or inappropriate to say *The children are watching tv.*

These predicates, then, seem to have an extended sense in which they may be true of a group. But if we modify (183) with *all*, either on the subject or on the predicate, then the truth conditions are stronger, and the sentence is only true if

[49]Frey & Kamp (1986) also point out examples of this phenomenon, such as (i):

(i) The boys in the eleventh grade are cheating.

where it is not necessary for all the boys to be cheating in order for the sentence to be true.

each reporter asked questions. Thus, *all* also seems to strengthen the distributivity of these "distributive" predicates. Dowty suggests that if we regard the distributive entailments of ordinary distributive predicates as a special case of the distributive sub-entailments mentioned in (182), then the hypothesis may be generalized to hold over all predicates, and not just the collective ones.

Dowty does not provide an explanation of Partee's (180), but I believe that in Link's framework this may be viewed as an extension of the use of *all* to the mass domain. Suppose that *be dense* means something like 'the material correlate of the subject has the mass property of density.' *The trees* is a group denoting NP. In this context, it may be taken to refer to the i-sum of all the trees in the forest. Then, the (a) example means that 'the mass of the trees in the forest is denser in the middle.' But *all* in (b) distributes this mass property over the atomic i-parts of the group-denoting subject, that is, it forces each individual tree to have this mass property. So the truth conditions of the (b) example are considerably different from those of (a): 'the mass of each tree in the forest is denser in the middle.'

Summarizing Dowty's account of *all*, it seems to distribute the lexical subentailments of a verb over the members of a group denoting subject. Where the verb is itself basically distributive (i.e., involving activities or states which we generally attribute in the strict sense only to individual agents with a single will and consciousness) or a mass predicate, then *all* "maximizes" the distributivity of the predicate, so that it holds of each atomic i-part of the subject. Dowty points out that there are difficult cases involving what he calls "cooperative group endeavors." These are illustrated by Link's (1983) (185):

(185) (a) The children built a raft.

(b) All the children built a raft.

(c) The children all built a raft.

If *all* were translated as the adverbial D operator, then we might expect that (185b) and (c) would mean only that each child built a raft, but this is not the only reading of these sentences. Link proposes that *all* be translated as a 'participates-in' operator, so that the difference between (185a) and the examples in (b) and (c) is that, although the group of children as a unit may have accomplished the raft building in each case, in (b) and (c) each individual child participated in the building, while in (a) some may not have taken part actively. Dowty shows that this may be just a subcase of *all* distributing the lexical subentailments of such a verb over the members of the group. For example, there are a number of different tasks involved in building a raft. The predicate itself only requires that its subject accomplish all those tasks, but if *all* is involved, either as a determiner (or modifier of a determiner) or as an adverbial operator, then each of the children must satisfy some of the lexical subentailments of the verb. That is, each child must actively participate.

With this perspective, we may return to the question of whether, and when, floated quantifiers are acceptable with distributive subjects. Consider the unacceptability of floated quantifiers in examples such as (174). *All (of) the students* is not a group denoting NP; it has a distributive element. Thus, the sentence could only mean that each of the students has the property of 'having all left.' But what can it mean for a single individual to have 'all left'? This is quite strange, for it implies that the individual could have partly left. Similarly, (176) should mean that each of a large number of the students has the property of all being successful, but this is quite an odd property to predicate of an atomic individual.

By contrast, in (177) we have a mass predicate, *wet*, and it seems quite reasonable to say of a number of people who came in from the storm that they each have the property of being all wet. When used in conjunction with mass predicates, *all* seems to be able to split atoms, by shifting to consideration of homogeneous material parts of the material correlate of the subject. This is clearly related to its use in the mass partitives. These facts about *all* suggest that it is not adequately translated by Link's D operator, (83) above, which requires distributivity of the full sense of the predicate over all and only the atomic i-parts of an individual denoted by its subject. *All* is flexibly distributive: according to context, it may distribute either the whole sense of the predicate or its subentailments, and it may also select the level of individuation of individuals over which it distributes such properties, either atomic or subatomic (mass parts).

Floated *each* and *all* are different in this respect, and I believe these differences (which are also reflected in their use as determiners) may be captured by translating *each* as the D operator. First, notice that there are no mass partitives with *each*, suggesting that it doesn't have the flexibility to distribute over mass parts, as does *all*:

(186) # John is each wet.

Now consider the following examples:

(187) (a) The children all built a raft.

(b) The children each built a raft.

(188) (a) Every group of children built a raft.

(b) Every group of children all built a raft.

(c) # Every group of children each built a raft.

(189) (a) That group of children all built a raft.

(b) # That group of children each built a raft.

The use of *each* in (187b), in contrast to the use of *all* in (a), seems to require that each child built a raft by herself. That is, *each* does not seem to be able to distribute subentailments in general, but only the full sense of the predicate. ((187a) may also have the reading of (187b), so that it is ambiguous.) In (188), *all* seems felicitous in (b), at least for some speakers, with a reading where each child in each group participated in the group project of building a raft. But (c) is unacceptable. And in (189), the (a) example may only mean that all the children participated in building a single raft, while the (b) example is infelicitous.

If we assume that *each* does translate as the D operator, then we can explain these differences. The difference between (187a) and (187b) falls out automatically, since D distributes the full sense of the predicate over each atomic i-part of the denotation of the subject. With respect to (188), since *every* is distributive, then (188c) means that any given group has the property of each building a raft. If *each* translates as the D operator, and if the denotation of *group* is nonatomic, then applying an adverbially distributive predicate to this subject would mean that each atomic i-part in each group, each child, built a raft. But (188c) doesn't have such a reading (and in fact neither does (188b), although in other examples, such as (187a) *all* may lead to a reading which is synomous with the use of D).

However, recall that I discussed above the possibility that a CN such as *group* may denote an atomic individual. This example supports this analysis of group nouns. *Group* seems to put a lower bound on the distributive potential of *each*, since none of the i-parts of a group is also a group. Hence, even though the denotation of the subject in (188) is a group in the pretheoretic sense, distributivity over the individual members does not take place, as it does when *the children* or *the children in the groups* is substituted as the subject. The examples in (189), with a nondistributive subject, support this analysis of *group* as denoting atomic individuals, since the (a) example may only mean that all the children participated, and the (b) example is infelicitous.

Throughout this discussion of examples with nongroup-denoting subjects and adverbial distributivity, I have used the symbol for infelicity, #, instead of the * marking ungrammaticality. This is because, like Dowty & Brodie, I do not think the floated quantifier counterpart to the partitive constraint is a requirement on grammaticality. Examples (177) and (188b) are acceptable, though they have nongroup denoting, distributive subjects. And we could understand the unacceptability of examples (174) and (176) as a consequence of the pragmatic oddness of the resulting translation.[50] I think the unacceptability of (188c) is parallel to that of other examples where a predicate with floated *each* has a subject which denotes an atomic individual:

[50]Angelika Kratzer (p.c.) points out that (i) seems unacceptable:

(i) # The committee all sing.

I am not sure why this is so. I find (ii) alright:

(ii) The committee all sang Christmas carols at the last meeting.

This suggests that the generic mood of (i) may be the source of the problem.

(190) # John each built a raft.

If we translate *each* as D, the truth conditions for (190) are simply that each atomic i-part of the subject has the property of building a raft. Now, John is the only atomic i-part of the denotation of *John*, so the sentence should mean the same as *John built a raft.* The function of adverbial *each* is to distribute its predicate over the i-parts of the denotation of the subject. It may be that its use presupposes or implies that the subject has more than one i-part. Then, when a subject has none, the presupposition is unsatisfied, or the cancellation of the implicature violates Gricean cooperative maxims. In any case, the result seems to me odd, and not ungrammatical.

In summary, while *each* and *all* are both adverbial distributivity operators, they have slightly different properties, the former translatable in terms of Link's D operator, the latter able to distribute below the atomic level (as with the *group* examples) or to shift into the mass domain. And while I cannot comment here on the status of the partitive constraint, the parallel constraint on floated quantifiers does not appear to be a condition on grammaticality.

3.4.2 The D operator

I argued above that the source of the distributivity in examples such as (56) and (85) is an implicit adverbial operator, which we may translate as Link's D operator:

(56) The women from Boxborough brought a salad.

(85) John gave a pumpkin pie to two girls.

Let me review the evidence for this claim. Both *the women* and *two girls* are individual denoting: we know that they are not quantificational, or distributive, both because of the general character of the determiners *the* and *two*, discussed in Section 3.3, and, in these particular examples, because they both may serve as discourse antecedents. The properties of *bringing a salad* and of *being an x such that John gave x a pumpkin pie* are both mixed predicates in Link's sense, that is, they may be true of a group (a non-atomic i-sum) or of an individual (an atom). But if the sentences have a group reading, then *a salad* and *a pumpkin pie* are accessible to serve as discourse antecedents, while if the sentences have distributive readings these NPs are not accessible for discourse anaphora. We need to explain how, if these singular indefinites are not under the scope of a quantificational NP, they are masked with respect to anaphora.

My proposal is that they are under the scope of a quantificational operator, an implicit adverbial on the predicate. This will explain both the distributive reading of the sentence and the anaphoric masking, and, since the subjects (syntactic in (56), by abstraction in (85)) are not themselves under the scope of the adverbial operator, we can understand why they are accessible for discourse anaphora even though their sentences have a distributive reading.

There is another type of example which I believe involves the use of the D operator. Choe (1985) has noted the existence in Korean of what he calls an "anti-quantifier," the postnominal *-ssik*. *-ssik* generally occurs on NPs in the syntactic VP, though it may occasionally occur on the syntactic subject. It seems to require that some other NP distribute over a predicate in which it occurs (either the syntactic VP or one formed by lambda abstraction). This happens even when the (syntactic or quantified in) subject is group-denoting, such as a plural definite description or plural pronoun. Link (1986) discusses the German particle *je*, which seems to have similar properties. He proposes that *je* triggers the application of the D operator on a predicate in which it occurs. And there seem to be a number of other languages which have such anti-quantifiers. For instance, David Pesetsky (p.c.) suggests that Russian and Polish *po* may be an antiquantifier.

What about English? There is a use of *each* in ditransitive predicates which differs from the floated quantifiers considered by Dowty & Brodie (1984). The floated quantifiers occur generally after the first auxiliary of the predicate (though they may also occur before a modal, indicating they have wider scope). Ditransitive *each* is exemplified in (191) – (194):

(191) The students gave the guardsmen a flower <u>each</u>.

(192) The students gave a flower <u>each</u> to the guardsmen.

(193) The students gave the guardsmen <u>each</u> a flower.

(194) * The students gave a flower to the guardsmen <u>each</u>.

The occurrence of this *each* seems to be restricted to adjacency to the direct object of a distransitive verb.[51] [52] The requirement of adjacency to the direct object is

[51] I take the direct object to be the NP which occurs immediately following the verb when dative *to* marks the indirect object. This may not be an uncontroversial assumption (see Bach (1979,1980b), Dowty(1982)). Alternatively, in these examples, we might say that ditransitive *each* must follow the theme of *give*.

[52] David Pesetsky (p.c.) also notes that this *each* appears to be unacceptable in examples involving wh-movement:

(i) What kind of flower (*each) did the students give the guardsmen (*each).

illustrated by the unacceptability of (194). In (191) and (192), where *each* follows the direct object, there are two readings available, one where each of the students gave a flower to the guardsmen, the other where the students as a group gave a flower to each of the guardsmen. (193) has only one reading, where each of the guardsmen received a flower from the students.

The descriptive generalization seems to be that ditransitive *each* requires that the direct object occur in a distributive predicate. If *each* follows the direct object, as in (191) and (192), then either the syntactic predicate or one formed by abstraction on the indirect object may be distributed, in the first case over the syntactic subject, in the second, over the indirect object. But if *each* precedes the direct object, as in (193), then it is only the predicate formed by abstraction on the indirect object which is to be distributed, over the direct object.

My proposal is that, like Choe's Korean antiquantifier, ditransitive *each* triggers the use of the adverbial D operator on some predicate in which it occurs. Its varying position may put additional constraints on what predicate is distributed over what argument. Now consider Partee's (195) – (197), which receive the type of reading which was not available in (188b), with floated *each*, a reading where each man receives $5:

(195) That group of men received $5 each.

(196) Every group of men received $5 each.

(197) Every group of delegates had the same number of votes each.

Consider also:

(198) The group received \$5 each.

(199) Four boys received \$5 each.

(200) Alison gave the boys \$5 each.

(201) Jim sold all the ginseng plants he had collected. He received \$5 each.

Like distransitive *each* in (191) and (192), this use of *each* follows the direct object. And like ditransitive *each*, it seems to amount to the requirement that a predicate containing the object should be distributed over some other range of individuals. This range may be explicit, as the subject in (199) (which, on the most likely reading, is equivalent to *The boys each received \$5*), or it may be available via a part-whole relation, as in Partee's examples and (198), even where the parts are part of an atomic individual such as a group. The predicate may be the syntactic predicate, as in (195) – (199), or a predicate derived by abstraction, such as $\lambda x[gave(Alison,x,\$5)$ in (200).

(201) is interesting because here the range of individuals over which the predicate containing *\$5* is to distribute is given only in the context, by *the ginseng plants* of the preceding sentence. It is as if *receive* in this example requires an implicit, contextually given argument for its interpretation, present in the discourse representation, which is referentially dependent on *the ginseng plants.* Note that this same kind of reading is available for other examples, given a suitable context. For example, consider (198) after *John, Max, and Jose collected several ginseng plants.* (198) may then mean that the group of boys received \$5 for each of the plants, a reading which would not be available for *the boys each received \$5.* So, postnominal

each seems to permit distributivity over the elements of a contextually given group, unlike auxiliary *each*, which is restricted to i-parts of the subject.

There are a number of important unanswered questions about adverbial distributivity. Consider the range of quantificational determiners in English — there a quite a few of them, which differ considerably in meaning. Does adverbial quantification in English only display universal force? There are a number of other examples which it is tempting to analyze as involving nonuniversal adverbial quantification, as in (202):

(202) The children in my class mostly have a computer at home.

The most readily available reading of this example is that most of the children have a computer. But, although *mostly* here doesn't appear to quantify over times or situations, it often does so in other examples, and is regarded as one of Lewis' (1975) adverbs of quantification. This raises the question of the relation of adverbial distributivity in general to adverbs of quantification.

Another open question is whether adverbial distributivity is generally atomic, as suggested in Link's translation of D, or whether there are more cases which are like those with *all* and those within postnominal *each* in (195) – (201) in being flexible both in what property is being distributed, and in the level of individuation of parts of the subject.

In sum, though the D operator is adequate to derive the proper truth conditions for a variety of examples, its character and the extent of its use need to be investigated further, as well as its relation to more general processes of adverbial modification.

3.4.3 Numeral based donkey sentences

Rooth (1986a) discusses examples which he calls "numeral based donkey sentences."[53] In these, the plural subject with a numeral determiner may serve as antecedent for discourse anaphora, yet it licenses intrasentential anaphoric effects which parallel those of donkey sentences with universally quantified subjects. A universal donkey sentence is given in (203a), and a numeral based donkey sentence parallel to those in Rooth (1986a) is given in (143a):[54]

(203) (a) [Every father with two children$_j$]$_i$ sends them$_j$ to Montessori school.

(b) # They$_j$ both love it.

(c) # He$_i$ thinks it's a good investment.

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[53]Rooth (1986a) is an earlier version of Rooth (1986b). The two manuscripts differ considerably; among other things, examples like (143) are only discussed in the earlier version; Rooth (1986b) discusses instead related examples with partitive subjects, such as (i):

(i) Each of the farmers with a donkey beats it.

Whatever Rooth's reasons for omitting them in his later manuscript, I think the numeral based donkey sentences have the relevant readings, as in (143), and illustrate an important fact about distributivity.

[54]Rooth focuses on the following example:

(i) Three researchers$_i$ with two microscopes$_j$ use them$_j$ both.

While I agree that this example may have the reading indicated, I find that these examples improve when the relation between the head and the complement NP is more likely pragmatically to be distributed, and especially when the head is relational, as in (143). My informants concur. There is no difference here in structure or the potential for discourse anaphora.

(143) (a) [Seven fathers with two children$_j$]$_i$ send them$_j$ (both) to Montessori school.

(b) #They$_j$ both love it.

(c) They$_i$ think it's a good investment.

The relevant reading of (143a) is the one where each father has two children and sends both of them to the school. *Two children* in (143a) binds the pronoun *them* in the same way as in (203a). And as with the narrow scope indefinites in the donkey sentence *two children* cannot license discourse anaphora, as shown in (143b) and (203b). But *seven fathers with two children* can serve as discourse antecedent for the pronoun *they* in (143c), while the subject of (203a) may not license the subject of (203c).

Rooth argues that a grammar which incorporates a variation on Heim's (1982) file change semantics can provide an analysis of these examples. He points out that the essential idea of file change semantics is that a sentence meaning is a relation between information states (Heim's 'file change potential'). He then points out that what Barwise (1985) calls 'dynamic interpretation' may be viewed as another formal realization of this same idea, in an extensional fragment. His grammer, then, builds on the idea of dynamic intergration.

Barwise's proposal is different from Heim's in three principal respects. He has a slightly different conception of the structure of files than that of Heim, called *dynamic interpretation*; he extends dynamic interpretation to constituents below the sentential level; and he introduces the use of *parameterized sets.* Heim views the extensional file change induced by a sentence as an ordered pair: the Domain, which is a set of numerals corresponding to the numbers on the file cards required in processing the sentence, and the Satisfaction Set, a set of assignment functions such that for any assignment function, the conditions on the files whose indices are in the domain are true of the individuals denoted by the correspondingly indexed variables under that assignment function. A file change potential is a function from such ordered pairs, or files, to other ordered pairs, or files. Barwise's treatment essentially eliminates the Domain, and makes the denotation of a sentence a function from partial assignment functions to partial assignment functions, showing, thus, that the Domain is inessential in an extensional fragment.

Barwise also takes his 'dynamic interpretation,' or file change potential, below the sentential level. That is, not only are the denotations of sentences functions from assignment functions to assignment functions, but smaller constituents involve such functions, as well. For example, a VP denotation is not simply a set of individuals, but a set of triples of the sort defined for the intransitive *walk* by Rooth's (204), a relation between individuals and pairs of assignment functions:

(204) $g, x, \lceil \text{walk} \rceil g'$ iff $x \epsilon F(\text{walk})$ and $g' = g$

The input function, g, and the output function, g', are the same because the predicate contains no indefinite NPs which might set up antecedents for NPs later in discourse. Any individuals x are required to be in the extension of *walk*, *F(walk)*. The denotation of an indefinite NP, on the other hand, has an output function which differs from the input function just in the value assigned to the variable which has the same index as the NP:

(205) $g, x, \lceil \text{a man}_n \rceil g'$ iff $x \epsilon \text{F}(\text{man})$ & $g' = g^n_x$

Here, the output function g' may differ from the input function g in the value for the n^{th} variable, which is specified to be that of x, an element of the extension of *man*; this is the meaning of "$g' = g^n_x$."[55]

Finally, Barwise introduces the *parameterized sets* analysis of quantification. In generalized quantifier theory the denotation of a quantificational determiner such as *every* is taken to be a relation between the denotations of two predicates, that of the CN and that of the VP, i.e. a relation between two sets. But parameterized sets contain as elements ordered pairs of individuals and assignment functions. In universal donkey sentences such as (203a), there is a subject internal NP, *two children$_i$*, whose value varies with that of the whole subject (a given father). The CN of the subject *father with two children$_i$* denotes a parameterized set, where in each ordered pair the individual is a father and the i-th variable of the assignment function is an individual whose i-parts are two children. Recall that a VP, for example *send them$_i$ (to Montessori school)*, denotes a set of triples, where the second element is an individual with the relevant property. Since *them* is pronominal, and hence requires a prior antecedent, the input and output assignment functions will be the same for all the triples in the denotation of *send them$_i$*, as they were for *walk*. In general, a nonquantificational subject of such a predicate must denote an individual who is the second element in one of the triples in this set. The quantifier *every* in (203a) is a relation between a parameterized set, that denoted by its CN, and another parameterized set, $\{\langle x, g'\rangle | \exists g(\langle g, x, g'\rangle \epsilon F(\text{send them}_i)\}$, i.e. a parameterized set drawn from the denotation of the predicate. The relation between the two parameterized sets is the subset relation, i.e., the parameterized CN denotation must be a subset of the parameterized set drawn from the VP denotation. This permits the binding of an object pronoun *them$_i$* by *two children$_i$*, since the assignment functions in the ordered pairs of the CN denotation will now be the same as those in the VP.

[55] This condition as it stands does not guarantee that the indefinite is unfamiliar, in Heim's (1982) sense. Apparently, adding such a stipulation to the grammar Rooth develops is not a trivial question, as he discusses in (1986a).

Rooth develops a small fragment of English which incorporates the relational semantics and parameterized set constructions of Barwise (1985). He then compares this with a Montague grammar treatment of the same fragment, and shows that apart from the inability of the latter to treat donkey anaphora, there is a natural mapping between the two fragments. This gives insight into the way in which indefinite NPs may be interpreted as variables à la Heim (1982) and yet be equivalent to Montague's quantificational indefinites.

Besides this theoretical result, Rooth claims that his fragment shows two applications of Barwise's ideas. The first lies in the treatment of a problem with examples such as (206), a problem which Partee (1983) pointed out, and which is discussed in Bauerle & Egli (1985); Rooth calls this 'Farmer/Donkey Asymmetry' and Kadmon (1986) calls it 'the Proportion Problem':

(206) Most farmers that own a donkey beat it.

Basically, people feel that (206) is false in situations where nine farmers own one donkey each and don't beat it, but one farmer owns thirty donkeys and beats them all. Yet, since both Kamp (1981) and Heim (1982) quantify over farmer/donkey pairs without distinguishing the two elements of the pairs, they predict that (206) is true in such a situation.

