Dependent Plurals and Plural Meaning

by

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While writing this thesis, there were many things I wanted to get right. I wanted to get the data right. I wanted to get my analysis of the data right. I certainly wanted to get all my citations right, which can get pretty tricky when one is trying to finish a chapter at 2am. But if an error did creep in somewhere in the body of the thesis, that is not a disaster. Sooner or later, I will get a chance to correct it in a future publication. However, this part of the thesis, which sits right at the beginning but was among the last to be written, is different. I only have one opportunity to express, in print, how thankful I am to the people whose assistance was so important to me over the past years. Which is unfortunate, since if I were to truly elaborate all I am thankful for, these acknowledgements would be the lengthiest chapter of the thesis. But I hope this brief version will suffice in its stead.

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ABSTRACT

Bare plural arguments (*dogs*) behave in ways that quantified plurals (*some dogs*) do not. For instance, while the sentence *John owns dogs* implies that John owns more than one dog, its negation *John does not own dogs* does not mean "John does not own more than one dog", but rather "John does not own a dog". A second puzzling behavior is known as the dependent plural reading; when in the scope of another plural, the "more than one" meaning of the plural is not distributed over, but the existential force of the plural is. For example, *My friends attend good schools* requires that each of my friends attend one good school, not more, while at the same time being inappropriate if all my friends attend the same school.

This dissertation shows that both these phenomena, and others, arise from the same cause. Namely, the plural noun itself does not assert 'more than one', but rather the plural denotes a predicate that is number neutral (unspecified for cardinality). The 'more than one' meaning arises as an scalar implicature. I propose a theory that derives this implicature, based on two factors. The first is that, as is well-known, the domain of number neutral predicates is a superset of the domain of atomic predicates. However, this scalar implicature is insufficient to derive an implicature, as the entailments associated with distributivity mean that the fact that the scalar relationship between plural and singular predicates does not result in a scalar relationship between the sentences that create them. I address this problem by showing that in a Neo-Davidsonian theory, a scalar relationship does exist before existential closure of the event variable. It is at this point, I argue, that the implicature is derived. I will show how this accounts for the behavior of plurals in a wide array of environments. Furthermore, I will explore the consequences this theory has for the analysis of the quantified noun phrases that interact with bare plurals, such as the three way contrast between indefinite DPs such as *three boys*, which can take part both in cumulative readings with other indefinites and in dependent readings with bare plurals, DPs such as *all boys* which participate in dependent readings but not in cumulative readings, and singular universals (*every boy*) which do neither.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In English, and many other languages, all count nouns are marked as either singular or plural. But what does the use of the plural contribute to the interpretation?

This may seem like a strange question. Unlike many other linguistic questions, the question of plural meaning is one that even linguistically naive people think they can answer. And the answer they give is invariably the same one that is found in many linguistic texts:

> "Plural means 'more than one of'" Pinker (1999)

> "The [English] number system itself simply contrasts singular and plural ('more than one')." Huddleston and Pullum (2002)

In this dissertation, I argue that this view, no matter how widely held and intuitive it may be, is not correct. While plurals are commonly associated with a 'more than one' meaning, they do not always (and quite possibly, they never) contribute it to the sentence semantics. Specifically, bare plurals – those which are not paired with any quantifier or other element that contributes cardinality information – do not themselves contribute any cardinality information, and the 'more than one' meaning is a pragmatic, rather than semantic, effect.

To see this, I will look closely at bare plurals in their existential reading, and examine their interaction with other sentential operators. Of particular importance will be the interaction between bare plurals and other plurals, where they exhibit a puzzling phenomenon known as dependent plurality. The puzzle, first noticed by Chomsky (1975), is why is it perfectly true to say "Unicycles have wheels", even though it is not valid to say of any unicycle "This unicycle has wheels"? This question has been studied many times over the past thirty years, but most attempts to answer it focus only on sentences similar to the ones originally proposed by Chomsky. In this dissertation, I will cover a much wider array of data, including novel data, as well as bringing together data points that have been previously discussed independently from each other. I will show that the behavior of existential bare plurals can only be explained by a theory that posits that they are inherently number neutral, but that, in certain environments, they give rise to a scalar conversational implicature that contributes the 'more than one' meaning. The means of calculating this implicature will be shown to depend on the event structure of the sentences, providing another piece of evidence to the body of literature that posits that the semantics of plurals and events are closely related.