Root (1986) proposes to handle this problem within the DR framework. She suggests that we consider not just all farmer/donkey pairs, or, technically, all embedding functions such that the discourse referent for the whole subject corresponds to a farmer who owns a donkey which is the denotation of the discourse referent for *a donkey*; but rather that we consider equivalence classes of such embedding functions, where all embedding functions which pick the same farmer but different donkeys are in the same equivalence class. Before, we interpreted (206) as meaning that most of the embedding functions where there was a farmer and a donkey in the owning relation could be extended so that the farmer beat the donkey. But under Root's proposal, (206) means that most equivalence classes of embedding functions can be so extended. Now (206) won't be true in the problematic situation described above. Rooth points out that with the distinction between the farmers and the donkeys which is built into the parameterized set approach, one can incorporate Root's proposal very naturally.[56]

The other application which Rooth considers is more directly relevant to our main topic in this chapter, distributivity. He proposes to account for examples such as (143) by treating both the subject and the predicate as involving parameterized individuals, even though the subject is not quantificational.

He does this by means of a rule which changes ordinary set-denoting CNs into parameterized set-denoting CNs, prior to pluralization (the latter along the lines of Link (1986)). Any rule which forms an NP out of a (not necessarily quantificational) determiner and such a parameterized CN will end up denoting triples defined by a relation between a parameterized individual and a pair of assignment functions. A separate parameterization rule for VPs makes them denote triples, each of which is defined by a relation between a parameterized individual and a pair of assignment functions. The subject-predicate combination rule then has the effect of permitting only pronouns in the VP to have access to the indefinite complement in the subject (*two children* in (143)), and not any subsequent pronouns in the discourse. The entire subject, however, since it is not inherently quantificational, may induce a change in the output assignment functions, so that it may serve as a discourse antecedent:

[56]See also Kadmon (1986) for extended discussion of the Proportion Problem in the context of Discourse Representation Theory.

(143) (a) [Seven fathers with two $\text{children}_j]_i$ send them_j (both) to Montessori school.

(c) # They_j both love it.

(b) They_i think it's a good investment.

While this way of treating the numeral based donkey sentences is descriptively adequate, it misses an important generalization. In all the examples where parameterization is appropriate, distributivity is involved. In quantified donkey sentences like (203), the distributivity is introduced by the quantificational determiner, *every* in that example. In numeral based donkey sentences such as (143), the possibility of the subject serving as a discourse antecedent suggests that the NP is not itself quantificational, but that the implicit adverbial D operator causes the predicate to distribute over the atomic i-parts of the extension of the subject. As Rooth suggests, in these examples the complement (*with two children*) is combined with the singular CN (*father*) before CN pluralization, using Link's $\star$ operator; in this way, each atomic i-part of the i-sum denoted by the subject is a father with two children.

Furthermore, parameterization, or donkey anaphora with numeral or other group denoting NPs, seems to be licensed by NPs other than the syntactic subject, so long as the group-denoting NP c-commands the pronoun which is bound by the parameterized indefinite. Consider the following example:

(207) The surgeon told [the two patients with a cancerous $\text{growth}_j]_i$ that he thought it_j should be removed immediately.

Here, the property of 'being an x such that the surgeon told x that he thought it_j should be removed immediately' is predicated distributively of the two patients who each had a cancerous growth.

Thus, it seems that something like Rooth's (1986a) VP parameterization may take place whenever an NP is distributed and c-commands the donkey-bound pronoun, whether the distributivity is introduced by the NP's determiner or adverbially. One way to incorporate this generalization into Rooth's theory would be to introduce parameterization only via distributive operators, whether determiners or adverbial D. In Rooth (1986b), the rule for the interpretation of a quantificational determiner in the subject introduces VP parameterization. As Rooth notes, his (1986a) rule which permits the parameterization of VP independently of its subject, to yield the anaphoric results in the nonquantificational numeral based donkey sentences, would appear to over-generate parameterized VPs. If parameterization were only introduced via the rules for the quantificational determiners and for D, this would constrain VP parameterization to occur only in the company of distributivity, capturing the generalization about examples such as (143) and curbing the overgeneration of parameterized VPs.

What I think examples such as (143) show is that a distributive predicate has access to conditions on the atomic i-parts of its subject, in this case, to the information that they each have two children. In Chapter 4, I will suggest how we can build this into a Discourse Representation.

3.5 Dependent plurals and global agreement

Dependent plurals (DPs) are exemplifed in the following examples. (208) is from Chomsky (1975); (209) and (210) are from deMey (1981):[57]

[57]The acceptability of DPs and whether or not they are required in such examples seems to be language-specific, and even to vary from person to person within English. I have not yet had an opportunity to investigate its distribution in other languages. What is

(208) Unicycles have wheels.

(209) All the boys have brought their fathers along.

(210) From here, trains leave regularly for Amsterdam.

We may understand the speaker of (208) as claiming that each unicycle has one wheel, (209) may mean that each boy brought his own father along, and (210) may be taken to inform us that in each of some regularly spaced temporal intervals, a single train leaves for Amsterdam. There is a distributive sense in each case, yet *wheels*, *their fathers* and *trains* are syntactically plural. And in each case, there is another plural element, whether the explicit plural subjects *unicycles* or *all the boys*, or the adverb *regularly*, which seems to suggest a number of regular intervals. It is generally the case that DPs must be in the scope of such a plural element; hence the name.

In this section I will consider the consequences of the dependent plural phenomenon for a theory of plurality and distributivity. I will argue that we should distinguish whatever it is that licenses dependent plurals from their effect on interpretation. With respect to interpretation, I believe that they may be interpreted as regular plural NPs, and so have little truth conditional effect, though in some cases they may be pragmatically useful in avoiding misunderstanding. And although I cannot offer a theory of what licenses dependent plurals, I will present some data which suggests the appropriate line of approach. First, however, I want to review some earlier suggestions in the literature regarding dependent plurals. In particular, some authors have taken this phenomenon as evidence for what Barbara Partee

said here is to be taken as a claim about English, though I presume it may be relevant for other languages with DPs.

(p.c.) calls a rule of *global pluralization.* For example, Chomsky (1975) uses (208) to argue that:

> ...a principle of compositionality is suspect. Global properties of the sentence, which may be quite involved,[FN] [[FN]Compare 'unicycles are believed to have wheels,' 'unicycles are believed to have been believed to have wheels.'] seem to play a role. We cannot simply assign a meaning to the subject and a meaning to the predicate (or to a sentence form with a variable standing for the subject), and then combine the two. Rather, the meaning assigned to each phrase depends on the form of the phrase with which it is paired ...Plurality is, in some sense, a semantic property of the sentence rather than the individual noun phrases in which it is formally expressed. 'Unicycles have wheels' means that each unicycle has a wheel, and is thus true, though 'each unicycle has wheels' is false. (pp.164–165)

He then proposes that predicates such as 'have wheels' have two senses, one which is identical to the sense of the "corresponding singular" 'have a wheel,' and the other, "inherent sense," which is presumably that found in "John has wheels." Chomsky makes no proposal about the form this rule would take.

Other, more recent proposals have made use of such a rule of global agreement. Link (1986) proposes an account of (211) in which he treats the first pronoun as a DP, generating it via a rule of predicate pluralization, which (though he is not entirely explicit about its syntactic consequences) presumably changes the singular form of the DP into its plural form.

(211) John and Mary invited $\underline{\text{their}}_{\text{distr}}$ parents to $\underline{\text{their}}_{\text{group}}$ place.

He proposes the following derivation of (211):[58]

(212) (a) $\lceil$John and Mary$\rceil$: $\lambda PP(j \oplus m)$

(b) $\lceil$invited his parents to their$_{\text{coll}}$ place$\rceil$:

$$\lambda u[\text{invited-to}'(u, \sigma y\ \text{parents-of}'(y,u), \iota v\ \text{place-of}'(v,z))]$$

(c) $j \oplus m$ is then quantified into the z-position of the translation of the predicate, yielding:

$$\lambda u[\text{invited-to}'(u, \sigma y\ \text{parents-of}'(y,u), \iota v\ \text{place-of}'(v, j \oplus m))]$$

(d) VP pluralization applies, yielding:

$$^*(\lambda u[\text{invited-to}'(u, \sigma y\ \text{parents-of}'(y,u), \iota v\ \text{place-of}'(v, j \iota m))])$$

(c) might be paraphrased, 'the property of being someone who invites her parents to John and Mary's place.' The denotation of the starred version of this property in (d) is the semilattice generated by the denotation of (c). I assume from Link's remarks that he takes the predicate in (c) to be a DistrP (raising again the question of how such a complex predicate can be called "lexically" distributive), for he then assumes that when applied to the denotation of *John and Mary* in (a), the result will be distributed by virtue of the meaning postulate T10 about starred DistrPs, yielding the translation in (212e):

(212) (e) (4) denotes:

$$[\text{invited-to}'(j, \sigma y\ \text{parents-of}'(y,j), \iota v\ \text{place-of}'(v, j \oplus m)) \ \&$$
$$[\text{invited-to}'(m, \sigma y\ \text{parents-of}'(y,m), \iota v\ \text{place-of}'(v, j \oplus m))$$

[58] Where, again, $\lceil x \rceil$ means 'the denotation of x.'

Hence, 'John invited his parents to their place and Mary invited her parents to their place.' We will return to a discussion of the treatment of anaphora which this example implies in Chapter 5. Here, we will focus on the feasibility of a rule of pluralization such as this as a general approach to the problem of DPs.

Notice that what Link's pluralization does is make *their* an identify function on elements in the restricted domain of the distributivity induced by $\star$, i.e. on the i-parts of the i-sum *john$\oplus$mary.* Since the head *parents* is a function from elements denoted by the possessive NP to a male and a female person, this makes the whole NP *their parents* a function from *john$\oplus$mary.* Imagine the following extension of this treatment to a general rule of global pluralization: Suppose that in general DPs are functional, although not always identity functions, and that they contain an implicit variable for the argument of that function. To illustrate what I mean, consider the following derivation of *The unicycles have wheels*:

(213) (a) $\lceil$the unicycles$\rceil$: λPP(σy unicycles$'(y)$)

(b) $\lceil$have a wheel$\rceil$: $\lambda u[\exists x(\text{wheel-of}'(x,u)\ \&\ \text{have}(u,x))]$

(c) VP pluralization applies to (b), yielding:

$$^{*}(\lambda u[\forall x(\text{wheel-of}'(x,u)\ \&\ \text{have}(u,x))]$$

(d) $\lceil$the unicycles have wheels$\rceil$:

$$^{*}(\lambda u[\forall x(\text{wheel-of}'(x,u)\ \&\ \text{have}(u,x))](\sigma y \text{unicycles}'(y))$$

In (a), *the unicycles* denotes the i-sum of all unicycles; in (b) *have a wheel* denotes not just the property of having any old wheel, but of being an individual who has that individual's wheel. This may seem a bit redundant with *have*, but it isn't if *wheel-of'* is a singular DistrP, and hence contains only atomic individuals in its extension. Now let us assume that when a predicate such as (b) is pluralized as in (c), this triggers syntactic pluralization of the affected NPs, those whose translation contains the bound variable. So *a wheel* becomes *wheels*, just as *his* became *their* in (212). Actually, if Link had wanted to derive the same kind of reading as (211) for the very similar *John and Mary invited their mothers to their place*, he would have had to percolate the plurality of the pronoun up to the head there, as well.

Chomsky seems to have had a different kind of account of DPs in mind, one which operated syntactically on VPs, affecting morphology only. Notice that if we are to entertain a rule of global pluralization or agreement, it must be at least as sophisticated in its characterization of what it is to be a predicate as the one I have sketched, following Link. This is because DPs do not always "distribute" over the syntactic subject, as we see in (214) and (215):

(214) Jane gave the kids toys for Christmas.

(215) German civil defense workers spotted two of our planes.

Toys in (214) can have a DP interpretation, where each kid received one toy. In (215), when *two of our planes* has wider scope than the subject we may understand the sentence to mean that one worker spotted each plane. My extension of Link's approach, utilizing lambda-abstraction, can develop the appropriate abstracted predicate for such cases.[59] Also, this approach belies Chomsky's claim that

[59] In her reply to Chomsky (1975), Partee (1975) notes the following example:

(i) The boys gave the girls nickels.

In this example, not only the bare plural *nickels* can receive a DP interpretation, but the definite NP *the girls*. Chomsky's 'inherent' vs. pluralized reading dichotomy would predict only two readings of the predicate here, 'gave the girls nickels,' the inherent reading, and 'gave one of the girls a nickel,' the pluralized reading. But two other readings are possible, 'gave the girls a nickel,' and 'gave the one of the girls nickels.' The extended-Link approach would permit us to derive any of the readings available for (i).

the DP phenomenon requires an uncompositional treatment. Since bare plural DPs (plural CNs with no determiner) are treated as involving an implicit bound variable, pluralizing them in the fashion described seems no less compositional than pronominal agreement.

However, even though such an approach might be initially appealing, it is ultimately inadequate to deal with the full range of DP data. Barbara Partee (p.c.) has noted examples like the following:

(216) Those men married wives who are similar.

Here, although we easily interpret the direct object as dependent on *those men* in the sense that we understand that each man has one wife, the relative clause contains a symmetrical group-denoting predicate, one which isn't true of atomic individuals in the extension of *wife'*. We cannot provide a derivation of (216) along the lines of (213), since there is no singular DistrP *wife which is similar*, with only atomic individuals in its extension.[60] Thus, there are at least some examples with DPs which would not be accounted for on the extended-Link approach.

Partee also points out that a rule of global pluralization which operates to pluralize the predicate of a plural subject cannot account for the examples of DPs with a non-NP antecedent, such as deMey's (210) above, and her (217):

[60]There is, of course, a functional use of *similar* which could be treated as containing a discourse bound variable, as in (ib) and (ib′):

(i) (a) Allen's wife is tall and dark.
(b) Steve has a wife who is similar.
(b′) Steve and Jerry have wives who are similar.

The relative clause on the DP in (b′) could be treated by the extended-Link proposal, since it is not symmetrical, as shown by the felicity of (ib).

(217) John often wears loud neckties.

In this instance, we may naturally assume that John wears these neckties one at a time.

DeMey (1981) offers an analysis of the DP phenomena which does not involve a global pluralization rule. He notes the following general characteristics of DPs:[61]

A) We can't account for them "by just introducing a rule that replaces, under suitable circumstances, a singular by a plural." I take this to be an argument against global pluralization of the sort just discussed. As evidence, he points out the dependent plurals which are not licensed by NPs.

B) He notes that all DPs must have a plural "antecedent" which has wider scope, whether an NP or a temporal adverbial. (He also claims that only bare plurals and plural possessives may have DP readings.)

C) "Dependent readings can arise only in cases where there is additional [lexical or pragmatic] information that makes such a reading probable or even mandatory." He cites the DP reading of (208) as evidence. Since we know that a unicycle can

[61]Besides these characteristics which DPs have in common, deMey claims that there are really two kinds of DP, those with an NP antecedent and those with a temporal antecedent. His evidence for this claim stems solely from the difference in number of the possessive pronouns in (169) and (i):

(169) All the boys have brought <u>their</u> fathers along.
(i) He always takes <u>his</u> girlfriends to such parties.

However, I think this difference has nothing to do with the DP phenomenon, but stems solely from a strict requirement of number agreement on anaphors and their antecedents. In (169) the plural subject happens to be both the anaphoric antecedent, so that the pronoun must be syntactically plural, and the "antecedent" for the DP *fathers*. In (i), *always* is the DP "antecedent" for *girlfriends*, and it is the singular subject which is anaphoric antecedent for *his*. I will argue for this view of the number of pronouns in Chapter 5.

only have one wheel, we interpret *wheels* as a DP. In further support of this, I note that the structurally identical (218) does not normally receive a DP reading, due to our knowledge of the nature of bicycles:

(208) Unicycles have wheels.

(218) Bicycles have wheels.

D) In many cases a DP reading is obligatory, possible, or forbidden for idiomatic reasons. For example, though both Dutch and English display DP phenomena and the DP is not usually obligatory in either language, in English the DP in (219a) is obligatory and (219b) sounds illformed, while in Dutch the translation of (219a) is unacceptable, and one says the translation of (219b) instead:

(219) (a) The sailors lost their lives.

(b) The sailors lost their life.

This contrasts with the optionality of the DP in both languages in (209). (220), with singular *father* is acceptable to most people in both languages:

(220) All the boys have brought their father along.

DeMey suggests that we analyze examples with DPs semantically in terms of Scha's (1981) collective — collective readings of NPs. Both the DP and its "antecedent" receive a collective reading, where if the "antecedent" is a temporal adverbial it must be possible to analyze it as denoting a collectivity of times or periods. I will not discuss his technical proposal in detail, since it lacks some of the advantages of Link's approach to plurality and distributivity. Essentially, in proposing that the proper treatment of DPs is as collective-collective readings, he claims that the apparent one-to-one relation between the members of the group denoted by a DP and the members of the group denoted by antecedent is a pragmatically motivated, and in some cases partly lexically-motivated additional constraint on the truth conditions, above and beyond the logical form of the sentence.

As an example of what he has in mind, he offers what he calls a "meaning rule" (presumably optional), which would apply to the interpretation of (209). This rule has the effect that, in the case of a functional CN such as *father-of*, if two collectivities are related via the *father-of* relation and some other relation given by the verb (here *bring along*), then there is a function from one group to the other which takes, for example, a boy, and gives as output the individual who is that boy's father and was brought along by the boy.

Let me characterize deMey's collective-collective account of DPs as follows: When one group-denoting plural NP a, is under the scope of another group-denoting plural b, then a may be considered the range of a function f on b. b may be an NP, or it may be an adverbial element denoting a group of temporal periods, places, etc. The function f is at least partly given by the denotation of the predicate of which a (and b, if it's an NP) are arguments. In the case where a has a functional head CN, that may contribute to a complex function.

The characterization I have given of deMey's proposal makes a prediction that not only bare plurals and pronouns, but other group-denoting terms can also have DP readings, since there is no principled reason that they should not be able to enter into the same collective-collective interpretations as deMey's examples. DeMey denies this, but I think (221) argues that a DP reading of plural definite descriptions is possible:

(221) Those men married the ex-wives of their neighbors.

It isn't necessary to interpret the *ex-wives of their neighbors* as a DP to make sense of the sentence, but we tend to do so.

As deMey acknowledges, the meaning rule he offers for (209) to add the distributive sense which underlies the DP reading is ad hoc in several respects. Just as we saw with the interpretation of sentences containing reciprocals and in Scha's examples of collective quantification, it is very difficult to develop a single characterization of the nature of the relations between the individuals in the two groups which is adequate to all cases. DeMey himself offers (222) and (223), where weaker relations between the two groups may be denoted than in (209):

(222) The boys surprised their fathers with a school play.

(223) The boys helped their fathers build the new school.

It seems like two factors play a role in the DP reading of an example like (209). First, the noun *father* is functional — there is one for each child. Second, the verb *bring along* triggers certain pragmatic expectations: where did they bring the fathers along from? Perhaps from home to some event. But which boys would be in a position to bring along any particular father from home? Most likely his own son or sons. Hence, we may interpret a sentence more strictly than its truth conditions require.

The similar contrast between the most natural readings of (208) and (218) undoubtedly lies in similar facts about the denotations of *unicycles* and *bicycles*. An even looser relation is suggested in (224):

(224) Junkyards have wheels.

(225) is an example involving another kind of DP licensing adverbial:

(225) In all the rooms, there were smoke detectors.

Here, the locative adverbial licenses the DP reading of *smoke detectors*. The same pragmatic considerations apply; the DP reading is much less likely in:

(226) In all the rooms, there were books.

The variation in the relationships between two groups is just the sort we found in our consideration of reciprocals and the cumulative reading in Section 3.1.3.2. This suggests that the collective-collective reading may be an appropriate interpretation for many DP examples, but that, as with the reciprocals, it would be futile to attempt to give any but a very weak unified characterization of the relations which may hold between the sets. And this in turn suggests that the functions between collectively interpreted NPs which deMey proposes should not a part of the truth conditions of sentences such as (209) and (225). They are pragmatically given, as with the character of the relations in cumulative readings and reciprocals more generally.

Though I think deMey is correct in pointing out the importance of pragmatic information (world knowledge, particular lexical items, etc.) and convention in the use and interpretation of DPs, his account in terms of collective-collective relations is not sufficiently general to cover the full range of dependent plural phenomena. There are some technical problems with the treatment of some examples of the DP in this fashion, and, more importantly, if DPs are instances of the more general type of collective-collective readings, we need to explain why we think of them as a separate phenomenon. If we simply treat them as collective-collective readings, like the many others we considered in Section 3.1.3.2, then this blurs the distinction between DPs and other examples.

Technically, examples such as (208), (218) and (224) present a problem because both their subjects and their objects are bare plurals, and the sentences have a generic interpretation. We do not seem to be talking about some indefinite set of unicycles or bicycles or junk yards, but about natural kinds (or, in the case of *junkyards* nominal kinds — see G. Carlson (1983) for discussion of the distinction). G. Carlson (1977) presents an analysis of bare plurals in which they always denote kinds. It is only certain non-generic ("stage-level") predicates which "lower" them to apparently denote individual exemplars of the kind they denote.[62] But if these NPs denote kinds, not groups like the plural indefinite *some unicycles*, then it doesn't seem that we can count for the relevant examples by means of a collective-collective interpretation.

The view of bare plurals as kind-denoting is not uncontroversial. See, for example, G. Carlson (1986), which explores a variety of problems with his earlier view, and Wilkinson (1986), who explores the parallels between singular indefinite generics and bare plurals. But it remains to be seen whether an adequate analysis of the bare plural can support an analysis of DPs such as deMey's.

Another kind of problem involves examples with quantificational subjects. Consider:

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[62]Note the singular *kind* in this (spontaneously produced) sentence. Of course, it could also have the DP *kinds*. This illustrates well the flexibility in our use of DPs and their singular counterparts.

(227) Few bicycles have horns.

In this example, a distributive plural subject appears to license a DP reading, since we may readily interpret it as meaning that each bicycle under consideration has only one horn. Assuming that the subject does not denote a group, as argued in Section 3.3, there can be no question of the reading arising by virtue of a pragmatically suggested function between the members of two groups.

Edmund Gettier (p.c. to Barbara Partee, 1975) has noticed another kind of DP example with quantificational "antecedent":

(228) No students wore neckties that were similar.

Like Partee's (216), the direct object here contains a restrictive relative clause with a symmetric, group predicate. The determiner *no* makes the subject distributive; but the most natural reading of (228) isn't that there few students each of whom wore some set of similar neckties. Rather, we want a reading where there were few groups of students who stood in the wearing relation to a group of similar neckties. The denotation of *neckties*, including both atomic individuals and i-sums, must be intersected with that of the predicate *be similar*, giving a denotation whose elements are all i-sums whose i-parts bear the similarity relation. Then the intersection of this set with the set of elements in **student* must be made.

I think one of the problems in offering an adequate analysis of DPs is that given a semantic theory of plurality and distributivity such as I have outlined here, there are in fact too many ways to assign the correct truth conditions to some examples of the DP. For examples with an group-denoting subject, deMey's suggestion about the collective-collective reading, on the purely pragmatic basis I suggest, is plausible. We saw above, in Section 3.1.3.2, that such readings are quite common, and often seem to introduce some suggestion of a function between individual members of the groups involved, in both reciprocal sentences and those with two plural group-denoting NPs. But also, recall that for Link, the extension of a plural CN includes the atomic elements in the extension of its singular counterpart. Hence, strictly speaking, *the unicycle has wheels* is true if the unicycle has only one wheel. And *few bicycles have horns* is true if the number of bicycles which have one or more horns is few. We might claim that in *the unicycles have wheels* the predicate is adverbially distributive, so that the property of 'having wheels' is predicated of each individual member of the group of unicycles. Since something may have this property by virtue of having exactly one wheel, this would also give us the proper truth conditions both for the examples with group-denoting subjects, and those with quantificational subjects. Thus, this approach seems to generalize over a broader range of phenomena than deMey.

With respect to Gettier's example, (228), the DP reading is just the reading we get through plural quantification, *few* quantifying perhaps over i-sums of students instead of atomic individuals. No such i-sum has the property of wearing similar neckties. Then because neckties are items of personal apparel generally worn one at a time, we understand the sentence to suggest that there is a function from each student in a given group in the domain to the single necktie he wore. Here we see the collective-collective interpretation suggested by deMey under the scope of a plural quantifier.

I think it is important to distinguish our formal treatment of DPs from speculation about the motivation for using DPs instead of their singular counterparts. I suspect that the motivation derives from something like agreement. One kind of case which argues for this view is Link's (1986) example:

(229) Strange voices were to be heard everywhere.

On the reading where *everywhere* has wide scope, *strange voices* may have a DP reading, even though *everywhere* is not itself syntactically plural. But of course, this adverb seems to presuppose that there are several salient locations. So the plural implicatures here license the DP. This argues that DPs do not arise from some sort of syntactic process per se.

But there is evidence to suggest that they respect constituency in function/argument structures: There are structures which may involve more than one DP, and Barbara Partee (p.c.) has brought to my attention the fact that in such cases there are restrictions on the order of combinations of DPs and singular NPs. Consider her examples in (230):

(230) (a) The boys bought cars that had a steering wheel with a leather cover.

(b) The boys bought cars that had steering wheels with leather covers.

(c) The boys bought cars that had steering wheels with a leather cover.

(d) # The boys bought cars that had a steering wheel with leather covers.

In these examples, the whole NP *(a) steering wheel(s) with (a) leather cover(s)* is referentially dependent on its complement *(a) leather cover(s)*. The generalization seems to be that if this complement is a DP, then the matrix NP itself must be. If the complement is not a DP, the matrix itself may or may not be.

Now consider examples with more than one NP in a VP:

(231) (a) All my neighbors put their dog in a kennel.

(b) All my neighbors put their dogs in kennels.

(c) All my neighbors put their dogs in a kennel.

(d) # All my neighbors put their dog in kennels.

Assuming that in each case where there is a plural in the predicate it has the DP interpretation, the generalization here about which NPs may be plural, which singular seems to be that the direct object must be plural if the locative object is, but not vice versa.

This is similar to the facts with ditransitives:

(232) (a) All my neighbors gave their dogs furcoats.

(b) All my neighbors gave their dog a furcoat.

(c) All my neighbors gave their dogs a furcoat.

(d) # All my neighbors gave their dog furcoats.

(e) # All my neighbors gave furcoats to their dog.

(f) All my neighbors gave a furcoat to their dogs.

Again, (232d) seems not to have the intended reading, where there is one furcoat per dog. The contrast between (e) and (f) shows that the generalization cannot have to do with the linear order of the arguments. The direct object must be plural if the indirect object is.

It may be that the reason for these restrictions has to do with the order of combination of arguments with the predicate semantically. *Putting-in-a-kennel* and *giving-a-furcoat-to* seem to be semantic constituents, while *putting-a-dog* and *giving-*

to-a-dog do not.[63]

And consider the following, due to Partee (p.c.):

(233) The men carried a spear in their hands.

(234) # The men carried spears in their hand.

Here, the PP is a manner adverbial on *carried spears*. It seems that if the VP it modifies has a DP, then it too must be a DP, but not vice versa.

Link's (229) argues that the DP phenomenon isn't only licensed by syntactically plural "antecedents," but by NPs which implicate the existence of a group (or set of times, etc.). The DPs in the cases we have just considered seem to be involved in a successive dependency relation, which shows that the occurrence of the phenomenon is restricted by something like function/argument structure: Once agreement has begun in a constituent, it must spread to nominal elements in more inclusive constituents. I use the term "agreement" because it seems to share some features of verbal agreement. It is syntactically constrained (the verbal dependencies), but there is a certain discretion on the part of the speaker about when to use DPs: as deMey pointed out, DPs are most often optional, they are idiolectal, and they are in some cases conventional (or idiomatic).

I think that functionally, one use of DPs is to avoid confusion about scope and distributivity. Consider:

(235) The men lifted pianos.

[63]See Bach (1979, 1981b) for discussion of the treatment of discontinuous constituency in a categorial grammar.

Unlike the similar examples in (1) and (2) with singular definite direct objects, one is not likely to give (235) a reading where the group of men together lifted one piano. In fact, it may mean that as a group they lifted a bunch of pianos, but the DP use suggests that there was more than one piano, and, in line with the collective-collective reading suggested by deMey, that there was some function between the lifters and the pianos. Whether the two NPs are in fact both group denoting or the VP is interpreted as adverbially distributive, the use of the DP seems to the same effect in this example, and a range of others, as a quantified subject or floated quantifier.

Though my arguments here are inconclusive about the nature of the dependency relation involving DPs, I believe that they generally tend to support treating DPs, including bare plural DPs, semantically as if they were ordinary group-denoting NPs. Whatever their syntactic motivation and manner of percolation, it is not clear that DPs have any effect on the semantic interpretation of sentences in which they occur, though they may help to clarify (or obscure) what is intended.

3.6 Conclusions

We can now be more precise about what is meant by 'distributivity'. But first, I need to introduce some basic ideas about the nature of predication. There is one notion of predication which is syntactic — that of Williams (1980). There, a subject may take as predicate any constituent AP, NP, VP, or PP which it c-commands at S-Structure. However, we have seen above that when an NP which is not a syntactic subject takes wide scope in a sentence, its predicate is the lambda abstract formed from the original sentence by abstracting on a variable in place of the NP. Since distributivity may arise in such cases, either via a quantificational determiner on the NP or via the D operator, the predication which licenses distributivity cannot be characterized in terms of the surface syntactic predicate structures of Williams.

Semantically, all predication boils down to predicating a given property, of type $\langle e,t\rangle$, of some individual in the domain of the model, of type e. Recall that NPs do not always denote individuals in the model. (In fact, in Montague's theory, they never do, but in the theories of Heim and Kamp, nonquantificational NPs are essentially of type e.) In generalized quantifier theory all determiners are characterized as relations between two sets. (See Barwise & Cooper (1981), van Benthem (1983).) The NPs which I have argued, on the basis of anaphoric and truth conditional properties, to be quantificational are all those whose determiners establish that a certain proportion of the atomic elements of the CN denotation is a subset of the VP denotation. The proportion involved may be one hundred per cent, as with the universal quantifiers, or zero percent, as with *no*, more than fifty percent, as with *most*, or whatever percent (or cardinality) is taken to be *few* or *many* on the basis of contextual and lexical factors.

In cases where the NP is quantificational, it is at the level of logical form, or, in a theory such as Heim's or Kamp's, at the level of DRs or Files, that semantic predication is a part of the meaning of such a subject/VP. In (c) is the schema for the translation of sentences of the form *every CN VPs*, while in (d) is the DR schema for such sentences:

(236) In IL terms: $\forall x(\mathrm{CN}(x) \rightarrow \mathrm{VP}(x))$

(237) In DR terms:

$$\boxed{\boxed{\begin{array}{c} x \\ \mathrm{CN}(x) \end{array}} \Longrightarrow \boxed{\begin{array}{c} \\ \mathrm{VP}(x) \end{array}}}$$

In each of these representations of universal quantification, the predications are underlined. In each predication, a property is said to hold of a variable x. In set theoretic terms, this means that the value of x is an element of the predicate. Also, each representation entails that the set of elements of the CN denotation is a subset of the set of elements of the VP denotation, i.e., the denotation of the CN is a subset of that of the VP.

Another way of saying this is that when a quantificational NP takes a predicate P as argument, then in order for the denotation of the whole to be true, $P(x)$ must be true for some proportion of the atomic elements x of the set denoted by the CN, the proportion given by the particular determiner in the NP.

If we consider again the effect of adverbial D when it modifies a predicate P, we see that a very similar situation arises. Informally, D requires that for all the elements x of the set of atomic i-parts of the group denoted by the subject, $P(x)$. Thus, again, $P(x)$ must be true for some proportion (one hundred percent) of the atomic elements x of a set.

Where adverbial distributivity differs from that introduced by determiners, is that the set in question is not the denotation of the CN, but a subset of the CN denotation. How this subset is determined varies according to the determiner of the NP in question. I think the relation between adverbial and determiner distributivity is clearest when viewed in terms of a Kamp/Heim theory of discourse. Consider the simplified discourse representations for (238) and (239):[64]

(238) Few men lifted a piano.

x_i *man(x_i) atomic(x_i)	= FEW =	lifted-piano(x_i)

(239) The men each lifted a piano.

x_k

*man(x_k)

$x_k = x_?$

x_i i-part(x_i, x_k) atomic(x_i)	$\Longrightarrow$	lifted-piano(x_i)

(238) has truth conditions along the lines of 'for few x_i such that x_i is an atomic element of the denotation of **man*, x_i lifted a piano.' (239) means 'there is an individual x_k in the denotation of **man* (which may be a nonatomic i-sum), whose antecedent in discourse is $x_?$, such that any x_i which is an atomic i-part of x_k lifted a piano.' In both (238) and (239) we have box-splitting. Each box might be taken

[64]See the following chapter for details on the mapping from S-Structures which derives these DRs.

to denote a set in the model in which it is embedded; the lefthand box in (238) denoting the set of all atomic elements in the set denoted by $^*man$, that in (239) denoting the set of all atomic elements in the set of i-parts of the individual denoted by x_k. Think of the righthand box in each as denoting the set of individuals who lifted a piano. Then, in each case, in order for the original sentence to be true, some proportion (few in (238), one hundred per cent in (239)) of the elements in the denotation of the lefthand box must be in the denotation of the righthand box.

In each case, a restrictive term delimits the subset of elements in the universe of the model which are to be considered: the set of men for (238), the set of i-parts of x_k for (239). In these cases, then, distributivity is a relation between two sets A and B, such that a given proportion of elements of A is a subset of B. Or, in other words, it is a requirement that a given proportion of elements of a set A have a property P.

The requirement that we further limit consideration to only the atomic elements in the restricted domain is not essential to the notion of distributivity, but is part of the interpretation of quantifiers with count CNs (as opposed to quantifiers with mass CNs such as *some mud*, *most mud*) and of the meaning of adverbial D. Recall that we have considered examples where distributivity with floated *all* seemed to shift into the mass domain; we noted that it makes no sense to speak of all atomic parts of some mass. And *all* and postnominal *each* seem to be able to distribute over members of a group which is itself somehow conceived of as atomic, as we saw in examples involving 'group' nouns. Furthermore, we saw in the latter case, as in the case of conjoined NPs such as *the Leitches and the Latches*, and in examples of "plural quantification" that what is atomic for the purposes of distributivity may not be an individual in the pretheoretic sense of that term, but only in the sense that it is conceived of as a whole unit. All of these cases show that the phenomenon of distributivity is broader than a characterization in terms of atomic i-parts would suggest. Distributivity involves the predication of a property over homogeneous parts of some subset of the domain. Atomic i-parts are just one type of such homogeneous parts.

Though we have left a number of issues unresolved, the discussion in this chapter has tended to support the hypothesis that distributivity always arises in a semantic predication due to a distributive operator, either a determiner on the subject or an adverbial modifier on the predicate. This analysis accounts for the fact that NPs within the scope of such an operator are masked anaphorically. And the distinction between types of determiners helps to explain how some subjects in sentences with distributive interpretations, those which are individual-denoting by virtue of a nonquantificational determiner, may themselves license discourse anaphora.

Chapter 4

The Representation of Quantifier Scope and Distributivity

The goal of this chapter will be to suggest a representation for quantifier scope and distributivity which is compatible with the theory of anaphora I outlined in Chapters 1 and 2, and with the discussion of plural anaphora in Chapter 5.

I argued in Chapter 2 that the Binding Theory applies at an S-Structure which contains anaphoric indices. Coindexation at that level will ultimately be interpreted as bound anaphora. S-Structure is mapped directly onto a Discourse Representation, and it is at that level that Discourse Binding is represented, via the equation of discourse referents. The theory of anaphora, then, does not require a level of Logical Form, or LF, in the sense of May (1977,1985).

In order to make the approach I am suggesting convincing, it is necessary to show how we might represent quantifier scope without LF. There are two ways one might approach this problem. One would be to disambiguate quantifier scope at the level of the DRs. However, May has explored in detail a number of structures where the possibilities of quantifier scope, and in some cases anaphoric binding dependent on scope, are constrained by configurational properties of the sentence in which the relevant NPs occur. Some of the most interesting cases along these lines involve the phenomenon of inverse linking. Because of such cases, the other approach to the disambiguation of quantifier scope without LF seems preferable: the representation of scope at S-Structure. In Section 4.1, I will propose an extension of Williams' (1986) proposal to indicate scope at S-Structure by means of scope indices, showing how we may represent phenomena such as inverse linking by the use of complex indices.

I will then turn to the question of how to represent distributivity. The general hypotheses about distributivity which I proposed in Chapter 3 might be implemented in various ways. Again, the implementation I propose here is intended to facilitate integration with the material on anaphora in Chapters 1, 2, and 5. Recall that although distributivity is distinct from quantifier scope, they interact crucially: the scope of a NP which is interpreted distributively is the predicate over which it is distributed. Thus, the representation of this phenomenon must be integrated with that of scope. In Section 4.2 I will discuss an aspect of S-Structure which is important for distributivity: the representation of some cases of adverbial distributivity with the D operator.

In Section 4.3 I will propose how the representation of quantifier scope and adverbial distributivity at S-Structure influence the mapping onto a DR. The idea is simple: NPs with widest scope are mapped first onto the DR. Distributivity, whether induced by a quantified NP or by an adverbial operator, involves the introduction of subordinate DRs, or "box-splitting," which we saw earlier in Kamp's treatment of universal and conditional donkey sentences, as well as in my proposed representation of epistemic modal subordination. Since box-splitting puts constraints on the anaphoric potential of material in the subordinate boxes, via the accessibility relation, the anaphoric phenomena associated with distributivity will fall out automatically from this treatment.

As in Chapter 1, I assume that interpretation of a DR is model theoretic. In many respects, the model I assume and the relation between syntactic categories and semantic types are of the sort which is standard in recent extensions of Montague's 'The Proper Treatment of Quantification in English' (1973).[1] There is one important departure from the PTQ models: Following the discussion in Chapter 3, Section 3.2, these models will have a lattice structured domain of the sort proposed by Link (1983). Thus, both single objects and groups are treated as individuals, the latter non-atomic, or i-sums. Discourse referents will not be distinguished according to whether the NPs which correspond to them are singular or plural; the type of individual onto which they are mapped in the model, whether atomic or i-sum, will depend on any conditions in the DR which constrain their interpretation. However, I will postpone discussion of this aspect of the theory until Chapter 5, in the discussion of plural anaphora.

4.1 The representation of quantifier scope

In the 1960's both George Lakoff (see references) and Richard Montague (see Thomason 1974) independently developed systems for the representation of quantifier scope: Quantifier Lowering within the Generative Semantics framework, and Quantifying In in what has come to be called Montague Grammar. Cooper & Parsons (1976) showed various ways in which Montague's treatment of quantification could be integrated into a version of the Extended Standard Theory. Chomsky

[1]This is not to be taken as a rejection of recent proposals which introduce radical changes in Montague's models, e.g. Chierchia (1984) and Landman (1986a), among others. Rather, the issues involved in such discussions do not bear directly on the issues under consideration.

(1975,1976), Sag (1976) and Williams' (1977) all argued for the establishment of a level of Logical Form, or LF, within grammars in the Extended Standard Theory, and May (1977) developed an influential treatment of quantification at LF. May (1985) proposes radical departures from his earlier work, permitting him to address more complex issues within the Government and Binding framework of Chomsky (1981). In frameworks closely related to Government and Binding, van Riemsdijk & Williams (1981), Haïk (1984; see discussion in Chapter 2), and Williams (1986) argue for the representation of scope via indices at S-Structure. In this section, I will briefly consider the proposals of Montague (1973), Cooper & Parsons (1976), May (1977, 1985), and Williams (1986) in order to argue for a theory of the representation of quantifier scope at S-Structure which incorporates insights from each of them.

4.1.1 Quantifying in and quantifier raising

Montague (1973) interprets NPs as generalized quantifiers, constituents which take a VP argument to form a sentence. The type of NPs is uniform, whether or not the NP contains a quantificational determiner. In this basically categorial grammar, NPs may either be generated in place or they may be quantified in at the S, VP or CN level.[2] When an NP is quantified into an S, in the corresponding translation into intensional logic a lambda operator abstracts on a variable in the S, say e_i, in the argument position of the NP; it also binds any pronominal elements with the same index. The constituent derived by this abstraction is of type $\langle e, t\rangle$, the same semantic type as VPs. The translation of the NP then takes (the intension of) this abstracted predicate as an argument, as in standard subject/predicate combination. This has the same effect as coindexing the NP with the variables e_i in the Binding

[2]The syntactic categories S, VP and CN in Montague (1973) are called t, IV (t/e), and CN ($t//e$), respectively. I use S and VP to facilitate comparison with other theories.

Theory — the result is bound anaphora, in Reinhart's (1983) sense. Versions of Montague's (1973) syntactic rules for Quantifying In, S14 – 16, are given below, with minor terminological changes, as well as his translation rules T14 – 16, translating the syntactic categories derived in S14 – 16 respectively into expressions of intensional logic (whose model theoretic interpretation is straightforward). P_x denotes the set of all phrases of the category x; the rules are schemata, so that for any rule $F_{10,n}$ there are an infinite number of rules $F_{10,0}$, $F_{10,1}$, $F_{10,2}$, etc, depending on the index of the variable which is abstracted over; e in the following rules denotes a variable, although Montague's original rules used subscripted pronouns instead of e. I have given purely extensional versions of the translation rules, in the interest of simplicity:

S14. If $a \epsilon P_{NP}$ and $p \epsilon P_S$, then $F_{10,n} \epsilon P_S$, where either (i) a does not have the form e_k, and $F_{10,n}(a,p)$ comes from p by replacing the first occurrence of e_n by a and all other occurrences of e_n by the appropriate pronominal form (with respect to gender, number, and case), or (ii) $a = e_k$, and $F_{10,n}(a,p)$ comes from p by replacing all occurrences of e_n by the appropriate pronominal form.

S15. If $a \epsilon P_{NP}$ and $b \epsilon P_{CN}$, then $F_{10,n}(a,b) \epsilon P_{CN}$.[3]

S16. If $a \epsilon P_{NP}$ and $b \epsilon P_{VP}$, then $F_{10,n}(a,b) \epsilon P_{VP}$.[3]

T14. If $a \epsilon P_{NP}$, $p \epsilon P_S$, and a, p translate into a', p' respectively, then $F_{10,n}(a,p)$ translates into $a'(\lambda x_n p')$.

[3]Note that the same rule number, *10*, is involved as in S14 — the syntactic operation therefore has the same effect on the surface form of the resulting CN as we saw on the resulting S in S14.

T15. If $a\epsilon P_{NP}$, $b\epsilon P_{CN}$, and a, b translate into a', b' respectively, then $F_{10,n}(a,b)$ translates into $\lambda y a'(\lambda x_n[b'(y)])$.

T16. If $a\epsilon P_{NP}$, $b\epsilon P_{VP}$, and a, b translate into a', b' respectively, then $F_{10,n}(a,b)$ translates into $\lambda y a'(\lambda x_n[b'(y)])$.

We see an example of the use of S14, T14 in (1), where the sentence is formed by the application of S14 to the NP and S in (a) and (b) (shown with their rough translations); the translation rule T14 applies simultaneously to give (c):

(1) A lightening bug flew to every child.