1.1 Overview

In many environments, bare plurals act as if they are equivalent to an indefinite denoting "more than one":

(1) a. That article is about Germanic languages. $\Leftrightarrow$

b. That article is about more than one Germanic language.

But in other environments, this parallelism does not hold. One such environment is when the bare plural is in the scope of another plural DP:

(2) a. All those articles are about Germanic languages. $\not\Leftrightarrow$

b. All those articles are about more than one Germanic language.

In addition, the parallelism fails in downwards entailing environments:

(3) a. That article isn't about Germanic languages. $\Leftrightarrow$

b. That article isn't about more than one Germanic language.

I argue that the environments in (2) and (3) should be treated together, as examples of the same phenomenon. Furthermore, contrary to what may be the more intuitive belief, I argue that the proper explanation of this, and related, data is that bare plurals never contain a 'more than one' meaning as part of their denotation. Rather, bare plurals are number neutral. In theory neutral terms, this means that the predicate GERMANIC LANGUAGES contains both individual languages, and collections of languages, in its denotation. In other words, the bare plural really means 'one or more', not 'more than one'. While there are alternative proposals that seek to preserve the 'more than one' analysis of bare plurals and to posit a different explanation for (2) or for (3), there is no alternative that can explain both examples at the same time[1].

Of course, arguing for a number neutral analysis of the bare plurals may offer a solution for (2) and (3), but it opens a new question: why does the plural in (1) appear to denote 'more than one'? I argue that this effect is the product of an implication that there was more than one relevant entity involved overall. So (1) and (2) actually mean:

[1] These alternatives and the problems they face are discussed in detail in chapter 2.

(4) a. That article is about Germanic languages. $\Rightarrow$

b. That article is about one or more Germanic language, and it's not true that there is exactly one Germanic language that this article is about.

(5) a. All those articles are about Germanic languages. $\not\Leftrightarrow$

b. All those articles are about one or more Germanic language, and it's not true that there is exactly one Germanic language that all these articles is about.

This implication is notably absent from downwards entailing environments such as (3); this leads me to argue that it arises as a scalar implicature. And indeed, we already have a scalar relationship that could explain it: if the plural form *languages* ranges over individual languages and collections of languages, and the singular form *a language* only ranges over individual languages, then *languages* is strictly weaker than *a language*, and would be expected to give rise to an implicature much like the one suggested above. However, there is a major difficulty in this reasoning, as not only does (6) entail (7), but, since the verb *study* is distributive in this context, (7) entails (6) as well (it is impossible to study a collection of languages without studying each of the languages in that collection):

(6) There is a language that I studied.

(7) There is a language or collection of languages that I studied.

Solving this problem is a two step process. First, I argue, following work such as Schein (1993) and Landman (2000), that a proper analysis of plurals requires a Neo-Davidsonian theory that takes sentences to include quantification over events. Secondly, following independent developments in recent literature, especially Chierchia (2004, 2006), I argue that implicatures are also calculated during the computation of sentence meaning, not just at the end. Specifically, an implicature is calculated before the final existential closure of events occurs. While there is no scalar relationship between (6) and (7), there is a scalar relationship between the following two sets:

(8) $\{E$: E is an event of my studying a language$\}$

(9) $\{E$: E is an event of my studying a language or a collection of languages$\}$

Applying existential closure over events to (8) and (9) leads to (6) and (7) respectively. But if the two sets are compared first, it can be seen that (8) is a subset of (9). Thus, if scalar reasoning is applied at this point, we would prefer (8) if it is appropriate. Making reference to (9), then, implies that (8) is inappropriate in the current utterance, leading to the following implication:

(10) $\{E$: E is an event of my studying a collection of languages, and not of my studying a language$\}$

Applying existential closure here gives the final sentence meaning:

(11) I was involved in an event of studying more than one language.

The fact that (11) entails that there were also smaller events, each of which is an event of eating a single language, no longer stands in the way of our calculation.

Exactly parallel reasoning applies in (4) and (5)[2]. Thus, the combination of a number neutral semantics for bare plurals, Neo-Davidsonian event structure, and a theory of implicature that derives them at pre-sentential levels of the derivation can explain the full behavior of bare plurals.