(a) $[_{NP}$ every child$]$: $\lambda P \forall y(\text{child}'(y) \rightarrow P(y))$

(b) $[_S$a lightening bug flew to $x_i]$: flew-to$'$(a-bug$'$,x_i)

(c) $[_S$A lightening bug flew to every child.$]$

$[\lambda P \forall y(\text{child}'(y) \rightarrow P(y)]$ $(\lambda x_i[\text{ flew-to}'(\text{a-bug}',x_i)])$

$\Rightarrow$ (by lambda conversion)

$[\forall y(\text{child}'(y) \rightarrow \text{flew-to}'(\text{a-bug}',y)]$

Quantifying into VP or CN works in a similar fashion, and permits the derivation of the truth conditions shown for example (2), showing the use of S16, T16 for Quantifying In to VP, and Joan Bresnan's (3) (cited in Partee (1975)), showing the use of S15, T15 for Quantifying In to CN:

(2) Every child$_i$ has a lightening bug$_j$ in her$_i$ jar and plans to release it$_j$ before bedtime.

(a) $[_{\text{NP}}$every child$]$: $\lambda P \forall y$ $(\text{child}'(y) \rightarrow P(y))$

(b) $[_{NP}$a lightening bug$]$: $\lambda P \exists z$ (bug$'(z)$ & $P(z)$)

(c) $[_{VP}$has x_i in w's jar and plans to release $x_i]$:

λw[has-in-w's-jar$'(w, x_i)$ & plans-to-release$'(w, x_i)$]

(d) (b) QI'd into (c) by T16:

$\lambda u \lambda P \exists z$ (bug$'(z)$ & $P(z)$) λx_i(λw[has-in-w's-jar$'(w, x_i)$

& plans-to-release$'(w, x_i)$](u))

$\Rightarrow$ (by lamba conversion)

$\lambda u \exists z$(bug$'(z)$ & has-in-u's-jar$'(u, z)$ &

plans-to-release$'(u, z)$)

(e) (a) combined by function-argument application with (d):

$\lambda P \forall y$(child$'(y)$ $\rightarrow$ $P(y)$) [$\lambda u \exists z$(bug$'(z)$

& has-in-u's-jar$'(u, z)$ & plans-to-release$'(u, z)$)]

$\Rightarrow$ (by lambda conversion)

$\forall y$[child$'(y)$ $\rightarrow$ $\exists z$(bug$'(z)$ & has-in-y's-jar$'(y, z)$

& plans-to-release$'(y, z)$)]

(3) [Every girl who attended a women's college$_i$ who made a large donation to it$_i$] was included in the list.

(a) $[_{NP}$a women's college$]$: $\lambda P \exists y$ (women's-college$'(y)$ & $P(y)$)

(b) $[_{CN}$girl who attended x_i who made a large donation to $x_i]$:

$$\lambda u[\text{girl}'(u)\ \&\ \lambda z(\text{attended}'(z, x_i))(u)\ \&$$
$$\lambda z(\text{gave-to}'(z, x_i))(u)]$$

$\Rightarrow$ (by lambda conversion)

$$\lambda u[\text{girl}'(u)\ \&\ \text{attended}'(u, x_i)\ \&\ \text{gave-to}'(u, x_i)]$$

(c) (a) QI'd into (b) by T15:

$$\lambda w[\lambda P \exists y\ (\text{women's-college}'(y)\ \&\ P(y))$$
$$[\lambda x_i(\lambda u[\text{girl}'(u)\ \&\ \text{attended}'(u, xi)$$
$$\&\ \text{gave-to}'(u, x_i)](w))]]$$

$\Rightarrow$ (by lambda conversion)

$$\lambda w \exists y[\ \text{women's-college}'(y)\ \&\ \text{girl}'(w)\ \&$$
$$\text{attended}'(w, y)\ \&\ \text{gave-to}'(w, y)]$$

(d) $[_{NP}$Every girl who attended a women's college who made a large donation to it$]$:

$$\lambda P \forall z[(\lambda w \exists y[\text{women's-college}'(y)\ \&\ \text{girl}'(w)$$
$$\&\ \text{attended}'(w, y)\ \&\ \text{gave-to}'(w, y)])(z)) \rightarrow P(z)]$$

$\Rightarrow$ (by lambda conversion)

$$\lambda P \forall z[(\exists y[\ \text{women's-college}'(y)\ \&\ \text{girl}'(z)$$
$$\&\ \text{attended}'(z, y)\ \&\ \text{gave-to}'(z, y)]) \rightarrow P(z)]$$

(e) (d) applied to *was included in the list*:

$$\forall z[(\exists y[\text{ women's-college}'(y)\ \&\ \text{girl}'(z)$$
$$\text{attended}'(z,y)\ \&\ \text{gave-to}'(z,y)])$$
$$\rightarrow \text{was-included}'(z)]$$

Bennett (1973) retains Montague's essential approach to quantification, extending Montague's fragment to include a variety of other determiners, and making other changes which do not concern us here. As we saw in Section 3.1.2 of Chapter 3, one of the advantages of this approach is that since any NP can be QI'd, even what I have called the nonquantificational, group denoting NPs, Bennett can give an adequate account of examples where a group denoting NP can have wide scope over an inherently distributional, or quantificational NP. It would be relatively straightforward to add an adverbial distributivity operator to the Montague fragment, as Dowty & Brodie (1984) have done (see Section 3.4.1). Then, abstracting away from problems of discourse binding such as the donkey sentences and adding further determiners along lines suggested by Bennett, Montague's approach would essentially yield the proper predictions regarding distributivity. Of course, the discourse problems are non-trivial, and it is phenomena such as the donkey sentences and modal subordination more generally which force us to reconsider some of Montague's assumptions about the form of a grammar. Hence, we need to consider how we may retain the advantages of Montague's approach in a theory of discourse.[4] May (1977) begins from a different perspective: Lakoff (1965,1970,etc.) had noted a strong parallel between the constraints on *wh*-elements and those on quantifier scope. May explores these parallels in the Extended Standard Theory of Chomsky

[4]Rooth (1986a) contains some very interesting discussion of the relationship between the NP types in Montague (1973) and in Heim (1982) and Barwise (1985). His results there suggest that the differences between them should not be overestimated.

and associates (see, e.g., Chomsky (1976,1977)) by comparing the characteristics of *wh*-movement and those of a rule of Quantifier Raising, or QR. QR is taken to map S-Structures onto LFs by moving certain NPs to adjoin to a dominating S, in the same way that *wh*-movement maps D-Structures onto S-Structures by moving *wh*-elements into the COMP of a dominating S′. The NPs which are (obligatorily) moved by QR are just those which are "quantificational," containing determiners like *every* or *some*, and not those which are "referential," such as definites, pronouns and proper names.[5]

There are two major problems with this approach to quantification. First, since adjunction is only to S, the system lacks the flexibility required to treat the full range of distributive phenomena, including (2) and (3) above, as well as others we will see below. Second, because QR applies only to quantificational NPs, and then obligatorily, this approach is subject to the same problem that we saw with regard to Lakoff's Quantifier Lowering approach to distributivity: it cannot generate readings where a "referential," or group denoting NP takes wide scope over a distributed NP.

May (1985) offers a very different system for the treatment of quantifier scope, one whose primary goal is not to fully disambiguate a given sentence in this respect, but rather to provide a partially disambiguated representation which allows the incorporation of an account of the subject/object asymmetries studied by Kayne.

Kayne (1981a,1981b) addressed asymmetries involving multiple *wh*-constructions, *that*-trace phenomena, and relative quantifier scopes in French and English. He proposed to account for these by means of the Empty Category Principle, or ECP; this principle is taken to apply at LF, in order to handle the quantifier scope cases.

[5]Note that the NPs which are quantificational in May's terms (and those of many other GB theorists) include some, including *some CN*, which are non-quantificational by the criteria of distributivity for determiners discussed in Chapter 3, Section 3.3.

The ECP requires that all traces be properly governed (see Chapter 2 example (4), and (9) below for two definitions of *government*), which means that they are either lexically governed or, in the case of a subject trace (which has no lexical governor) are governed in a specially stipulated fashion by a raised constituent, either a *wh*-element in COMP or a QR'd NP adjoined to S. In the latter type of government, the *wh*-element or NP must be the first raised, so that nothing intervenes between its raised position and the S immediately dominating the subject trace. With multiple *wh*-constructions, this predicts the so-called Superiority Effects, whereby only the subject *wh*-element may be *wh*-moved at S-Structure, as shown by the contrast between (4) and (5):

(4) $[\text{who}_i]_{\text{COMP}}$ $[_S\ t_i$ likes $\text{whom}_j]$

(5) * $[\text{whom}_j]_{\text{COMP}}$ does $[_S$ who_i like $e_j]$

If we assume that the subject *who*$_i$ in (5) must be moved to adjoin to COMP at LF, then from this position it will not properly govern its trace t_i, and the result will violate the ECP at that level. May (1986) not only addresses Kayne's data, but also discusses a number of examples where interaction of a *wh*-raised element in COMP and the scope of a quantified NP provides further evidence for some principle along the lines of the ECP. Consider, for example, his (6) and (7):[6]

(6) What$_i$ did everyone buy e_i for Max?

(7) Who$_i$ e_i bought everything for Max?

---

[6]Examples of this sort had been discussed previously by a number of other authors, including Keenan & Hull (1973) and Karttunen (1977).

(6) is ambiguous, either asking for the identification of the one thing which everyone together bought for Max, or asking, for each person, what that person bought for Max. (7), on the other hand, is unambiguous, asking only for the identity of the person (or group) which bought all of Max's presents.[7] This type of asymmetry, May points out, appears to be related to the Superiority effects we saw in (4) – (5). He suggests that this shows that the quantified NP *everything* in (7) cannot be adjoined to S by QR at LF, since that would bring about an ECP violation — who_i in COMP would no longer properly govern its trace in the subject position of (7), since *everything*, adjoined to S, would intervene. How is this related to the relative quantifier scopes which are available for the two examples?

May argues that any two operators which stand in a certain relation at LF can be interpreted with either relative scope, in accord with his Scope Principle, given in (11) below. These are operators which both form part of what he calls a "Sigma Sequence;" the definition of *Sigma Sequence*, given in (10), in turn depends upon the definitions of *c-command* (8) and *government* (9), which May (1985) adopts from Aoun & Sportiche (1981):

(8) *a c-commands b* $=_{df}$ every maximal projection dominating *a* dominates *b*, and *a* does not dominate *b*.

[7] Fred Landman (p.c.) argues that although this reading of (7) is very dominant out of the blue, the other reading, where the direct object has wide scope over the *wh*-element, is also possible. He offers the following parallel example, in (i), which does seem to have the relevant, ECP-violating reading in the context (ii):

(i) Let's check to see <u>who fired every employee</u>.

(ii) Here's a list of the employees fired in the last two years. If you suspect fraud, we have to be very careful. So, let's check to see <u>who fired every employee</u>.

(9) *a governs b* $=_{df}$ *a* c-commands *b* and *b* c-commands *a*, and there are no maximal projection boundaries between *a* and *b*.[8]

(10) A *sigma sequence* is any class of operators Ψ, such that for any O_i, O_j which are elements of Ψ O_i governs O_j. By "operator" here is meant phrases in A′ positions at LF.

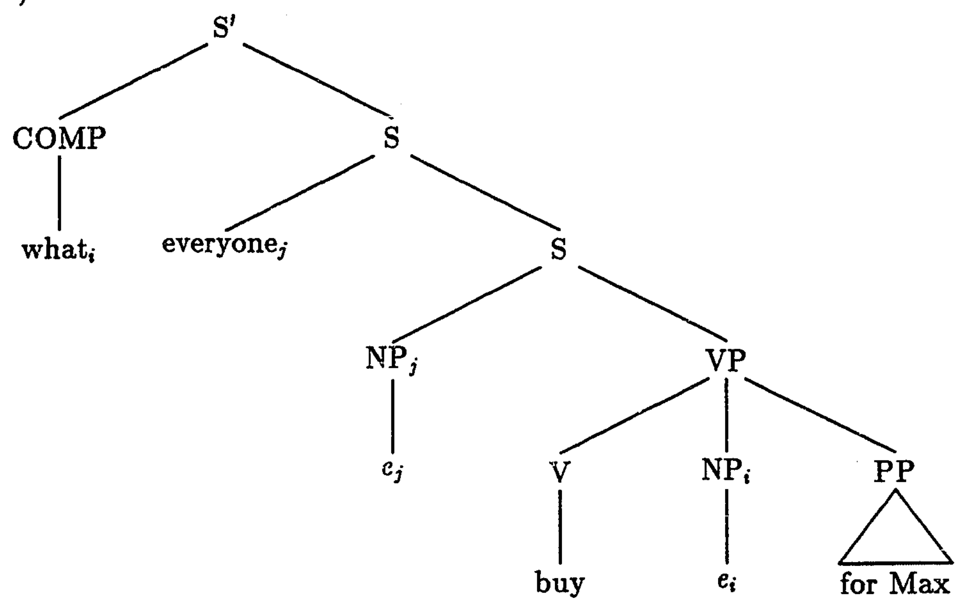
(11) **Scope Principle:**

Sigma Sequences are arbitrarily interpreted.

There is only one LF for (6), where, in addition to the *wh*-element *what* in COMP, the subject *everyone* has been adjoined to S. In this configuration, *everyone* properly governs its trace in subject position, since nothing intervenes. *What* and *everyone* here form a Sigma Sequence — as shown in (12), both are in A′ positions, and the only maximal projection which governs either, S′, governs both, so that they mutually c-command each other and, hence, govern each other:

[8] We will see the importance of the distinction between a maximal projection and its boundary below.

(12)



Since the two operators form a Sigma Sequence, they can take either relative scope, so that the two different readings of (6) can both be derived from this single LF.

In (7), on the other hand, raising *everything* to adjoin to S at LF would bring about an ECP violation, since then *who* would not properly govern its trace in subject position. *everything* must undergo QR; however, May argues that an object NP may be adjoined to VP, instead of S.[9] He offers various independent arguments for this possibility, to which we may add the examples involving anaphora between conjoined VPs under the scope of the subject, as in (2) above, which motivated Montague's Quantifying In at VP. However, if *everything* in (7) is adjoined to VP, then it will not form a Sigma Sequence with *who* in COMP, and thus their relative

[9]May argues that a subject NP may not be adjoined to VP, since in that case a maximal projection (VP) would intervene between the QR'd NP and its trace in subject position. Thus, the subject trace would not be properly governed, and an ECP violation would result.

scopes will be fixed, with the *wh*-element wider than the quantified object.[10]

In addition to May's discussion of the subject/object asymmetries, he makes another contribution to the question of the representation of relative quantifier scope in his examination of the phenomenon of inverse linking, exemplified by (13) – (15):

(13) $[$Everyone in $[$some Italian city$]_i]_j$ met John.

(14) $[$The head of $[$every public authority in New York$]_i]_j$ is a crook.

(15) $[$Someone from $[$every city$]_i]_j$ despises it_i.

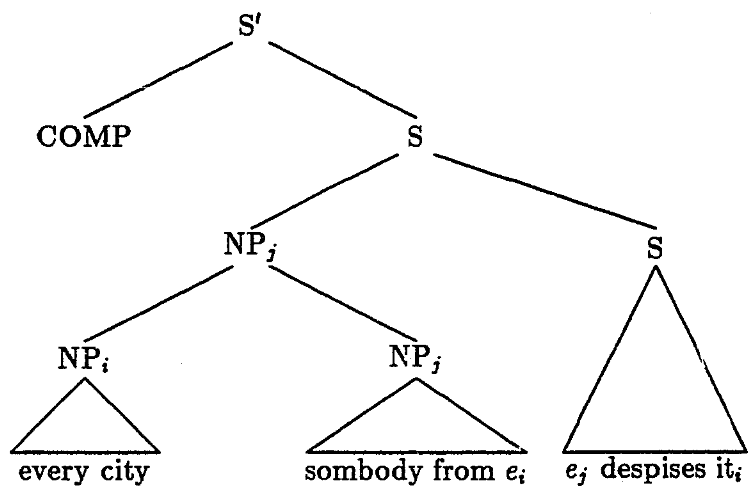
May (1977) considered examples such as (13) unambiguous, with *some Italian city* taking wide scope over the entire subject, and claimed that QR of such quantified complement sentences to S was obligatory. However, May (1985) no longer takes examples such as (13) as unambiguous; he considers (14), where it is clear that the sentence may be true if there is a different person heading each public authority and each is a crook, the inverse reading, or on a non-inverse reading, where there is a single man (e.g. Robert Moses) who heads all the public authorities and is a crook. Examples such as (15) are taken by May (1985) to argue that the complement NP in such inverse examples must have scope over the entire S in order to bind the object pronoun *it*. This also presupposes that anaphoric binding is checked at LF. Such examples have in the past proven a strong argument for this level of representation,

[10]For reasons which are not directly relevant here, May (1985, Chapter Five) later argues that the ECP as Kayne (1981b) formulates it is inadequate, and that the proper account of the subject/object asymmetries should be based on Pesetsky's (1982) theory of Paths, a theory which is closely related to Kayne's (1983) theory of Connectedness. In each of these theories, certain overall characteristics of a configuration, involving multiple operator/variable relations, are considered in determining the well-formedness of the representation. In this revision, the adjunction possibilities which I have just described, leading to the contrast between (6) and (7), remain the same.

along with the ECP and weak crossover.

The representation of inversely linked readings in May (1985) requires that the complement quantified NP first be QR'd to adjoin to its matrix NP (in order to respect syntactic islands) and then the entire matrix is QR'd to adjoin to S. The resulting configuration in shown in (16):

(16)



NP$_i$ has been Chomsky-adjoined to NP$_j$, and then NP$_j$ has been Chomsky-adjoined to S. May stipulates that a node *a* must be dominated by all the nodes bearing the label of a maximal projection *b* in order to say that *b* dominates *a*. In this configuration, NPi is not dominated by the maximal projection NPj, since there are two nodes labelled "NP$_j$," only one of which dominates NP$_i$. So, NP$_i$ and NP$_j$ mutually c-command and govern each other, thus forming a Sigma Sequence. Notice that *every city*, NP$_i$, c-commands both its trace e_i and the pronoun *it$_i$* in the matrix sentence, so that the binding is well-formed.

May also adopts the suggestion of Fiengo & Higginbotham (1980), that the so-called "relative," or non-inverse, interpretation of examples such as (13) and

(14) should involve NP-internal adjunction. He proposes that in these examples adjunction is to PP, though N′ or NP-internal VP adjunction are also possible.

There are a number of other interesting aspects of May's (1985) general proposal which I will not consider here. His principal contribution lies in his exploration of the constraints that syntax puts on scope possibilities, particularly the relation of QR to Move-*Wh*. He has addressed the first problem which we saw for May (1977), since now adjunction of QR'd NPs may be to S′, S, VP, NP, or within NP to PP, N′, or the VP of a gerund.[11] However, the second problem, the inability to represent readings where a group-denoting NP has wide scope over a distributively interpreted NP, remains, since May (1985) retains the view of referential and quantificational NPs that only the latter undergo QR. And there are other problems which arise in the attempt to broaden the coverage of the theory.

Williams (1986) points out some problems with accounts of the subject/object asymmetries in terms of the ECP or Paths. He notes that May uses a very narrow range of quantifiers in his examples, principally *everybody* and *everyone*, and points out that the asymmetry is not manifest with all quantifiers. For example, *each* may have wide scope over the *wh*-element in both Williams' (17) and (18):

(17) Who$_i$ does each boy dance with t_i

(18) Who$_i$ t_i danced with each boy

[11]See Stowell (1981) for an earlier suggestion that QR may be to any major category which dominates the NP in question. However, Stowell does not investigate this idea in any detail. De Carrico (1983), following Stowell, suggests the rule:

(i) Adjoin Q to X''.

and offers arguments involving opaque verbs. She does not cite the earlier Montague grammar literature on this subject.

It has been widely noted that *each* must take wide scope over some other element in the sentence in which it occurs. Thus, whatever causes the subject/object asymmetries, *each* is able to overcome it in (18).

Williams also claims that "multiplicity of questions" readings are available in examples involving group-denoting NPs, such as (19) and (20), and not (as May would predict) only in examples involving quantified NPs, such as (6) and (7):

(19) Who$_i$ did they dance with t_i

(20) Who$_i$ t_i danced with them

But Williams denies that this reading is available in all cases where a quantified NP is subject in a question, claiming that the multiplicity of questions reading is not available for (21):

(21) Who$_i$ did every girl dance with t_i

I think the data pertaining to the asymmetries are as yet unclear (witness the frequent use of question marks and the difficulty of many judgments in the ECP and parasitic gap literature), and that it would be difficult at present even to make a clear descriptive generalization about the extent and character of the subject/object asymmetries, although I do agree that they exist in a wide range of cases, and that they probably involve configurational properties of representations, such as Connectedness, Paths or Koster's (1984) Global Harmony. However, it may well be that other factors are at play as well.

Another factor which complicates judgments about possible answers to questions such as Williams' (18) is the relationship of scope in a question to the possible answers which would satisfy the question. This is a very complex matter, addressed by Engdahl (1979,1986), and Groenendijk & Stokhof (1984), among others. For example, suppose that (18) does not have a reading where *them* takes wide scope over the *wh*-moved who_i. Does this mean that it cannot be satisfied by what Groenendijk & Stokhof call the "pair-list" answer, where we name for each person in the group denoted by *them* the person who danced with that person? I myself am not sure, and in any case this would require more of an argument than Williams has given.