1.2 Structure of this dissertation

The structure of this dissertation is as follows:

The following chapter introduces the phenomenon of dependent plurality in detail,

[2]A fully formal explication of this reasoning can be found in chapter 6 and appendix B.

and discusses the two main approaches to it in the literature, that differ primarily in whether they treat bare plurals as denoting 'more than one' or not. A considerable range of data is discussed, which, when combined, point towards the view that bare plurals do not denote 'more than one', but rather that this meaning is derived via implicature. The third chapter broadens the discussion of bare plurals and discusses their special properties beyond dependent plurality, in particular the fact that they can only take narrow scope, and summarizes some of the implementations of bare plurals in the literature. In the fourth chapter, two fundamental questions in the semantics of plurality are introduced: the nature of plural reference and the role of events in plural semantics. The fifth chapter contains an implementation of the ideas from the previous two chapters, providing a formal framework for the truth conditions of sentences that contain plural arguments, including bare plurals. Then, in the sixth chapter, it is shown how these truth conditions account for the creation of a multiplicity implicature, as well as the peculiarities of this implicature's behavior as discussed in chapter 2. Finally, the seventh chapter discusses the consequences of the previous chapters and raises some additional questions for future research.

1.3 A terminological note

One of the basic problems about writing about plurals, especially when trying to argue that the plural form is not always associated with a 'more than one' meaning, is that the terminology can become quite confusing. The word "plural" can mean a lot of different things, both in informal parlance and in the semantic literature. In order to save both myself and the reader from this confusion, I will now set out some terminological guidelines.

Throughout the following chapters, the word **plural**, used either as a noun ("English allows bare plurals as subjects") or as an adjective ("Plural nouns have several readings") will be used to refer to the morphological form of words. At no point in the text does the use of **plural** imply 'more than one'. **Plurality** is the morphological property that plurals have that differentiates them from non-plurals.

In the formal sections of this dissertation, I will talk of **plural variables**. As will be made clear in chapter 4, there is considerable disagreement in the semantic and philosophical literature about the exact nature of these variables, and the entities that they can be used to refer to. In theory neutral terms, however, a plural entity is a formal object that *can* be used to refer to a collection of more than one entity; but crucially, nothing inherent to the fact that it is a plural variable entails that it *does* refer to more than one, and my use of the term should not be taken as having such an implication. The same applies to terms like **plural predication** and **plural reference**.

In order to refer to the 'more than one' meaning, whose relationship to plurality forms the core of this dissertation, I will use the term **multiplicity**. A condition in the form of $|X| > 1$ in the interpretation of a sentence, or within the denotation of a lexical item, will be referred to as a **multiplicity condition**.

Similarly, the word **singular** will be used primarily to denote a morphological form of the noun. The term **quantified singular** refers to quantified DPs with singular head nouns, for example *every boy* or *more than one cat*. However, in cases where the context makes it clear, I will occasionally use the term **singular reference** to mean 'reference to exactly one'.

CHAPTER 2

DEPENDENT PLURALITY

2.0 Overview

In this chapter, I lay out the basic data and arguments of the dissertation, discuss the existential reading of bare plurals and introduce the phenomenon of dependent plurality. Two competing hypotheses for this behavior, which differ primarily in whether they take plural NPs to include a ‘more than one’ condition as part of their denotation, are contrasted with each other. Next, data which poses challenges for both hypotheses will be presented, with the overall conclusion being that plural NPs do not contain ‘more than one’ as part of their denotation, but rather that this meaning is derived via scalar implicature.

2.1 Existential Bare Plurals and Dependent Plural Readings

It is easy to find examples of bare plurals, interpreted existentially, that appear interchangeable with other types of plural DPs . For example, both (12a) and (12b) can be paraphrased as (12c); and (13a) and (13b) can be paraphrased as (13c) equally well:

(12) a. John owns some rare Amazonian parrots.

b. John owns rare Amazonian parrots.

c. There are two or more rare Amazonian parrots that John owns.

(13) a. Several dogs were barking outside my window all last night.

b. Dogs were barking outside my window all last night.

c. There were two or more dogs that barked outside my window last night.

Based on examples such as (12) and (13), it is quite plausible to conclude that bare plurals are, in at least one of their interpretations, an indefinite with a multiplicity condition written in. For example, *a dog* might denote something like (14), while both *dogs* and *some dogs* denote (15)[1,2]:

(14) $[\![a\ dog]\!] = \lambda\phi\exists x[\textsc{dog}(x)\ \&\ \phi(x)]$

(15) $[\![dogs]\!] = [\![some\ dogs]\!] = \lambda\phi\exists X[\textsc{dog}(X)\ \&\ |X| > 1\ \&\ \phi(X)]$

It turns out, however, that this simple picture becomes considerably more complicated once additional data is considered. As was first noted by Chomsky (1975), a bare plural noun phrase that falls in the scope of another plural does not behave like other plural indefinites. One simple illustration of this fact is as follows:

[1] For now, I will informally use lower cap variables like x to denote individuals, and higher cap variables like X to denote pluralities, while glossing over what this actually translates to in ontological terms. Chapter 4 addresses this question in depth.

[2] Note that this is not a claim about how the bare plural and indefinite plural come to mean the same thing, or the relationship between this reading and the kind reading. It could be that there is a straightforward ambiguity in the bare NP denotation between kind and an indefinite, as has been suggested by Wilkinson (1991) and Gerstner-Link and Krifka (1993). Or it could be that bare plurals inherently denote something other than indefinites (for example, kinds) and that the denotation in (15) is derived via type shifting or interaction with other sentential elements (Carlson 1977, Chierchia 1998). What is at stake is that this denotation includes a condition saying that there is more than one dog.

(16) a. All the linguistics majors dated several chemistry majors.

b. John is a linguistics major.

c. ∴ John dated several chemistry majors.

The inference in (16) is a valid one. Given the premises in (16a) and (16b), it is proper to deduce (16c). But if we substitute a bare plural for *several chemistry majors*, we suddenly get a different picture:

(17) a. All the linguistics majors dated chemistry majors.

b. John is a linguistics major.

c. ∴ John dated a chemistry major.

From (17a) and (17b), we cannot deduce (16c). Instead, a valid deduction is (17c). Note that the predicate *date* is distributive; but nonetheless, while the condition requiring more than one chemistry majors is associated with each of the linguistics majors in (16), it does not distribute in the same way in (17). Instead, in this context, it looks like the bare plural seems more similar to the singular indefinite in (18):

(18) a. All the linguistics majors dated a chemistry major.

b. John is a linguistics major.

c. ∴ John dated a chemistry major.

The term **dependent plurals** was coined by de Mey (1981) as a way to refer to bare plural arguments, such as *chemistry majors* in (17), that display this behavior. While it is highly useful to have a name for the phenomenon in question, de Mey's terminology has some unfortunate connotations that are important to dispense of at this early stage. First, by naming *chemistry majors* a dependent plural in (17), but not in (19) below, de Mey implies that the bare plural itself is somehow ambiguous:

(19) The linguistics major dated chemistry majors.

Furthermore, this terminology introduces the notion of *dependence*; it implies that the singular-like behavior of *chemistry majors* is somehow justified or caused by the plurality of *all the linguistics majors*. While this is certainly a logical possibility, and is a feature of several analyses of the phenomena, I will argue that there is only a single interpretation for existential bare plural arguments, and that the behavior in (17) is a consequence of their normal interpretation. Dependent plurality, I will show, is what happens when the normal interpretation of the bare plural interacts with the normal interpretation of other DPs. Indeed, de Mey (1981) himself ends up taking an approach along these lines. In order to avoid these problems, and be able to present my own view and also discuss earlier literature, I will mostly talk about **dependent plurality** as a reading of the sentence, not of the bare plural itself, and leave the terminology neutral as to what parts of the sentence are involved in creating the reading.

At the same time (contrary to Chomsky's (1975) original proposal) it is not the case that the dependent plural can be treated as a purely morphological plural that is semantically identical to the singular. Take the following example:

(20) Ten students live in New York boroughs.

(21) Ten students live in a New York borough.

It is most natural to assign (20) a dependent plural reading, as world knowledge tells us that a typical student has only a single dwelling place. For example, if five students live in Manhattan and five live in Brooklyn, (20) would be judged as true. Replacing the object with a singular DP (21) results in a sentence that is also true in such a scenario. However, if all the ten students in question live in the same borough (for instance, Manhattan) (20) would not be judged true, unlike (21).

In addition to sentences which feature a bare plural and another plural DP, dependent plural readings can also arise in sentences containing a bare plural and a quantificational adverb (or adverbial phrase). For example, given (22), it is not valid to deduce (23a), but it is valid to deduce (23b):

(22) John always wears suits.

(23) a. John is wearing several suits.

b. John is wearing a suit.

At the same time, if John only owned a single suit, which he wears continuously, it would be inappropriate to utter (22). (22) requires that John wear different suits, but it does not require that he wear more than one at a time.

Speaking informally, then, a sentence has a dependent plural reading when it displays two properties:

1. The existential statement associated with a (bare) plural argument is distributed over, but the multiplicity component of its meaning does not distribute.