I also seem to get the subject/object asymmetry in examples such as (22) and (23):

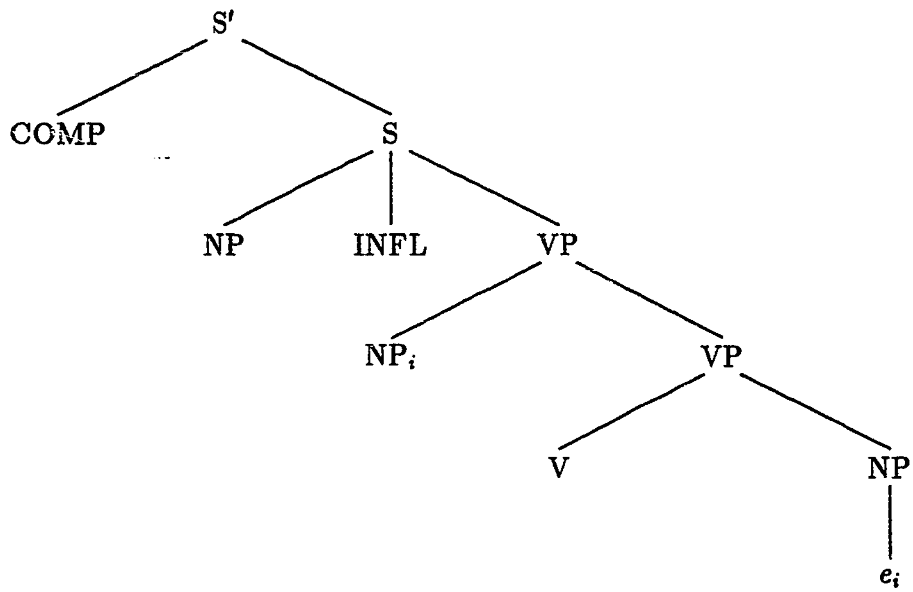
(22) What$_i$ did the kids see t_i

(23) Who$_i$ t_i saw the kids

I think that *the kids* can have wide scope over the *wh*-element in (22), but not in (23). What this would suggest is that there is a general subject/object asymmetry phenomenon, but that it involves all NPs, and not just quantificational NPs. This is an area which I think requires a great deal more work.

Another problem with May (1985) arises in cases where an NP is Chomsky adjoined to VP via QR. Consider the type of structure involved:

(24)



In this structure, NPi has been adjoined to the VP. May claims that in this position, NPi c-commands both the subject and any operators in A′ position, but that it does not govern elements in either position. He reasons as follows: As we saw in example (16) above, where an inversely linked NP was QR'd to S, the nodes created by adjunction constitute together a single projection. In (24), the two VP nodes are a single maximal projection. But, by May's stipulation, a constituent dominated by only one of the nodes in such a multi-node projection is not dominated by the projection. This is relevant for the Aoun & Sportiche definition of c-command given in (8). In particular, in (24) NP$_i$ is not dominated by the VP projection, so the only maximal projection which dominates it is S′, as is the case with A′ operators and the subject; hence these elements all mutually c-command each other. But because there is a maximal projection boundary, the top VP node, between NP$_i$ and the higher A and A′ NP positions, there is not mutual government between these positions. The lack of mutual government has various consequences. Among them, NP_i cannot form a Sigma Sequence with any operators in COMP or adjoined to S.

The problem arises from the fact that NP_i c-commands the subject and COMP positions. On the assumption required for his treatment of inverse linking and crossover, that binding principles apply at LF, this should permit a quantificational object to bind pronouns in these positions. For some examples, May capitalizes on this possibility, since it allows the backwards bound anaphora required for an account of the crossing coreferences sentences, as in (25). However, he does not note that, since such structures do not involve crossover, this feature of his theory also permits the unacceptable readings of examples (26) and (27):

(25) Every pilot that shot at it hit some Mig that chased him.

(26) * His mother loves every boy.

(27) * Which of his friends loves every man.[12]

I take it that this does not demonstrate the undesirability of permitting quantifiers to take VP scope, but rather that, as I argued in Chapter 2, binding in general, and the crossover phenomena in particular, are to be characterized in terms of S-Structure A positions, and not at LF.

The remaining argument for applying the Binding Theory at LF is the inverse linking phenomenon. I will show in 4.1.2.1 how this might be accounted for at S-Structure as well. There is an empirical problem with May's treatment at LF.

[12]Note that it is not the functional reading of Engdahl (1980) which is at issue in this example.

Given the mutual governance of the adjoined NP_i and its S-adjoined matrix NP_j in (16), either relative scope order should be possible. Of course, if NP_j, with its unbound trace of NP_i were taken to have wide scope over NP_i, then the result would be uninterpretable, and would be ruled out on these grounds. (Since NP_i would still c-command its trace in NP_j, the configuration would satisfy the Binding Theory at LF even where NP_j took wider scope in the ultimate interpretation. Thus, the unacceptability is not syntactic under May's account.) The problem arises when there is another quantified NP in the same sentence. After this NP is QR'd at LF, it will form a Sigma Sequence with NP_i and NP_j. Given May's Scope Principle, this predicts that any order of scope for the three NPs should be possible (apart from the interpretive requirement just discussed, that NP_i have wider scope than NP_j). But this doesn't seem to be the case. Rather, as Larson (1985) points out, the scope of NP_i is tied to that of NP_j, and no other NP's scope may intervene, as we see in (28):

(28) Two politicians spy on someone from every city.

No reading in which the relative scopes are "every city — two politicians — someone from x" is available for this or related examples, even though in such a reading *every city* would have wider scope than its trace in the matrix NP. Thus, May's theory predicts unacceptable readings for such examples.[13]

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[12] Actually, for reasons which do not concern us here, it would be Chomsky-adjoined to NP_j, rather than to S.

[13] Barbara Partee (p.c.) points out that in examples such as (i), the relevant order of scopes does seem to be available, as indicated:

(i) Every detective joined in a search for a man with red hair.

The reading which interests us is that where there is a man with red hair such that each detective joined in some one (of possibly several) searches for that man. While I agree that this reading does seem to be available for (i), it is not clear what is at issue here. First, note that the intensionality of *search* does not seem to be a factor in the availability

Larson (1985) develops an account of Inverse Linking in a modified Montague grammar fragment which uses Cooper Store, (cf. Cooper (1983)). The central proposal there is that inverse linking arises when an NP internal complement has scope over the whole NP. Larson suggests revisions and extensions of Cooper's system to incorporate this possibility. He is able to predict the correct scope and anaphoric possibilities for a range of examples (not including *wh*-operators), and he recognizes the piggyback relationship between the scope of the inversely linked complement NP and that of its matrix NP, formally ruling out the undesirable ∀-2-∃ reading of (28). However, the usual problems which the donkey sentences and other examples of discourse anaphora present for Montague grammar remain.

Neither of the two systems for the representation of quantifier scope which we have considered here, Montague's Quantifying In or May's Quantifier Raising at LF, permits us to develop the kind of mapping from S-Structures directly to DRs which we found desirable on anaphoric grounds in Chapter 2. In the following section I will propose a theory of quantifier indexing at S-Structure, modifying and extending ideas from Cooper & Parsons (1976) and Williams (1986), which will permit such a mapping.

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of this reading, as shown by the availability of a reading with the same scope orders for (ii):

(ii) Every woman made one of the gifts for a new baby in our building.

In (ii), the wide scope of *a new baby in our building* seems to arise because the NP has a specific flavor, however that is to be analyzed (see Fodor & Sag (1982) for some discussion). But more importantly, I have not been able to find an example where such a scope order is possible with inherently quantificational NPs in the inversely linked complement of the object:

(iii) Every detective participated in a search for many men with red hair.

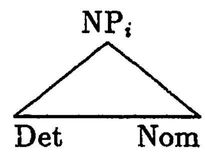
Many is not generally regarded as a "referential" indefinite determiner. And I cannot get a reading of (iii) along the lines of 'there are many men with red hair such that every detective participated in one of (possibly many) search.

4.1.2 Scope indexing at S-Structure

Cooper & Parsons (1976) propose a grammar which, when certain filters on indexing are added, is equivalent in power to that of Montague's (1973) fragment of English, while using a syntax which consists of a Deep Structure and a Surface Structure which are transformationally related, rather than a categorial syntax of the sort proposed by Montague. Quantifier scope is represented by indexing at Deep Structure; NPs are not in general indexed in this system, but only receive an index when they are affected by the rules of Abstraction Marking (for relative clauses) or Quantification Marking (for quantifier scope). The rule of Quantification Marking coindexes a node of the category S, VP, or Nom (the categories for which Montague (1973) provided Quantifying In rules) with a) some nonpronominal NP which it dominates, and b) (optionally) one or more pronouns which it dominates and which are preceded by the NP in (a). Interpretation is off of this Deep Structure, and includes interpretations of Quantification Marked trees which parallel the interpretations the Quantified In structures of Montague which we saw in the previous section. In the general schema for interpretation which follows, I have changed Cooper & Parsons' notation slightly, but inessentially, to clarify the relationship of their proposal to others under consideration here, and, again, have given a purely extensional version:[14]

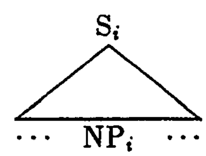
[14]Recall that the prime notation, e.g. a', in the translations here means 'the translation of a,' and is not the same as its use in X' notation.

(29)



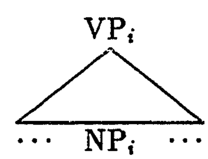
translates as $\lambda PP(x_i)$

(30) **S Scope:**



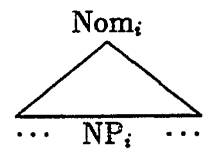
translates as $NP' \, (\lambda x_i[S'])$

(31) **VP Scope:**



translates as $\lambda y[NP'(\lambda x_i[VP'(y)])]$

(32) **Nom Scope:**



translates as $\lambda y[\mathrm{NP}'(\lambda x_i[\mathrm{Nom}'(y)])]$

(29) tells us that any NP which is indexed is translated as a variable with the same index. This rule enters into the compositional interpretation of the S, VP or Nom constituent whose top node is coindexed with this NP, so that the interpretation of the larger constituent contains a variable e_i in the position of NP_i, but then acts as a lambda abstracted argument for the 'true' denotation of the indexed NP, NP$'$. This gives the same interpretations as Montague's for similar constructions.

Cooper & Parson's fragment is very limited, and, as we saw in Chapter 2, D-Structure as it is currently conceived in Government and Binding theory is not the appropriate level for interpretation. However, Williams (1986) argues for the representation of quantifier scope via scope indexing at S-Structure, and his discussion suggests that the interpretation he has in mind is compatible with their schema for interpretation. I will adopt Williams' idea, extending it to include the representation of inverse linking and showing how its interpretation in terms of DRs parallels the lambda abstractions of Montague (1973) and Cooper & Parsons (1976).

Williams (1986) points out that in general there are four elements of a quantificational structure, or "Q-Structure," as given in (33):

(33) **Q-Structures:**

(a) a Quantifier

(b) a restriction on the range of the variable

(c) a variable

(d) a scope

In general, when an NP is fronted by *wh*-movement, the resulting structure is as in (34), with the elements of (33) as shown:

(34) Which car did John see

[Det car]$_i$ [John saw t_i]$_S$

a = Det of NP in A$'$ position

b = N$'$ of NP in A$'$ position

c = trace t_i

d = S

(34) illustrates what Williams calls the "Adjunction Schema" for Q-Structures. However, modifying ideas originally presented in van Riemsdijk & Williams (1980), he suggests that languages such as English also have another schema, the "in situ Schema," shown in (35):

(35) **In Situ Q-Structure Schema:**

$[\ldots[\mathrm{Q}\ \mathrm{N'}]_i \ldots]_{S:i}$

$a = \mathrm{Q}$

$b = \mathrm{N'}$

$c =$ the A-position with the index 'i'

$d =$ the phrase bearing the index '$: i$'

Here, although the NP_i has not been moved, it is its A-position which acts as the variable corresponding to (c) in (33), and thus the in situ schema displays the same elements as the adjunction schema, shown in its general form in (36):

(36) **Adjunction Schema:**

$[[\mathrm{Q}\ \mathrm{N'}][\ldots t_i \ldots]_{S:i}$

$a = \mathrm{Q}$

$b = \mathrm{N'}$

$c =$ the A-position with the index 'i'

$d =$ the phrase bearing the index '$: i$'

By pointing out that (35) and (36) are analogous in both containing the basic elements given in (33), Williams shows how it possible to capture the analogies between quantifier scope and *wh*-movement which May has emphasized, without requiring actual movement or a distinct LF level of the grammar. We may regard S-Structure as the sole grammatical level which serves as input to interpretation,[15] while avoiding the problems with reconstruction which we discussed in Chapter 2,

[15] Williams (1986) himself does not do so. For him, anaphoric relations are represented at NP-Structure. He does not consider interpretation into a discourse level; however, in mapping derivations in his grammar to such a level, we would presumably need input

some of which Williams (1986) discusses as well.

Williams proposes that scope indexing of the sort that builds structures like (35) takes place in the mapping from his NP-Structure to S-Structure, at the same time as the *wh*-movement which results in adjoined structures like (36). Here, I will regard them as introduced either in a mapping from a D-Structure onto S-Structure or in the construction of a base-generated S-Structure. Since I do not think the issue of whether or not S-Structure is transformationally derived is directly relevant to our topic here, I will not attempt to argue for one or the other.

Williams further argues, on the basis of evidence from Sluicing (see his p.269), that it is the scope index $:i$, and not the quantifier itself, which is the operator binding the variable. He does not suggest a formal semantic interpretation of such structures, but if we accept the suggestion that it is $:i$ which binds the variable and treat it as a lambda operator, then we can readily see how Williams' structures can be given a truth conditional interpretation along the lines suggested in Cooper & Parsons (1976). Besides the S-scope which Williams discusses, I also provide for VP-scope and N′-scope:

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from both NP-Structure and S-Structure, the former for anaphoric information, the latter for operator scope.

(37) **Interpretation of in situ Q-Structures:**

(a) S SCOPE:

Interpret a structure of the form

$[\ldots[\mathrm{Q\ N'}]_{NP_i} \ldots]_{S:i}$

as follows:

$\mathrm{NP'}\ (\lambda x_i\ \mathrm{S'}[\lambda \mathrm{PP}(x_i)/\mathrm{NP}_i])$

where 'S'$[\lambda \mathrm{PP}(x_i)/\mathrm{NP}_i]$' means 'the translation of S with $\lambda \mathrm{PP}(x_i)$ substituted for NP_i.'[16]

(b) VP SCOPE:

Interpret a structure of the form

$[\ldots[\mathrm{Q\ N'}]\mathrm{NP}_i \ldots]_{VP:i}$

as follows:

$\lambda y[\mathrm{NP'}\ (\lambda x_i[\ \mathrm{VP'}[\lambda \mathrm{PP}(x_i)/\mathrm{NP}_i](y)])]$

where 'VP'$[\lambda \mathrm{PP}(x_i)/\mathrm{NP}_i]$' means 'the translation of VP with $\lambda \mathrm{PP}(x_i)$ substituted for NP'_i.

(c) N' SCOPE:

Interpret a structure of the form

$[\ldots[\mathrm{Q\ N'}]\mathrm{NP}_i \ldots]_{\bar{N}:i}$

as follows:

$\lambda y[\mathrm{NP'}\ (\lambda x_i[\bar{\mathrm{N}}'[\lambda\ \mathrm{PP}(x_i)/\mathrm{NP}_i](y)])]$

where '$\bar{\mathrm{N}}'[\lambda\ \mathrm{PP}(x_i)/\mathrm{NP}_i]$' means 'the translation of $\bar{\mathrm{N}}$ with $\lambda \mathrm{PP}(x_i)$ substituted for NP_i.'

The interpretation of NP_i with S scope in (a) corresponds directly with Cooper & Parsons' (and Montague's) interpretation for the same constituent, and (b) and (c) extend Williams' proposal in a natural fashion to yield interpretations which also parallel those of Cooper & Parsons.

In the general theory I am developing, however, S-Structures are not interpreted in intensional logic, but are mapped onto a DR. We will see how quantifier scope indexing affections this mapping in Section 4.3.2.

So far, we have seen arguments that an NP may take scope over an S, VP or CN which dominates it. In the following section, I will propose a further extension of scope indexing to permit an NP to have a scope index at a dominating NP. This will permit an account of inverse linking and the scope of possessive NPs. I do not know of good arguments that scope indexing should take place at other constituents, and so I tentatively restrict it here to S, VP, CN and NP.[17] But before discussing the issue of scope indexing at NP, there are some more general questions to address.

Williams does not discuss the representation of the relative scopes of NPs in sentences with multiple NPs, as in (38):

(38) [Everyone in this room]$_i$ speaks [two languages]$_j$

Suppose that we represent structures where two NPs have sentential scope in the following fashion: instead of simple S:i, we have S:i/j or S:j/i, using the slash indices of Haïk (1984), though in a way which differs considerably from her intentions.

[16]$\lambda PP(x_i)$ is an extensional version of Montague's schema for pronoun translation.

[17]As Williams (p.c.) has pointed out to me, there is a sense in which the conservative assumption is that quantifier scope indexing may be at any dominating constituent, since I have offered no reason why NPs should be constrained to take scope only over S, VP, CN, and NP, and over no other types of constituents. His point is well taken; however, I am being conservative here from a descriptive point of view.

Since most people are familiar with the representation of relative scope in prenex form in the predicate calculus, let us use this familiarity as a mnemonic device and stipulate that the NP corresponding to the first index gets wide scope over any following indexes. As we will see in Section 4.3, in mapping a quantifier-indexed structure onto a DR, the order of scope, widest first, indicates the order of mapping of the NPs onto the DR.

Another issue of considerable interest is the relationship of an NP's scope to that of *wh*-moved elements in COMP, and constraints such as the subject-object asymmetries. While May's data is important, I feel that more research on this topic will be required before a clear picture emerges, and I will have nothing further to say about it here. I believe that any scope orders and constraints which can be represented at LF can be represented with quantifier indexing at S-Structure; in particular, it may be that the relative scope of a *wh*-element in COMP could be indicated in the same series of indices at S as that of NPs in situ, including unmoved *wh*-elements. Since the scope indices stand in relation to A positions, just as do the raised NPs in May's LF, constraints based on subject/object asymmetries should be expressible in terms of the relation of a scope index to the corresponding A position.

Also, although I will interpret indexed S-Structures as indicating fixed scope relations among the NPs involved, this is not a necessary feature of using scope indices at S-Structure, as opposed to QR at LF. One could just as well specify that the series of scope indices at a given node form something like May's Sigma Sequences, so that they would not fully disambiguate scope for a given S-Structure. The system which resulted would be very similar to that of May (1985).

In the system I envision, scope indexing helps to guide the order of interpretation of NPs in the mapping onto DRs. Each NP must have a scope; however, since its scope may be any S, VP, CN, or NP node which dominates it,[18] including the NP node itself, the system has essentially the freedom of Montague's (1973) approach to quantification, where an NP may either be generated in place or quantified in. Any given S-structure will be unambiguous with respect to quantifier scope.

Compare Heim's (1982) Logical Form, a level which is disambiguated with respect to quantifier scope and simpler than May's (1985) LF, from which her Files are derived. There, Quantifier Construal is obligatory for all NPs except pronouns, and involves adjoining the NP to a dominating S. The quantificational NPs, e.g. those with universal determiners, induce a tripartite structure in LF, the three parts being the determiner (or operator) of the NP, its CN (the restrictive clause), and the remainder of the sentence with a variable in place of the NP (the nuclear scope of the operator). Nonquantificational, or individual denoting, NPs induce a bipartite structure, the raised NP and its nuclear scope, the remainder of the sentence.

The distinction between the two types of NPs in Heim's LF is paralleled in Kamp's (1981) DRs by the way in which quantificational NPs induce box-splitting in DRs while other NPs do not. Box-splitting in effect puts the material in Heim's restrictive clause into the lefthand, or antecedent box, and the material in Heim's nuclear scope into the righthand, or consequent box. The operator is then syncategorematic in DRs, causing the splitting and the consequent differences in mapping from the DR onto a model. Kamp appears to treat the syntactic representations from which his DRs are mapped as ambiguous with respect to scope; he has suggested (class lectures, 1983, University of Massachusetts at Amherst) operations on DRs which have the essential effect of May's (1977) Quantifier Raising, changing the relative scopes of the NPs represented. Landman (1986a) and Heim (p.c.) each

[18] As we will see in the following section, the scope of a possessive NP is obligatorily given as that of its matrix NP.

point out that his system thus corresponds in this sense not to her Files, but to her LF. But the present proposal differs from Kamp in this respect. DRs here are derived from S-Structures which are fully disambiguated with respect to scope. And while my proposal differs from Heim's (1982) in lacking an LF, Williams' (35) above shows that all the essential elements of her tripartite structures are still available, the operator and its restrictive range in situ but possibly interpreted 'out of turn,' for example when indexed at a dominating S, and the A-position itself interpreted as a variable along the lines I suggest in the schemas in (37) above. The system is more flexible than Heim's in the scopes it permits, but it is intended to cover a broader range of data than she considers.

One remaining question is whether pronominal NPs should be assigned scope. Montague (1973) permitted Quantifying In of pronouns, and in general in the system proposed here this would appear to be relatively innocuous. If a pronoun is discourse bound, the order in which we process it in mapping the sentence onto a DR does not affect its interpretation, so long as an accessible discourse antecedent has already been interpreted, in Kamp's sense of *accessible* discussed in Chapter 1. If this is not the case, then an ill-formed reading, with a free variable, results. On the other hand, if a pronoun is c-command bound, then by the indexing algorithm proposed in Chapter 2, it is already coindexed with its binding antecedent when the mapping to a DR takes place, and hence, correctly, they will have the same scope.

I will leave one final question unanswered. Roger Higgins (p.c.) has pointed out that in general the use of indices may actually be a way of overlaying one structure on another. In the present case, this would amount to S-Structure representing two structures at once, one the surface order of the constituents (more or less), and the other, via various indices, a sort of covert LF, giving binding and scope relations. Similarly, Cooper & Parsons (1976:344) note that in their system, "nothing hinges on the fact that we mark the indexing on the trees. It would be possible, though less perspicuous, to represent the indexing as a separate object, not unlike Jackendoff's (1972) tables of coreference, and then define the translation procedure on a tree and its indexing in a way strictly analogous to the present proposal." I concur with these observations. It may well be that what we have here is two structures in one. Yet, as we saw in the discussion of the Binding Theory in Chapter 2, the information which is thus available at the combined S-Structure and index structure to guide interpretation is not the same as that available in a transformationally derived LF of the type proposed by May (1977) or (1985). Because non-*wh*-moved NPs remain in situ, we retain aspects of the underlying S-Structure which are crucial for the understanding of anaphora and its relation to quantifier scope, aspects of S-Structure which LF with Reconstruction and Weak Crossover does not adequately represent.