2. At the same time, there is a requirement that there be more than one of the things to which it refers overall.

2.2 Two Approaches to Dependent Plurality

In the years since Chomsky's original formulation of the problem, there have been several attempts to account for it. These attempts can be categorized into two main approaches: one which attempts to maintain multiplicity as part of the inherent denotation of bare plurals, and the other which rejects it. In this section, I will summarize both approaches.

2.2.1 Inherent multiplicity + cumulativity

The basic intuition that plurality means 'more than one' is a powerful one, and it is only natural that many semanticists chose to adhere to it. And indeed, there is good reason to believe that this is an entirely reasonable approach, as dependent plurality is similar to another, better-known, phenomenon in the semantics of plural noun phrases: cumulative readings. The prototypical cumulative reading arises in sentences with multiple numerical indefinites, as exemplified below:

(24) a. Three women gave birth to five babies.
 b. *A total of 3 women gave birth to babies, and a total of 5 babies were born.*

(25) a. Ten judges presided over a thousand cases last year.
 b. *A total of 10 judges presided over cases, and a total of 1000 cases were presided over.*

The resemblance of dependent plural readings to cumulative readings can be easily demonstrated by the following minimal pair:

(26) As part of the local crafts show, two carpenters built tables.

(27) As part of the local crafts show, two carpenters built at least two tables.

(26) is readily interpreted with a dependent plural reading – it is perfectly acceptable and true if each carpenter built a single table in the show (but not if they spent the entire show collaborating on a single table). (27) can be understood in several ways, but the cumulative reading is definitely available. It might be used by a reporter covering the event, for example, if she knows that each carpenter erected at least one table, but is unsure whether they built more.

In fact, under the dependent reading of (26) and the cumulative reading of (27) both sentences would be judged true in exactly the same conditions. Taking into account the fact that *at least two tables* in (27) is basically an explicit spellout of the denotation of *tables* under the view that the latter encodes multiplicity, it is not surprising that it is tempting to take dependent plural readings as just one more example of cumulativity.

2.2.1.1 Existing implementations

As the notion that plurals denote multiplicity is widespread, and as cumulativity is, independently, a well-studied aspect of natural language quantification, this explanation has been the basis of the line of inquiry taken by many researchers. Indeed, for some researchers (notably, Roberts (1990), and Beck (2000)), the main concern is not dependent plurality itself, but rather using it as an argument, either in favor of cumulative quantification as a semantic primitive independent from collectivity (Beck 2000), or against it (Roberts 1990).

A somewhat different tack is taken by de Mey (1981), who, in a foreshadowing of the approach taken by Roberts (1990), argues that dependent plurals are cases where both plural arguments involved are interpreted collectively. Unlike Roberts, however, de Mey's main concern is not with the status of cumulative quantification, but rather with using dependent plurals to establish a parallel between DP quantification and adverbial quantification. As mentioned, he assumes that dependent plurals involving DPs are cases of collective/collective readings. Using this as a starting point, he then uses adverbial sentences such as (22) to argue that quantificational adverbs and adverbial phrases such as *every day* or *usually* can denote collections of events. However, this position does not seem to be at all plausible. Consider the following pairs:

(28) a. Three boys built a raft.

b. Three boys built rafts.

(29) a. John usually built a raft.

b. John usually built rafts.

Roberts and de Mey argue that in (28b), *three boys* is interpreted collectively. This is justified by the existence of a collective reading for *three boys* in (28a). If the explanation for the dependent reading of (29b) is that *usually* can denote a collection of events (such that it can be paraphrased as "There were some usual events in John's life, that, when taken together, encompassed the building of a collection of rafts"), then it would be predicted that *usually* could also mean a collection of events in (29a). In other words, the collective explanation for (29b) ends up predicting that (29a) can mean something like "There were some usual events in John's life, that, when taken together, encompassed the building of a single raft". But that is clearly not the case.

A third variation on this approach can be found in Bosvald-de Smet (1998) and de Swart (2006). It is worth noting that neither paper discusses English bare plural examples, but rather they deal with French *des* plurals[3]. However, both seem to treat dependent readings of *des* plurals as representative of dependent readings in general. They discuss examples such as the following:

(30) Les Français portent des cravates jaunes.
The French wear indef$_{pl}$ yellow ties.
'The French wear yellow ties.'