4.1.2.1 Inverse linking and the scope of possessive NPs

In our discussion of May's (15), repeated below, we noted, following Larson (1985), that the inverse linking in these examples indicates that NP-internal complements may take quantificational scope over the whole matrix NP, and in addition that this scope appears to ride piggyback on that of the matrix, so that the scope of other NPs in A positions in the same sentence could not intervene between that of the inversely linked complement and that of its matrix. Of importance in developing an adequate account of inverse linking is the fact, also illustrated in (15), that the wide scope of the complement NP, here *every city*, licenses it to bind a pronoun c-commanded by the matrix, *someone from every city*.

(15) [Someone from [every city]$_i$]$_j$ despises it$_i$

We may observe a closely related phenomenon in (39), involving a possessive NP:

(39) $[[\text{Everyone}]_i\text{'s mother}]_j$ loves him_i

Here as well, *everyone*, with wide scope over its matrix NP_j, binds *him*, although the pronoun is only c-commanded by the matrix, and not by its binder.

Jackendoff (1977) earlier pointed out that an N' complement (but not an N'' complement) could take scope "out of an NP dominating it," and supported this claim with examples such as (40), where the N' complement in the subject NP, *few children*, licenses a negative polarity item, *any*, in the direct object.[19] This example contrasts with (41), where an N'' complement cannot license the negative polarity item.

(40) Fathers of few children have any fun.

(41) * Fathers with few children have any fun.

We will discuss the N'/N'' contrast below. At this point, (40) may be taken as further evidence that it is the wide scope of the subject's complement NP which is the central feature of the inverse linking phenomenon. And the possibility of negative polarity items in the similar (42) argues that wide scope is central in cases with possessive NPs such as (39) as well:

(42) Few children's fathers have any fun.

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[19]See Ladusaw (1979) for arguments that a negative polarity item must be in the scope of a downward entailing operator, such as the monotone decreasing determiner *few*.

Two other kinds of examples support the idea that inverse linking licenses what I have called c-command anaphora, as opposed to discourse anaphora. First, in all the cases where an inversely linked complement or a possessive NP binds a pronoun, such as (15) or (39), the matrix NP c-commands the bound pronoun. (43) shows that the matrix NP need not be the subject, while (44) shows that binding is not possible when the matrix doesn't c-command the pronoun:

(43) (a) The FBI warned the secretary of <u>every suspected spy</u> to keep an eye on <u>him</u>.

(b) The FBI warned <u>every spy</u>'s secretary to keep an eye on <u>him</u>.

(44) (a) * <u>He</u> is loved by the mother of <u>every boy in Amherst</u>.

(b) * <u>He</u> is loved by <u>every boy</u>'s mother.

The other type of example supporting the c-command requirement on inversely linked and possessive NP binding involves sloppy identity.[20] The following are generally conceded to be quite acceptable on the sloppy reading:

[20]The examples which I am using are drawn from unpublished experimental psycholinguistic work which I carried out with the help of Chuck Clifton and Lyn Frazier in the fall of 1985. The experiment was an attempt to ascertain the availability of sloppy identity in sentences where the binders are inversely linked or possessive NPs. The judgments on some examples with inverse linking were mixed, but preliminary results indicate that the likelihood of a sloppy reading increases when the head noun of the matrix NP which contains the inversely linked complement is functional, especially when it involves 'inalienable' objects or relationships such as body parts or kin. In the same study other examples testing for the availability of the sloppy identity reading without inverse linking or possessive NPs also seem to show an increase in probability of the sloppy reading when inalienability is involved, so this may be a characteristic of sloppy identity, rather than a symptom of a weaker binding relation when the binder is inversely linked.

Also, in general, possessive NPs seem to be slightly more likely to act as binders in sloppy identity than inversely linked NPs. I would attribute this to the obligatory wide scope of possessive NPs, as discussed below.

(45) The owner of <u>every cat</u> taught <u>it</u> to be well behaved, and the owner of every dog did too.

(46) <u>Many girls</u>' fathers are concerned about <u>their</u> schooling, and many boys' fathers are too.

There is only one type of example which I am familiar with which convincingly argues that inversely linked complement NPs may not have the same general potential to serve as binders as do NPs which directly c-command anaphors. (47b) and (48b) are taken from Reinhart (1977):

(47) (a) <u>Every organization</u> suffers some setbacks in <u>its</u> early years.

(b) In <u>its</u> early years, <u>every organization</u> suffers some setbacks.

(48) (a) Members of <u>every organization</u> suffer in <u>its</u> early years.

(b) * In <u>its</u> early years, members of <u>every organization</u> suffer.

Here, the matrix subject containing the inversely linked NP *every organization*, interpreted with wide scope, c-commands the trace of the preposed constituent which contains *it*, so that under the characterization of c-command anaphora given in Chapter 2, *every organization* should be able to bind *it*; however, the sentence is unacceptable on the binding relations indicated, in contrast to the well formed (47b), where *every organization* directly c-commands the trace. I have no account of why this is so. Several possibilities arise; one is that the system of binding I proposed in Chapter 2 is incorrect; another is that binding by inversely linked NPs is not c-command binding; a third is that there are extra constraints on binding into preposed constituents, besides c-command of their trace by the binder. Since there seem to be other problem examples involving preposed constituents (cf. the discussion of Lakoff's *Near John he saw a snake* in Chapter 2), I will assume here that the explanation lies in that area.

Under the assumption that binding by an inversely linked or possessive NP is c-command binding, I propose to account for these examples by giving the inversely linked or possessive NP scope over the matrix NP in which it occurs. This may be represented by adding a slash index to the matrix NP, as shown in the indexing schemas in (49) and (50):

(49) **Inversely Linked Complement NP** *(optional)*:

$$\mathrm{NP}_{i/j}$$

$$\mathrm{Det}\ [\cdots \mathrm{NP}_i \cdots]_{N'} \cdots$$

(50) **Possessive NP** *(obligatory)*:

$$\mathrm{NP}_{i/j}$$

$$[\mathrm{NP}_i\ \text{'s}]_{\mathrm{Det}} \cdots$$

In both schemas, the index of the NP-internal NP_i is added to that of the matrix, taking wide scope over it in the same way as when there are two or more scope indices at S.[21] There are two principal advantages of this approach to wide scope of a complement or posssessive over its matrix NP. First, inverse scope as represented in this fashion will have the piggyback characteristic we found to be desirable:

[21]Kayne (1981a) argues that QR can't adjoin to NP, on the basis of the fact that (i) cannot be synonymous with the reading of (ii) where the scope of *nobody* is confined to the complement sentence:

when the matrix NP is given scope, let's say at S, then its entire index will be copied, i/j. No other scope index will intervene between i and j because the scope indexing procedure simply adds one (possibly complex) index at a time to the front of any indices which are already present at the given node. Second, we may now stipulate that the matrix NP which results from (49) or (50) may c-command bind any pronouns indexed either i or j.[22] Thus, scope indexing at NP also serves as anaphoric indexing. This explains the binding in examples (15), (49), and (43). In examples (45) and (46), as in the sloppy identity examples discussed in Chapter 2, the sloppy identity is licensed by c-command binding in the first conjunct, with the indices of the corresponding constituents in the second conjunct substituted at the DR level.

In keeping with Jackendoff's claim that only N′ complements may take wide scope out of NP, (49) requires that NP_i be N′-internal. Jackendoff argued that N′ complements, and only N′ complements are subcategorized arguments of the head noun. He offered three tests to distinguish between N′ and N″ complements. One is

---

(i) John is bemoaning nobody's presence.

(ii) John is bemoaning that nobody is present.

But under the present proposal, this is exactly what we would expect — ***nobody*** in (i) is adjoined to the direct object NP, which may have either 'in situ,' VP or S scope. But, on any of these options, since ***John*** is not distributive, the same reading will result, where there is nobody whose presence John bemoans. More important, consider (iii):

(iii) Everyone bemoans nobody's presence at the dance.

I find this example ambiguous: either 'there is no one whose presence everyone bemoans' (the 'most popular missing person' interpretation) or 'everyone bemoans nobody's presence at the dance last night' (e.g., since the committee had worked so hard).

See rule (60) below giving the proposed intensional logic translation for *'s*.

[22]Here again my debt to Haïk (1984) should be obvious, although I use "indirect binding" in a way very different from her intentions. She does not seriously consider the inversely linked examples in her paper.

the possibility of inverse linking (though he didn't use this term). A second is order, under the assumption that an N′ complement may not be separated from its head. The third is behavior with *one* anaphora; under the assumption that *one* is an N′ anaphor, N″ complements, but not N′ complements may serve as complements of *one*. However, Jackendoff points out that *one* anaphora is not an adequate test because it "is valid only for *of*-NP complements, not for other PPs in N′;" it seems that some other PPs which are N′ complements by the first two tests also occur with *one*, giving mixed results.

I believe that Jackendoff's claim that it is only arguments of the head which may be inversely linked is plausible, though I find the suggested syntactic tests rather weak. Here, I merely make the restriction of inverse linking to N′ complements a stipulation, although it is possible that this might be made to follow from a requirement that the head govern its arguments.

However, if only N′ complements are true arguments of the head noun, then what about the head's relation to possessive NPs? This brings us to a discussion of the difference between the two kinds of cases, a difference encoded above in the fact that the indexing schema for inverse linking in (49) is optional, while that for possessive NPs in (50) is obligatory.

Consider the following:

(51) (a) John's picture

(b) a/the picture of John

(c) a/the picture of John's

(d) Al's picture of John

(e) * Al's picture of John's

In (51a), the possessively marked *John* may be construed as filling one of three relations to the head, *picture*: owner, painter, or subject of the study. However, in (b) and (d), the complement *John* may only be the thematic patient of *picture*, that is, the subject of the study. In (c), the possessively marked *John* may be either the owner or the painter of the picture, and possessive *Al* in (d) may bear these same roles. But (e) shows that two possessively marked NPs may not cooccur in the same sentence. I suggest that this is explained as follows: In unpublished work, Barbara Partee (p.c.) suggests that the relation between a possessive NP and its head is introduced by a free variable R over relations in the translation of *'s*; let us suppose that we implement this idea in an intensional logic translation of *'s*, as follows:[23]

(52) *'s* translates as:

$$\lambda \mathcal{P} \lambda Q \lambda P[\exists R \mathcal{P}(\lambda x \exists y[\ \underline{\forall z(Q(z) \leftrightarrow z = y)}\ \&\ R(x,y)\ \&\ P(y)])]$$

What this formula means is that *'s* first takes an NP ($\mathcal{P}$), as in *John's* above, to make a determiner type, that is, a function from a CN (Q) to a function from one place predicates (the VP-type variable P) to truth values. The constituent which results after combining *'s* with *John* is thus the usual type of determiners — a relation between two one-place predicates, the denotations of the CN and the VP.

The formula specifies that there is some two-place relation R which holds between the possessive NP and the unique element in the extension of the CN (the uniqueness clause is underlined here for clarity); the translation thus builds in the often noted definiteness of possessive NPs. As Partee has suggested, we will consider the value of R to be contextually given. This explains the variability of the relations

[23] $\mathcal{P}$ here is a variable over NP types, $\langle\langle e,t\rangle,t\rangle$ in an extensional system; P and Q are variables over the type $\langle e,t\rangle$, i.e. the type of CNs and VPs; x, y, and z are individual type variables. R is a variable over relations between individuals.

between the possessive and the head in (51a) — since there are various possible relations that a person might bear to a picture and since we have no context here to suggest that one is more salient than the others, we may suppose that John bears any of these relations to the picture under discussion. This is in contrast to the subcategorized complement *John* in (51b), since arguments are generally taken to have conventional thematic roles with respect to the predicate which subcategorizes for them. In (51c), I follow Stockwell, Schachter & Partee (1973), in considering the possessive to be extraposed; we may assume that the impossibility of interpreting *John's* here as the subject of the picture arises out of a sort of functional efficiency: since the true complement in (51b) bears this relation to the head in the same position, the extraposed possessive NP lacks this relation by contrast. This is similar to the possibilities for the interpretation of R in (51d), where the subcategorized *John* already has taken the role of subject. Finally, (51e) supports the extraposition account of (51c), showing that an NP with two possessive NPs is ill-formed.

Note that (52) also automatically gives the possessive NP wide scope over other elements of the NP. Of course, since we now have the possibility of quantifying in at NP (or its equivalent in DR terms), an N′ complement might still take wider scope than the possessive NP.

Now consider the following examples, parallel to those in (51), but with the inherently distributive *few CN*, instead of the referential *John*, permitting us to test for the possibilities of inverse linking:

(53) (a) Few people's pictures

(b) (the) pictures of few people

(c) * (the) pictures of few people's

(d) Al's pictures of few people

(e) * Al's pictures of few people's

(53a) has only one interpretation, where *few people* has wide scope over the entire NP; we are not talking about pictures whose subjects are few, but about the range of a function whose domain contains few people, each mapped onto his or her picture. The inverse character of the possessive licenses anaphoric binding, as when (53a) takes a predicate such as *look like them*, binding *them*; and because *few* is monotone decreasing, the predicate may contain a negative polarity item, as in the predicate *are attractive at all.* As in (51a), the type of relation which each of the few people in the domain may bear to his or her picture is open — owner, painter or subject; but since my intuition is that they must all bear the same relation to their pictures, I have given R wider scope than $\mathcal{P}$ in (52).

We already saw that the inversely linked reading of complement NPs is optional in May's (14), repeated here:

(14) [The head of [every public authority in New York]$_i$]$_j$ is a crook.

(53b) as well may have either the inversely linked reading, where the truth conditions are similar to those of (53a), or "relational reading," where each of the pictures under consideration (however many there may be) has few subjects.[24] But on either reading, the relation which the argument bears to the head is not free, as

[24]I believe this terminology is unfortunate, since on this reading *few* behaves more like a one-place predicate; cf. the predicative *few* of Section 3.2.4.

with the possessive NP cases, but is given by the subcategorization; here, as in (51b), it is a patient, the subject of the painting.

I cannot say why the extraposed quantificational NP seems to make (53c) unacceptable. It seems likely that it is a scope problem, since the parallel (51c) was fine. I can only speculate that extraposed elements behave as adjuncts (N'' or, more likely, N''' complements); as Jackendoff points out, these may not take scope over the matrix NP. Since the extraposed NP in (51c) was nonquantificational, this caused no problem for interpretation. For some reason here, the narrow scope of adjuncts is not acceptable in a possessive NP, which we are accustomed to giving wide scope.

(53d) is of interest with respect to the prediction that quantifying in at NP would permit the QId NP to have wide scope over a possessive NP in the matrix. (53d) doesn't have an inversely linked reading, where the predicates *look like them* (*them* bound by *few people*) or *are attractive at all* would be acceptable.[25] One way to handle this problem would be to stipulate that only one NP index may "perco-

[25]May (1985) claims that the parallel (i) does have an inversely linked reading, as opposed to (ii):

(i) John's pictures of everyone are hanging on the wall.
(ii) John's picture of everyone is hanging on the wall.

May attributes this difference in scope possibilities to the Specificity Constraint of Fiengo & Higginbotham (1981), under the assumption that "singular (as opposed to plural) NPs are specific." However, I know of no independent support for such an assumption. Further, the closely related (iii) is not acceptable, so that the examples seem to fail the anaphoric binding test for inverse linking:

(iii) * John's pictures of <u>every woman</u> are hanging on <u>her</u> wall.

Williams (1986) points out that *everyone* (as opposed to *every CN*) may have a group reading. (iv), with a collective predicate, provides evidence for this claim:

(iv) Everyone gathered in the square at 6pm.

late" up to the matrix NP. There are two types of examples which show that this is not the correct generalization. First, there are cases of inverse linking where the inversely linked NP itself has an inversely linked complement, as in the following example, after Larson (1985):

(54) The National Enquirer has been looking for [a gossipy friend of [every debutante in [an obscure midwestern city]$_i$]$_j$]$_k$.

Suppose that the National Enquirer's readers love scandals about small-town America. What the magazine wants to find is some obscure midwestern city where every debutante has a gossipy friend who will tell all. The fact that the most deeply embedded NP, *an obscure midwestern city* has the de dicto reading, so that it is under the scope of the opaque verb *looking for*, shows that it does not receive Fodor & Sag's (1982) specific reading, which would give it wide scope without inverse linking. The reading in question (which I think is available) may only be obtained if *an obscure midwestern city* has inverse scope over its matrix, NP$_j$ with the head *debutante*, and *every debutante in an obscure midwestern city* in turn has inverse scope over its matrix, NP$_k$ with the head *friend*. Hence, the direct object should end up with the index $i/j/k$.[26]

If *everyone* in (i) has such a group reading, then we might have a group-group relation between the denotation of the whole subject and that of its complement. As discussed in conjunction with cumulative readings in Section 3.1.3.2, there might then be an extra-truth conditional construal to the effect that there is a functional relation between the groups.

[26]One test for whether the indexing suggested is correct, in view of the binding potential of such indices, is to test whether all of the 'stacked' NPs in (62) can bind a pronoun which the full matrix NPk c-commands. For example, assuming that the friends are all male, can the various indices on the full matrix bind the pronouns in the following: *to tell everything he knows about her contempt for it's mores*? I'm not sure. However, note that May's system would make the same predictions as the present proposal in this case.

One might modify the constraint proposed to handle (53d) by saying that only one application of (49) per NP node was permissible, since then cyclic application would permit the intended reading of (54). Or, one might simply say that the presence of a possessive NP blocks the application of (49).[27] However, the other type of example where an NP receives more than two indices argues against either of these approaches. Consider (55):

(55) [[Some superpower]$_j$'s destruction of [every city]$_i$]$_{i/j/k}$ killed all of it$_i$'s inhabitants.

where both NP$_j$ and NP$_i$ have wide scope over the matrix NP$_k$. *Some superpower* may also bind a pronoun, as in the extension *with it's advanced technological weaponry.* Another possible reading of the subject is where *some superpower$_j$* has widest scope. At first one might be tempted to represent this by indexing the subject $j/i/k$. However, on this reading the binding of *it* by NP$_i$ does not seem felicitous, suggesting that the index of NP$_i$ should not appear on the matrix, but only j/k, with NP$_i$ receiving the relative reading. So the generalization here seems to be that the complement NP may not be inversely linked when the possessive NP takes even wider scope.

Further, note that the closely related (56) seems very awkward on any reading, even where only the possessive NP takes widest scope:

(56) Every city's destruction by some superpower

I do not at present see a coherent generalization to be drawn from these complex judgments, and I will leave the problem with (53d) and (56) open. My suspicion is

[27]See, for example, Fiengo & Higginbotham (1981). They might claim that (61d) is specific because of the proper name in SPEC, and hence violates their specificity constraint.

that the problems here may involve not merely scope relations, but the interaction of thematic roles with scope. In any case, more work on the syntax and the semantics of NPs is required before an adequate answer is forthcoming.

4.2 The D operator

Here, I will briefly consider the S-Structure representation of the adverbial distributive operator D which was discussed in Chapter 3, Section 3.4.2. The introduction of D into S-Structures will permit us to map onto the discourse level from a level which is fully disambiguated with respect to both NP scope and distributivity.

Recall that D may operate on either the syntactic VP or on a predicate derived by lambda abstraction, so that, for example, a group denoting object NP may distribute over a lambda abstraction of the dominating S, the lambda binding a variable in place of the NP. The representation of distributivity at S-Structure must thus take the more abstract possibility into account. For the sake of simplicity, the representation I propose introduces D only in conjunction with scope indices at an S node. This index on D will be used in the SS to DR mapping. The schema for introducing D at SS is as follows:

(57) For any NP index i, $S : \ldots i(D) \ldots$indicates that the D operator applies to the predicate which is the argument of NP_i.

The proposed representation rules out implicit distributivity for some representations of NP scope, for example where the subject (or some other NP) is interpreted in situ; however, I see no harm in this so long as there is there is some representation available of the distributed reading, i.e. where the subject is scope indexed at S.

In order to support the claim that (57) is adequate for the representation of distributivity, we might consider the so-called 'small clauses,' which, following Williams (1983), I regard as nonconstituents. Distributivity in (58) and (59) is induced by the determiners of the underlined NPs. In (60) it is suggested by the meaning of *tarred and feathered*, while in (61), it is induced by D:

(58) I want every oyster raw in its shell.

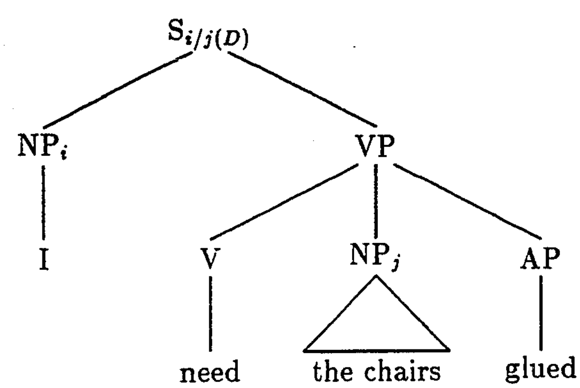
(59) I left many oysters raw in their shell.

(60) I saw the gamblers tarred and feathered.

(61) I need the dining room chairs glued back together.

Although (61) could mean that the speaker wants the chairs all glued into one unit (the group interpretation), the more likely interpretation is that she wants the joints of each chair reglued. Under the proposals for scope indexing and the representation of D, this reading may be represented by the S-Structure in (62), with an interpretation along the lines of (63):

(62)



(63) $\mathrm{I}'(\lambda x[\text{the chairs}'\ ^{D}(\lambda y[\ \text{need}'(x,[\text{glued}'(y)])])])$

Under the interpretation of D discussed in Chapter 3, its application to $\underline{(\lambda y[\text{need}'(x,[\text{glued}'(y)])])}$ in (63) means that each member of the group denoted by *the chairs* will be glued, i.e. each chair will be glued. Thus (57) is adequate for the treatment of distributivity in the "small clauses."

(57) rules out the application of D when NPs take scope at CN, VP or NP. It is difficult to argue one way or the other in such cases. As an exercise, let us consider whether a group denoting NP, such as the CN, which serves as an N′ complement or possessive NP and has scope over the matrix NP may distribute over the head of the matrix. Let us consider first what this would mean for the truth conditions of the sentence in which such an NP is embedded. Consider (64) and (65):

(64) (a) <u>The girls</u>' fathers bought <u>them</u> cars.

(b) <u>The girls</u>' fathers bought <u>them</u> cars, and the boys' fathers did too.

(65) (a) The fathers of <u>the girls</u> bought <u>them</u> cars.

(b) The fathers of <u>the girls</u> bought <u>them</u> cars, and the fathers of the boys did too.

The possessive NP *the girls* may bind the indirect object pronoun *them* in (64), and likewise the N′ complement in (65), as predicted by (49) and (50) and confirmed by the possibility of sloppy readings in the (b) examples.

How could the the fathers over the daughters? Consider again the translation of *'s* in (52), repeated below:

(52) *'s* translates as:

$$\lambda \mathcal{P} \lambda Q \lambda P[\exists R \mathcal{P}(\lambda x \exists y[\forall z(Q(z) \leftrightarrow z = y) \ \& \ R(x,y) \ \& \ P(y)])]$$

D operates on VP type constituents, of type $\langle e,t \rangle$ in Montague's system, so it would not apply to (52), which is of type $\langle\langle\langle e,t\rangle,t\rangle,\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$. The portion of the formula where the possessive NP is the subject of a VP type lambda expression is shown in (66):

(66) $\mathcal{P}(\lambda x \exists y[\forall z(Q(z) \leftrightarrow z = y) \ \& \ R(x,y) \ \& \ P(y)])$

The girls, substituting for $\mathcal{P}$ in (66), have the property of being a (nonatomic) individual x whose unique father-group (here the relation R is suggested by the functional character of the head noun *father*) bought them cars (the VP's translation substituting for P). If the property is modified adverbially by D, then each atomic i-part of the nonatomic individual denoted by *the girls* would have the property that her unique father bought her cars. (Recall that the denotation of *cars* includes the denotation of *car*.)

Distributivity of *the girls* over its matrix would work similarly in (65). Suppose that in a Montague grammar framework the translation rule for Quantifying In at NP would be something like (67), parallel to the Montague's (1973) rules T14 – 16 given in modified form in Section 4.1.1:[28]

(67) If $a \epsilon P_{NP}$, $b \epsilon P_{NP}$ and a, b translate into a', b' respectively, then $\mathrm{F}_{10,n}(a,b)$ translates into $\underline{\lambda P a'(\lambda x_n[b'(P)])}$.

Here, the distributive operator D would operate over the derived predicate

[28]This rule is quite similar to that given in Larson (1985), and amounts to the same thing truth conditionally.

$\lambda x_n[b'(P)]$, so that each atomic i-part of the quantified in NP (the girls) would have the property ('being an x such that x's bought x a car').

The question of whether D may apply in the way just discussed (or in the truth conditionally equivalent DR interpretation to be proposed in the following section) is obscured by two factors. First, it seems that the head of an NP with a plural possessive or an inversely linked N′ complement NP must itself be morphologically plural. Consider the following examples, where the inherently distributive character of the determiner *few* rules out the possibility that it discourse binds the pronoun *they*:

(68) (a) * The owner of few cats thinks they've got fleas.

(b) The owners of few cats think they've got fleas.

(c) * Few cats' owner thinks they've got fleas.

(d) Few cats' owners think they've got fleas.

(69) (a) * A resident of few cities hates them.

(b) Residents of few cities hate them.

(c) * Few cities' resident hates them.

(d) Few cities' residents hate them.

The (a) examples, where the bound anaphora indicated by underlining requires that the N′ complement be inversely linked, are unacceptable because their head nouns are singular. This is in contrast to the (b) examples, which are identical except that the head is plural. The (c) examples are completely ungrammatical; like the (a) examples, they have singular heads, but, as predicted by (50), they can only have scope over the entire NP. The cause of the ungrammaticality seems to be a clash between the singularity of the head and the NP scope of a plural NP. The full acceptability of the (d) examples confirms this generalization.

My hunch is that this phenomenon is related to the dependent plural phenomenon discussed in Chapter 3, Section 3.5. When the matrix has scope under a plural NP (whether group or distributive), its head must be plural, rather like the dependent plurals in predicates with plural subjects which we discussed there. The difference, however, is that here the plurality is obligatory.

The second factor obscuring the question of whether the distributive D operator may ever be involved in Quantifying In or Scope Indexing at NP pertains to the possibility of a cumulative interpretation for examples such as (64) and (65), the reading where the group of fathers of the group of girls bought them a group of cars. The functional head noun of the subject might then suggest that in fact there was a functional relation between the buyers and particular cars, such that each father bought a car for his own daughter. Thus, it is very difficult to tell whether true distributivity is ever involved.

I don't know of any tests which can settle the question. It would be possible to introduce the D operator at levels of scope indexing other than S; but because of the lack of evidence that it is involved in such cases I will ignore that possibility here.

4.3 Scope and distributivity in discourse representations

In the grammar I am arguing for here, S-Structures are mapped onto DRs, rather than formulae of intensional logic. This mapping is not bottom up, as in Montague Grammar, but top down, as in Kamp (1981) and Heim (1982). A DR, with discourse binding introduced consistent with the accessibility of (possibly accommodated) antecedents in its hierarchical structure, is then interpreted in a model. In Chapter 5 I will discuss the representation of number in DRs. Here, I am concerned with the representation of distributivity, whether introduced by explicit or implicit adverbial distributivity in a predicate or by the determiner of its subject NP. In general, it will be seen that both kinds of distributivity bring about box-splitting in DRs. And this, without further stipulation, will explain the anaphoric constraints on NPs under the scope of a distributive operator (determiner or adverb), just as it does in Kamp's (1981) and Heim's (1982) treatments of the classic donkey sentences.

4.3.1 Determiners and the mapping onto discourse representations

As discussed above, Kamp (1981) and Heim (1982) both claim that there are two kinds of NPs, those, such as singular indefinites, which are interpreted as variables and those, such as universally quantified NPs, whose determiner sets up a relationship between the denotation of the CN and that of the predicate of which the NP is subject. The first type of NP is what I called in Chapter 3 an individual-denoting NP. Recall that the group-denoting NPs are a subset of the individual-denoting NPs, those whose denotations include nonatomic elements of the lattice-structured domain. The second type of NP is what I called the quantificational NPs. In Chapters 1 and 2, I simply assumed that the two types of NPs behaved differently in the mapping onto a DR. Here, I will discuss in more detail how the discourse representation of NPs is related to their individual-denoting or quantificational character.

In DRs, all individual-denoting NPs are represented in much the same way as singular indefinites, with the possible addition of further conditions, such as the cardinality condition in the representation of an NP with a numeral specifier, or the anaphoric condition on definites (see Chapter 5). Recall that in Heim's theory, LFs involving such NPs have a bipartite structure; the NP is prefixed to the S in which it occurs, and the S itself, with a variable in place of the NP, is called the nuclear scope of the NP. Such an LF maps onto a File where the predicate denoted by the CN and the predicate denoted by the nuclear scope of the NP (as if it were a lambda abstraction on the NP variable) are conditions on the discourse referent introduced by the NP in the file. In DRs, similarly, for any individual-denoting NP we simply enter a discourse referent, with the CN and the nuclear scope of the NP acting as conditions on the discourse referent. The following is a general characterization of the mapping of nonquantificational NPs with sentential scope onto a DR:

(70) **Mapping individual-denoting NPs onto a DR:**

To map a constituent of the form $[\ \ldots[\text{DET CN}]_i\ \ldots]_S$ onto a DR, where NP_i is individual-denoting, enter a discourse referent x_i into the DR, along with the condition $\underline{\text{CN}(x_i)}$. Then enter the nuclear scope of the NP into the DR, where the nuclear scope is S with the variable x_i in place of NP_i.

The mapping is exemplified in (71), where the direct object in the predicate has been ignored for simplicity:

(71) [The man]$_i$ lifted a piano.

x_i
man(x_i)
$x_i = x_k$
x_i lifted a piano

Here, the equation of x_i with x_k is intended to satisfy the anaphoric requirement on the definite NP *the man*; x_k must be a pre-existing discourse referent accessible to x_i in a larger DR, as in other cases of discourse anaphora we have examined. The truth conditions for (71) will be 'the (already salient) individual which is a man has the property of having lifted a piano.' The nuclear scope may also be represented as *lifted a piano*(x_i).

The discourse representation of all quantificational NPs involves box-splitting. As I noted above, this reflects Heim's tripartite structures at LF: the lefthand (or antecedent) box represents the CN, Heim's restrictive term, and maps onto the set which it denotes, while the righthand box represents Heim's nuclear scope, the sentence with the NP replaced by a coindexed variable. Kamp's (1981) treatment of the universal operator is syncategorematic: the arrow between the two boxes tells us that the set denoted by the lefthand box must be a subset of that denoted by the righthand box, so that, as in generalized quantifier theory, the determiner is essentially a relation between two sets. Other quantificational determiners may also be treated in DR theory as relations between two sets, so that box-splitting occurs but the relation between the sets denoted by the boxes differs from determiner to determiner.[29] The following is a general characterization of the mapping of such

[29]I understand that Root (1986) works out something along these lines for the treatment

NPs:

(72) **Mapping Quantificational NPs onto a DR:**

To map a constituent of the form $[\ \ldots[\text{DET CN}]_i \ldots]_S$ onto a DR, where NP_i is quantificational, form two subordinate boxes, the left accessible to the right; enter a discourse referent x_i into the lefthand box, along with the condition $\text{CN}(x_i)$. Enter the nuclear scope of NP_i into the righthand box of the DR. DET serves to characterize the relation between the two boxes in the embedding into a model.

In line with (72), we might represent a sentence such as (73) roughly as in (88) (to be revised), again ignoring for the time being the singular direct object:

(73) [[Few men]$_i$ lifted a piano.

(74)

$$\boxed{\boxed{\begin{array}{c} x_i \\ {}^{*}\text{man}(x_i) \end{array}} = \text{FEW} = \boxed{\text{lifted-piano}(x_i)}}$$

(74) is parallel to the representation for similar sentences containing the universal quantifier, such as *every man lifted a piano.* The quantificational determiner *few* occurs between the two boxes as a guide for the embedding into a model. As with the conditional boxes of the *every* construction, the righthand box is subordinate to the lefthand box, so that x_i is accessible to pronouns in the predicate. For

of determiners such as *many* and *few* in Discourse Representation Theory, but I have not had the opportunity to read her account.

the proportional reading of *few*, the truth conditions should be along the lines of 'the elements in the intersection of the sets denoted by the CN and the VP are few in number proportionate to the number of elements in the complement of that intersection.'

However, there is one problem with the representation of (73) and its subsequent truth conditional interpretation. It is generally assumed that the truth conditions for *few* require a count of atomic individuals in the extension of the CN (see Bennett (1974) and Barwise & Cooper (1981), for example). But in (74), the condition on x_i specifies only that it must be an element of the predicate **man*, whose elements include nonatomic as well as atomic individuals, groups of men as well as single men. That is, the truth conditions for (74) would seem to require that we consider all individuals in the semilattice generated by *man*, which would lead us to an inappropriate plural quantification reading of the sentence.

I think this type of problem provides further evidence to support Link's contention that distributivity is a property pertaining only to atomic elements of a set. We have seen that D requires us to consider only the atomic i-parts of the group denoted by the subject. In (73) the distributivity is introduced by a determiner, but it too leads us to consider only the atomic elements in the extension of its CN. Accordingly, we will revise (74) as follows:

(75) Few men lifted a piano.

$$\boxed{\boxed{\begin{array}{c} x_i \\ {}^*\text{man}(x_i) \\ \text{atomic}(x_i) \end{array}} = \text{FEW} = \boxed{\text{lifted-piano}(x_i)}}$$

Thus, the distributivity in a quantificational determiner leads us to consider all and only the atomic elements in a given set.

However, recall that atoms need not be individuals in the pretheoretic sense. This is crucial for the representation of examples such as Link's (76), discussed above in Chapter 3, Section 3.2.4:

(76) All competing companies have common interests.

I argued in that section that these examples do not involve Link's plural quantification. Instead *all* quantifies over units each of whose members are competing companies. If we are willing to concede that each such unit is conceived of as an atom (possibly impure, in Link's sense), then the representation for (76) will be as in (91), parallel to that in (75):

(77)
$$\boxed{\boxed{\begin{array}{c} x_i \\ {}^*\text{companies}(x_i) \\ \text{competing}(x_i) \\ \text{atomic}(x_i) \end{array}} = \text{FEW} = \boxed{\text{have-common-interests}(x_i)}}$$

Here, each of the atomic elements in the set denoted by **competing-companies* involves more than one company, with truth conditions something like, 'each unit which consists of competing companies has common interests.'

When NPs do not have sentential scope, they behave in a fashion similar to the examples shown above. individual-denoting NPs simply introduce a coindexed discourse referent, and the remainder of the sentence is reduced by replacing the NP with a coindexed variable. Quantificational NPs always induce box-splitting, introducing a discourse referent over atomic individuals in the lefthand box, with the remainder of the sentence entered in the righthand box. We will see further examples of this in the following section.

4.3.2 Scope indexing, D, and the mapping from S-Structure to discourse representations

The mapping from an S-Structure to a Discourse Representation proceeds in a top-down and left-to-right manner. At any given node, we first consider any NPs whose indices appear on that node. At an S, for example, we first consider NPs whose scope indices appear on the S (if there are any), widest scope first. We then consider its daughters left to right, first the subject NP and its daughters, then the VP; and so on down the tree.

Suppose that first we encounter a node marked S:i/j. The indexing instructs us to first map NP$_i$ onto the DR, in a fashion dictated by its determiner. The remainder of the sentence, with the variable x_i in the place of NP$_i$ and the scope index S:j, is the nuclear scope of NP$_i$. Its representation will be entered into the DR in the position for NP$_i$'s nuclear scope. This begins with the mapping of NP$_j$ into the DR in a fashion appropriate to its determiner, and the substitution of the variable x_j for NP$_j$ in the remainder of the sentence. This remainder then is the nuclear scope of NP$_j$ and is entered in the appropriate position. Then the mapping proceeds to consider any daughters of S, top to bottom and left to right, until all the NPs have been treated. In this way, the full DR is derived.

This mapping procedure is given in general form in (78), which works in conjunction with the mapping of NPs given in (70) and (72) above:

(78) **Mapping algorithm for DRs:**

To map a constituent with root node C onto a DR,

(a) if C is indexed : i ..., map the first (moving from top to bottom, left to right) constituent NP$_i$ dominated by C into the DR. Then remove the index i from C.

(b) if C has no indices, map in turn its daughter constituents, left to right.

Now let us see how (78) works, in conjunction with (70) and (72), for the two different readings of (79) in (80) and (81):

(79) Everyone in this room speaks two languages.

(80) $[[\text{Everyone}]_i$ speaks $[\text{two languages}]_j]_{S:i/j}$

(a)

$$\boxed{\boxed{\begin{array}{c} x_i \\ \text{person}(x_i) \\ \text{atomic}(x_i) \end{array}} \Longrightarrow \boxed{\phantom{\begin{array}{c} x_i \\ \text{person}(x_i) \\ \text{atomic}(x_i) \end{array}}}}$$

remainder of the sentence:

x_i speaks $[\text{two languages}]_j]_{S:j}$

(b)

x_i		x_j
person(x_i)	$\Longrightarrow$	languages(x_j)
atomic(x_i)		$\lvert x_j \rvert = 2$

remainder of the sentence:

$[x_i \text{ speaks } x_j]_S$

(c)

x_i		x_j
person(x_i)	$\Longrightarrow$	languages(x_j)
atomic(x_i)		$\lvert x_j \rvert = 2$
		x_i speaks x_j

In (a), the mapping of the NP with widest scope, everyone$_i$, into the DR induces box-splitting, with the introduction of the discourse referent x_i in the antecedent box, along with a condition reflecting the restrictive term. In this case, since the CN is singular, the condition requiring that x_i be atomic is superfluous. In accord with the algorithms suggested above, NP$_i$ is replaced in the original sentence by the corresponding variable, and its index is removed from S. The remainder of the sentence is then treated as the nuclear scope of x_i by entering it in the right-hand box of (a). In (b) the NP two languages$_j$ is treated as an indefinite, individual-denoting NP with cardinality specification, as argued in Kadmon (1984). $|x_j| = 2$ means 'the number of atomic i-parts of x_j is 2.' NP$_j$ is then replaced with a variable in the remaining sentence, and its index is removed from S. The result is then irreducible in DR terms, since all the NPs have been treated, and it is added as the nuclear scope of NP$_j$ in the righthand box, in (c). When embedded in the model, this DR will yield the proper truth conditions for the reading indicated.

In (81), we see the mapping onto a DR from the other S-Structure for (79), where the direct object has wider scope than the subject:

(81) [[Everyone]$_i$ speaks [two languages]$_j$]$_{S:j/i}$

(a)

$$\begin{array}{|c|}\hline x_j \\ \text{languages}(x_j) \\ |x_j| = 2 \\ \hline \end{array}$$

remainder: [[Everyone]$_i$ speaks x_j]$_{S:i}$

(b)

$$\begin{array}{|c|}\hline x_j \\ \text{languages}(x_j) \\ |x_j| = 2 \\ \begin{array}{|c|}\hline x_i \\ \text{person}(x_i) \\ \text{atomic}(x_i) \\ \hline \end{array} \Longrightarrow \begin{array}{|c|}\hline \\ \phantom{\text{person}(x_i)} \\ \phantom{\text{atomic}(x_i)} \\ \hline \end{array} \\ \hline \end{array}$$

remainder of sentence: [x_i speaks x_j]$_S$

(c)

<table>
<tr><td colspan="3">x_j
languages(x_j)
$|x_j| = 2$</td></tr>
<tr><td>x_i
person(x_i)
atomic(x_i)</td><td>$\Longrightarrow$</td><td>x_i speaks x_j</td></tr>
</table>

In (a), the NP with widest scope, NP$_j$ is treated, an indefinite acting as a variable with conditions induced by its CN and cardinality specifier, as it did in (80b). The original sentence and its index are reduced accordingly and treated as the nuclear scope of NP$_j$. In (b) the universally quantified NP$_i$ induces box-splitting, as it did in (80a). The irreducible remainder of the sentence after this step is then entered as the nuclear scope on NP$_j$ in the righthand box of the final conditional.

Now consider an NP, say NP$_i$, which is itself group-denoting and hence does not induce box-splitting, but has a predicate which is adverbially distributive, i.e., to which the D operator has applied. NP$_i$ itself is first entered into the DR in a manner appropriate to its determiner, with the discourse referent x_i. Then the distributivity induces box-splitting, with the lefthand box containing a new discourse referent which is specified as an atomic i-part of the discourse referent for NP$_i$. The righthand box of the conditional contains the discourse representation for the (possibly complex) predicate itself.

(82) **Algorithm for the Treatment of Nuclear Scopes with D:**

To map a structure of the form $[\ \ldots e_i \ldots]_{S:(D)} \ldots$ onto a DR, where the structure is the nuclear scope of NP$_i$, introduce a conditional structure, with a new discourse referent x_k, in the lefthand box, along with the conditions $\underline{\text{i-part}(x_k, x_i)}$ and $\underline{\text{atomic}(x_k)}$. Remove (D) from the index on S, replace e_i throughout with e_k, and introduce this remainder in the righthand box of the conditional.

We see an example of this in (83):

(83) [[Some men]$_i$ lifted [a piano]$_j$]$_{S:i(D)}$

(a)

$$\begin{array}{|c|}\hline x_i \\ {}^{*}\mathrm{man}(x_i) \\ \hline\end{array}$$

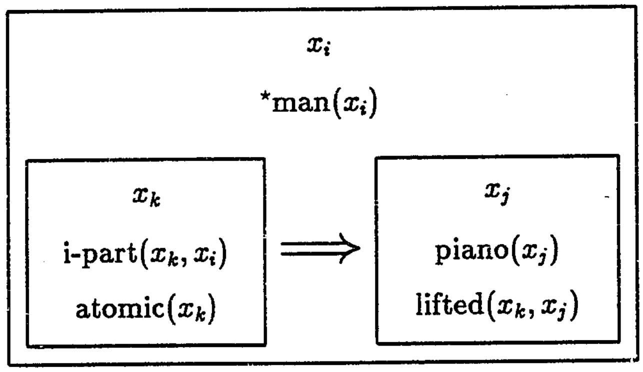
remainder of S: [x_i lifted [a piano]$_j$]$_{S:(D)}$

(b)

$$\begin{array}{|c|}\hline x_i \\ {}^{*}\mathrm{man}(x_i) \\ \begin{array}{|c|}\hline x_k \\ \text{i-part}(x_k, x_i) \\ \text{atomic}(x_k) \\ \hline\end{array} \Longrightarrow \begin{array}{|c|}\hline \qquad\qquad \\ \\ \\ \hline\end{array} \\ \hline\end{array}$$

remainder of S: [x_k lifted [a piano]$_j$]$_S$

(c)



Only the subject's scope is indexed at S; the object is interpreted in situ, though this is not essential to the interpretation of D. The D operator is indicated following the scope index of the subject, meaning that the predicate which remains after the treatment of the subject is to be modified by adverbial D. In (a) the group-denoting subject is treated in the usual way for indefinites, introducing a new discourse referent with the same index as the NP. The original sentence is reduced as we saw in earlier examples. In (b), *D* introduces box-splitting and a discourse referent in the lefthand box; conditions are put on the new discourse referent so that it must be an atomic i-part of that of the subject.[30] The *D* is then removed from the S node, and the index *k* is substituted for *i* everywhere in the sentence remaining. In (c) this remainder is treated as a nuclear scope in the righthand side of the conditional. A discourse referent is introduced for the only remaining NP, the indefinite NP_j, and the remainder of the sentence acts as a further condition on x_k, that is, on the atomic i-parts of x_i.

[30]The index of the discourse referent to be introduced by *D* might be introduced at S-Structure, as follows:

(i) $[[\text{Some men}]_i$ lifted $[\text{a heavy rock}]_j]_{S:i(D:k)}$

with the stipulation that the index of *D* has not been used in the discourse up to that point. I avoided adding such an index in the schema (65) for the sake of simplicity.

The truth conditions for the entire DR, following Kamp's original embedding algorithm, will be 'there are some men (x_i) such that all atomic i-parts of this individual (all of the men in the group) lifted a piano.' It need not be the case that all the men lifted the same piano. And, as we would expect on the reading of (83) with *a piano* under the scope of the distributive operator, the discourse referent for *a piano*, x_j, will not be an accessible antecedent for subsequent pronouns in the discourse. (Again, the in situ scope of NP_j is not essential to this effect.)

Note that in (83) when the D operator introduces box-splitting and a discourse referent x_k for atomic i-parts of the original subject, we substitute k for the index of the subject throughout the original sentence, and not just in subject position. In other examples, this is important for the treatment of anaphors bound by the subject. Consider (84) (perhaps uttered in the orthopedic ward of a hospital in Colorado):

(84) Those people broke their leg learning to ski.

The highly preferred distributive reading of (84) may be paraphrased 'Each of those people broke his or her leg learning to ski.' Since a demonstrative plural NP is unambiguously group-denoting, the distributivity here must be introduced via D. And though the pronoun is bound by the group-denoting subject at S-Structure, in the resulting DR it should be bound by the variable over atomic i-parts which is introduced in processing adverbial D. The construction of a DR for this sentence proceeds as follows, where I have ignored the demonstrative nature of the subject:

(85) [[Those people]$_i$ broke [their$_i$ leg]$_j$]$_{S:i(D)/j}$

(a)

$$\boxed{\begin{array}{c} x_i \\ {}^*\text{person}(x_i) \end{array}}$$

remainder of S: [x_i broke [their$_i$ leg]$_j$]$_{S:(D)/j}$

(b)

$$\boxed{\begin{array}{c} x_i \\ {}^*\text{person}(x_i) \\ \boxed{\begin{array}{c} x_k \\ \text{i-part}(x_k, x_i) \\ \text{atomic}(x_k) \end{array}} \Longrightarrow \boxed{\phantom{\begin{array}{c} x_j \\ x_k\text{'s leg}(x_j) \\ \text{broke}(x_k, x_j) \end{array}}} \end{array}}$$

remainder of S: [x_k broke [their$_k$ leg]$_j$]$_{S:j}$

(c)

$$\boxed{\begin{array}{c} x_i \\ {}^*\text{person}(x_i) \\ \boxed{\begin{array}{c} x_k \\ \text{i-part}(x_k, x_i) \\ \text{atomic}(x_k) \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_j \\ x_k\text{'s leg}(x_j) \\ \text{broke}(x_k, x_j) \end{array}} \end{array}}$$

In (85b), the index k was substituted for i throughout the remainder of (a), and hence in (c) the pronoun will be bound by the atomic i-part discourse referent, and not by the discourse referent for the group-denoting NP itself.

Mapping structures with possessive or inversely linked NPs requires no further stipulations. The NPs are simply processed in the order of their indices at any particular node, so that the first processed will have widest scope in the DR and the subsequent truth conditional embedding in a model. Consider the construction of a DR for one of May's examples in (86):

(86) [[Someone in [every city]$_i$]$_{NP:i/j}$ despises it$_i$]$_{S:i/j}$

(a)

$$\boxed{\boxed{\begin{array}{c} x_i \\ \text{city}(x_i) \end{array}} \Longrightarrow \boxed{\begin{array}{c} \phantom{\text{person}(x_j)} \\ \end{array}}}$$

remainder: [[Someone in x_i]$_{\text{NP}:i/j}$ despises x_i]$_{S:j}$

(b)

$$\boxed{\boxed{\begin{array}{c} x_i \\ \text{city}(x_i) \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_j \\ \text{person}(x_j) \\ \text{in}(x_j, x_i) \end{array}}}$$

remainder: [x_j despises x_i]$_S$

(c)

$$\boxed{\boxed{\begin{array}{c} x_i \\ \text{city}(x_i) \\ \\ \\ \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_j \\ \text{person}(x_j) \\ \text{in}(x_j, x_i) \\ \text{despises}(x_j, x_i) \end{array}}}$$

Since the index i of the inversely linked NP *every city* has widest scope at S, it is processed first, in (a). Since it is a universally quantified NP, it induces box-splitting. Then the scope index for NP$_i$ is removed from S. (When we turn to its daughter NP$_{i/j}$, since NP$_i$ will have already been processed and a variable entered in its place, treatment of NP$_i$ at that point will be vacuous.) In (b) and (c) the remainder of the sentence is entered in the righthand box of the conditional, as a predicate on NP$_i$. Note that the same DR would result if both the subject and object NPs were interpreted in situ, instead of having S scope, since the inversely indexed subject would be processed first in that case, and hence the inversely linked complement.

What of Rooth's (1986a) numeral based donkey sentences? As noted in Chapter 3, Section 3.4.3, these all have group-denoting subjects (or other c-commanding NPs) with adverbially distributive predicates. An example is repeated below:

(87) [The *[fathers with [two *children]$_i$]]$_j$ send them$_i$ (both) to Montessori school.

Intuitively, the anaphoric relation indicated is licensed in the following way: a) the star operator, $\star$, tells us that any atomic i-part of the nonatomic individual denoted by NP$_j$ will be a father and will have two children. b) The distributive operator D tells us that each of these atomic i-parts has the property denoted by 'sends them both to Montessori school.' c) Since any atomic i-part has two children and also has this property with an unbound plural pronoun, we conclude that it is the discourse referent for the NP *two children* which binds the pronoun.

Suppose that (87) maps onto a DR of the following form:

(88)

$$\boxed{\begin{array}{c} x_j \\ {}^*[\text{father with two children}](x_j) \\ \boxed{\begin{array}{c} x_k \\ \text{i-part}(x_k, x_i) \\ \text{atomic}(x_k) \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_i \\ \text{send-to-M-S}(x_k, x_i) \end{array}} \end{array}}$$

In mapping from (87) to (88), the algorithms for the treatment of numerically specified indefinites and D were used. But here there is no discourse referent accessible to the discourse referent for *them*, x_i, and so the representation is infelicitous.

Suppose that treatment of $\star$ in DRs involved universal quantification over atomic i-parts of the denotation of the plural CN. This would be consistent with Link's meaning postulates on $\star$, discussed in Chapter 3, Section 3.2. Under this assumption, both *fathers with two children* and *children* would induce box-splitting, a DR for (87) would look like (89):

(89)

$$\boxed{\begin{array}{c} x_j \\ {}^*\text{[father with two children]}(x_j) \\ \boxed{\begin{array}{c} x_k \\ \text{i-part}(x_k, x_j) \\ \text{atomic}(x_k) \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_i \\ \text{father}(x_k) \\ {}^*\text{child}(x_i) \\ |x_i| = 2 \\ \boxed{\begin{array}{c} x_m \\ \text{i-part}(x_m, x_i) \\ \text{atomic}(x_m) \end{array}} \Longrightarrow \boxed{\text{child}(x_m)} \\ \text{with}(x_k, x_i) \end{array}} \\ \boxed{\begin{array}{c} x_k \\ \text{i-part}(x_k, x_j) \\ \text{atomic}(x_k) \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_i \\ \text{send-to-M-S}(x_k, x_i) \end{array}} \end{array}}$$

Even though intuitions (a) and (b) are expressed in (89), the discourse referent x_i in the final conditional is still unbound, so that the DR is ill-formed. Since the two variables x_i are under the scope of different operators, the conditions on one are not relevant for the interpretation of the other.

$\star$ and D would have the same effect on DR construction on this approach. But I believe this is misleading, and that since they are not the same operator, they should not receive identical treatment. $\star$ is an operation which builds structure, in a sense — it gives a denotation for a plural CN by building the semilattice generated by the denotation of the singular form. From this we may conclude that all atomic i-parts of the lattice *CN are elements in the singular denotation. Perhaps this fact should be taken to be an entailment of <u>*(father with two children)</u>, rather than as an algorithm for deconstructing the constituent in a DR. D, on the other hand, is a distributivity operator, so the introduction of conditions on the atomic i-parts of the subject is its central function.

If we take the conditions on atomic i-parts of the *CN denotation to be an entailment, then it seems reasonable to assume that we may accommodate this information into the representation of the distributed nuclear scope of the subject NP. The representation which would result for (87) is given in (90):

(90)

$$\boxed{\begin{array}{c} x_j \\ {}^*[\text{father with two children}](x_j) \\ \boxed{\begin{array}{c} x_k \\ \text{i-part}(x_k, x_j) \\ \text{atomic}(x_k) \end{array}} \Longrightarrow \boxed{\begin{array}{c} x_i \\ \text{father}(x_k) \\ \boxed{\begin{array}{c} x_m \\ \text{i-part}(x_m, x_i) \\ \text{atomic}(x_m) \end{array}} \Longrightarrow \boxed{\text{child}(x_m)} \\ |x_i| = 2 \\ \text{with}(x_k, x_i) \\ \text{send-to-M-S}(x_k, x_i) \end{array}} \end{array}}$$

Here, the discourse referent x_i introduced by *child is available to serve as antecedent for the pronoun *them*, and the representation is both well-formed and gives the appropriate truth conditions, where each of the fathers with two children sends them to Montesorri School.

As we saw in Chapter 3, Rooth's use of Barwise's (1985) parameterization permits the variables bound by both operators to be complex, including instructions which constrain the value of the variable i for any given value of j. So far as I can see, the present proposal is no more of a stipulation than Rooth's rule, and in fact the idea that the representation of a plural CN entails certain facts about its atomic i-parts seems natural within the framework of a semantics of plurality such as Link's and the assumptions about the possibility of accommodation which we have explored above.

Chapter 5

Remarks on Plural Anaphora

In Chapters 1 and 2, I outlined a theory of anaphora. My basic assumption has been that English third person pronouns are interpreted as variables.[1] In attempting to defend this assumption, I proposed that there are two types of pronominal binding, subject to different constraints. The constraints on c-command anaphora are expressed in terms of configurational properties of sentences. This is the type of constraint embodied in the principles of the Binding Theory, as discussed and revised in Chapter 2. Another type of constraint is ultimately semantic in nature: an anaphor must be in the scope of its antecedent. In discourse, we find hierarchical structures which are defined by various kinds of operators, including modals, adverbs of quantification, and temporal operators. As in the case of pronouns c-command bound by quantified NPs, a pronoun under the scope of such an operator must be bound within that scope. However, the possibility of accommodating preceding propositions in the discourse to serve as restrictions on the domain of an operator (this possibility itself constrained by mood, tense and the like) licenses

[1] Again, I follow Heim (1982) in assuming that deictic pronouns are bound to discourse referents which are accommodated due to the salience of the referent in the context of utterance.

the phenomenon of discourse subordination, which seems to extend an operator's scope.[2]

The examples I considered in Chapters 1 and 2 all involved only singular pronouns. Anaphora involving plural pronouns presents special problems. Here I will focus on one of the most important of these, the relation of their syntactic number to interpretation. This problem raises anew the question of the semantic content of pronouns and how it is related to that of their antecedents.

In line with the hypothesis that pronouns are variables, completely dependent on their antecedents, I will argue here that the number of a pronoun is not a condition on its interpretation: the pronoun itself has no content. Rather, any features, including number and gender, serve only to guide the hearer in determining an appropriate antecedent. In general, antecedents and anaphors must agree with respect to these features, but this does not entail coreference.

In the Heim/Kamp theory not only pronouns, but all definite (and indefinite) NPs are treated as variables. Heim (1982,p.370) argues for what she calls the "Extended Novelty-Familiarity Condition" on the felicity of an utterance in a given context, or File. This condition places two different requirements on the felicitous use of a definite NP. The first is that a definite NP must be anaphoric; that is, in terms of Files or DRs, it is only felicitous in a discourse when it corresponds to a discourse referent which has already been introduced. The second condition is that the context in which it is uttered already presupposes its descriptive content, if it

[2] I believe the relationship between these two types of constraints is probably more intimate than their relegation to two different levels of representation would suggest. If one considers the correlates of the Binding Theory principles in a categorial grammar, so that they are couched in terms of function-argument structure (as in Bach & Partee (1980)) instead of c-command, the relationship of the configurational constraints to scope becomes more apparent. However, I'm not convinced that the configurational constraints reduce entirely to questions of scope.

has any.[3] The descriptive content of a definite or indefinite NP is given by its CN, which is treated as a condition on the corresponding variable (discourse referent) in the File (or DR).

One might pose the question about the relation of the syntactic number of a pronoun to its interpretation in terms of Heim's theory of definiteness: Do pronouns have descriptive content? i.e. do pronominal features for number, and perhaps gender as well, also induce conditions on the associated variable? Frey & Kamp (1986) answer in the affirmative. They stipulate that there are two types of discourse referents, those induced by singular pronouns and those induced by plurals; and that only the plural discourse referents map onto sets in the model — the equivalent of Link's nonatomic i-sums. However, I will argue that the answer should be negative.[4]

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[3]Kadmon (1986) argues convincingly that there is another condition on the use of definites, the Uniqueness Condition, which she formulates in terms of DR theory. The Uniqueness Condition is a variation of Evans' (1977,1980) requirement that the antecedent of a plural pronoun be the maximal collection determined by the clause containing the antecedent. For example, in his example (i):

(i) John owns some sheep. Harry vaccinates them.

them may not refer to just any group of sheep John owns, but must refer to the maximal collection of sheep which John owns. Kadmon revises Evans' condition in a restricted way, to reflect the fact that the maximality of a set (which is equivalent to saying its uniqueness, particularly in the context of a theory such as Link's) may be guaranteed not only by conditions on the antecedent which are introduced in processing its sentence, but by implicated, accommodated and contextually supplied material as well. She also shows that her Uniqueness Condition entails the anaphoric conjunct of Heim's Extended Novelty-Familiarity Condition; she then proposes a condition, the Uniqueness and Familiarity Condition, which combines her Uniqueness Condition and Heim's requirement that descriptive content be presupposed.

[4]In fact, I believe there are not two but three classes of anaphors, that is, of NPs which are interpreted as variables in a DR or File and require an antecedent. There is one class consisting of NPs with descriptive content, that is, definite descriptions. Another class is that of the pure pronominals, exemplified by English third person pronouns, and this is the class which I claim has no inherent content. But there is a third class of

I think that the number of a pronoun, in contrast to that of a CN (recall the discussion in Section 3.2.3), does not induce any conditions on the discourse referent with which it is associated, and thus has no effect on the embedding of a DR (or File) into a model. The strongest argument for this view centers on the interpretation of plural pronouns which are bound in distributed predicates. Consider (1), from the preceding chapter:

(1) Those people broke their leg learning to ski.

The most natural reading of (1) is distributive, where it is not the case that all of the people in question have broken the same, communal leg. Since the subject of (1) is group-denoting, I will assume, following the discussion in Chapter 3, that the distributivity here is adverbial. But on the relevant reading, the pronoun is not group-denoting, unlike its apparent antecedent, the subject *those people*. *Their*, then, might be considered a dependent plural. In this particular example its number has not 'percolated' onto the head of the NP in which it occurs, but the example is acceptable with *legs* instead of *leg*, with the same interpretation.

This reading is represented in the following S-Structure, using the extension of Williams' (1986) system of scope indexing at S-Structure which I proposed in Chapter 4:

(2) $[[\text{those people}]_i \text{ broke } [\text{their}_i \text{ leg}]_j]_{S:i(D)}$

nominal anaphors which lack descriptive content and yet have some content apart from agreement. The Dogrib disjoint anaphors of Saxon (1984) are members of this third class of anaphoric NPs. The disjoint anaphors seem to have the content 'other than x,' where x is the element bound by the antecedent. I believe that English reciprocals are similar to the disjoint anaphors in this respect. See Roberts (forthcoming) for development of this idea.

Recall that it is the scope index, interpreted as a lambda operator (or its truth conditional equivalent in DR terms), and not the NP itself, which binds the coindexed A-Positions. If we then apply D to the predicate derived by this lambda abstraction, as indicated by the scope index *(D)* after i on S, then the appropriate truth conditions are derived. The pronoun is translated as a variable, x_i, which is bound not by the subject, but by the lambda operator; this is equivalent to the following first order formula:

(3) (Those people) $^D\lambda x_i(\text{broke}(x_i, x_i\text{'s leg}))$

Here, 'the property of being x_i such that x_i broke x_i's leg' is predicated distributively of *those people.*

Then, even though the anaphoric relation between the subject and the plural pronoun in (1) is represented by means of coindexation, as it was in Chapter 4, Section 4.3.2, this coindexation relation is not one of coreference. Again, coindexation is a guide to a mapping onto a DR, and has no direct model theoretic translation. In this case, the coindexation of the subject and the pronoun in S-Structure has the effect that the subject's argument position and that of the operator are both bound by the same operator in a logical translation. Here is where the 'coreference' lies, and not between the the subject itself and the pronoun. Of course, it is not true coreference, either, since both variables are under the scope of the adverbial distributivity operator. Hence we can only say that their value varies in the same way.

The mapping of adverbially distributive predicates onto DRs which I proposed in Chapter 4 reflects these facts about the binding of the pronoun in (1). Recall that adverbial D induces box-splitting and simultaneously introduces in the lefthand box a new variable over i-parts of the subject. Then in the original sentence, all indices identical with that of the subject are changed to that of the new variable over i-parts of the subject. This has the same truth conditional effect as binding by a lambda operator.

The significance of the coindexation of the subject with *their* in (1), then, is only realized in the relative roles of the two NPs in a predication, and not directly in terms of the 'reference' of the NPs in a model, arguing that there should be no direct effect of pronominal number on interpretation.

We see further evidence of this in (4):

(4) Most boys think they like themselves.

Here, the A-Pronoun *themselves* must be bound in its governing category, the complement S, so we may conclude that its antecedent is *they*, and not *most boys*. The subject of (4) is quantificational, so that the only reading is distributive — there is no reading where some group has the property of liking itself. (5) is an indexed S-Structure for (4) which yields the proper truth conditions; this has the same truth conditions as the first order formula in (6):

(5) $[[\text{most boys}]_i \text{ think they}_i \text{ like themselves}_i]_{S:i}$

(6) $[\text{most boys}]\ \lambda x_i(\text{think}[x_i, (\text{like}(x_i, x_i))])$

There is no group-denoting antecedent for *their* in this example, and hence the plural number of the pronouns does not indicate that they are group-denoting. Rather, they only agree with their antecedent, a syntactically plural quantificational NP.

Example (7), from Link (1986), shows that pronouns in the same distributive predicate may be bound in two ways by the same antecedent, via c-command binding and discourse binding:[5]

(7) John and Mary invited their$_{\text{distr}}$ parents to their$_{\text{group}}$ place.

The intended reading is one where each of the two individuals John and Mary invited his or her parents to the place where they live together. We can account for this reading within the framework of my assumptions here by modifying the predicate with adverbial D and coindexing *John and Mary* with the first pronoun at S-Structure, while assigning a different index to the second pronoun, as in (8):

(8) $[[\text{John and Mary}]_i \text{ invited } [\text{their}_i \text{ parents}]_k \text{ to } [\text{their}_j \text{ place}]_m]_{S:i(D)}$

A DR for (8) which was constructed in accordance with the procedures in Chapter 4, Section 4.3.2, is shown in (9):

(9)

$$\begin{array}{|c|}\hline x_i \\ \text{John}\oplus\text{Mary}(x_i) \\ \begin{array}{|c|}\hline x_n \\ \text{i-part}(x_n, x_i) \\ \text{atomic}(x_n) \\ \hline \end{array} \Longrightarrow \begin{array}{|c|}\hline x_j \quad x_k \quad x_m \\ \text{parents-of}(x_k, x_n) \\ \text{place-of}(x_m, x_j) \\ x_j = x_i \\ \text{invited-to}(x_n, x_k, x_m) \\ \hline \end{array} \\ \hline \end{array}$$

In (9), the discourse referent x_i is first entered for the group-denoting subject. Then, adverbial D induces universal quantification over atomic i-parts of the subject,

[5]Unlike Link, I believe there is also a reading where both pronouns have a group reading.

replacing the index i of the subject throughout the reduced sentence with the index n of the new variable over such i-parts. In particular, this causes the first pronoun to be bound by the i-part discourse referent x_n instead of by the discourse referent of the subject, x_i (or, in terms of an equivalent intensional logic translation, by the lambda operator abstracting over the subject position). But the second pronoun was not coindexed with the subject. It must then be discourse bound, and one accessible antecedent is the subject's discourse referent, x_i. Equating them gives the second pronoun its group reading.

These examples argue that the syntactic number on a pronoun has no direct semantic significance. Syntactic number is an agreement phenomenon. If an NP is singular, it may in general only serve as an antecedent for a singular anaphor. If it is plural, it may in general only be antecedent for a plural anaphor. This assists a hearer who is attempting to locate the proper antecedent for a given anaphor. There are, of course, exceptions to the agreement requirement. One which is increasingly accepted is the use of third person plural pronouns as gender-free anaphors, avoiding the use of the awkward expressions *he or she*, and *his or her*, as in (10):

(10) Does <u>everyone</u> have <u>their</u> student ID handy?

Such exceptions tend to confirm the characterization of pronominal number as agreement, since this is the sort of phenomenon we expect with agreement (cf. the discussion of subject/verb agreement in Section 3.2.3.).

Since these restrictions on agreement generally hold across discourse, it is necessary to indicate in some way the syntactic plurality of NPs on their discourse referents. I assume that this should be accomplished via some sort of diacritic on the discourse referents. But on this view, contrary to Frey & Kamp's claim, any diacritics which distinguish between the discourse referents of singular and plural

NPs only serve to restrict potential anaphoric relations between discourse referents, and have no bearing on the embedding of the final DR in a model. That is, discourse referents introduced by singular NPs and those introduced by plural NPs are of the same type in the DR.

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