Bosvald-de Smet argues that dependent readings in French arise only in habitual sentences, and she accounts for them by stating that the *des* DP denotes a partition over ties, which allows for individual cells containing single ties. The dependent reading, she claims, is generated by an additional condition that the predicate denote

[3] But see Roodenburg (2004), le Bruyn (2005) for arguments that *des* has been reanalyzed in Modern French as a plural marker and that *des* NPs are in fact bare plurals.

a bijection (a one-to-one relation). Thus, each French person is only expected to wear one tie, and each tie is worn by one French person. However, Spector (2003) brings up problems with this analysis. He shows that French has dependent readings in non habitual contexts, and that they are not necessary interpreted as a bijection. (31) neither entails that no boy read more than one book, nor than no book was read by more than one boy :

(31) Tous les garçons ont lu des livres.
All the boys have read indef$_{pl}$ books.
'All the boys have read books.'

Addressing Spector's data, de Swart (2006) points out that Bosvald-de Smet's (1998) partition-based approach, which she appears to consider the general mechanism of cumulativity, can account for these examples by leaving out the bijection condition (which de Swart maintains for the habitual cases).

Thus, in summary, we have seen that various authors take dependent plurality to be a sub-case of the more general phenomenon of indefinite cumulativity. While there is considerable variation in the way the various authors account for cumulativity itself, they all are alike in that they treat bare plurals as containing a multiplicity condition in their denotation, and arguing that whatever explains cumulativity is a sufficient explanation for the properties of dependent plurality.

2.2.2 The two-part meaning hypothesis

The approaches described in section 2.2.1 all share the assumption that multiplicity is an inherent component of the meaning of plurals, and employ different implementations of the cumulative quantification to explain dependent plurality as seen above. In this section, I will present an alternative view.

Recall that the definition of dependent plurality involved two properties. The first is that bare plurals, when falling in the scope of another plural, may act as if they did not contain a multiplicity condition as part of their denotation. The second property is that there is a condition of *overall* multiplicity associated with the referent of the bare plural. Instead of treating these facts as indicators of cumulative quantification, we can take them at face value. It may be that multiplicity is not part of the truth conditional contribution of plurals. Rather, they are denotationally number-neutral[4]. However, their use as arguments is associated with a separate multiplicity condition, one which does not fall under the scope of other plural DPs.

In section 2.3 below, I will provide several different types of data that argue for this approach. I will then show that the data leads to the conclusion that the multiplicity condition is, in fact, a (conversational) scalar implicature. Before doing so, however, it is worthwhile to consider similar approaches that have been argued for in the literature.

2.2.2.1 Existing implementations

The idea that bare plurals, or at least those that take part in sentences with dependent plural reading, do not contain a multiplicity condition as part of their denotation is not, in itself, a new one. It has been present since the earliest work on the phenomenon, and while not as popular as the multiplicity + cumulativity-based theories, it has been present in the literature in various incarnations since. Curiously, however, none of the approaches that argue for number-neutrality *as an explanation of dependent plurality* provide an account of the overall multiplicity condition[5].

In fact, the very first such approach is based on the outright denial of the existence of any type of meaning difference between the bare plural in dependent readings and singular DPs: Chomsky (1975). Chomsky's proposal, which was later named **global**

[4]Or at least, that they are ambiguous between a 'more than one' reading and a number neutral one. See section 2.2.2.3 below for discussion of this point.

[5]But see section 2.2.2.2 for discussion of work that argues for number-neutrality of bare plurals based on phenomena other than dependent plurality.

plurality by Roberts (1990)[6], is that there is a general syntactic rule in English that allows VPs to undergo morphological pluralization. This rule has no semantic correlate. Therefore, when it applies, all nouns in the VPs appear morphologically plural but are interpreted singularly. For example, (32) below actually has a structure as in (33). The plurality feature on the VP exists only as an agreement reflex with the subject, and has no semantic effect:

(32) Unicycles have wheels.

(33) Unicycles $[_{VP}$ has a wheel$]_{+\text{PLURAL}}$.

Chomsky's purpose in giving this example was to argue that the pluralization rule is an example of semantics-free syntax, and thus an argument against a compositional syntax/semantics interface. This example works because of the generic nature of (32), where world knowledge independently leads us away from considering the case of a single wheel overall. Had Chomsky considered episodic sentences such as (17a), (20) or (28b) above, it would have been apparent that there, the bare plural and singular arguments allow for different readings[7].

A later variation of Chomsky's theory is presented by Roberts (1990), based on a variation of Link (1987). Like Chomsky, she considers the possibility that the plural form of the dependent plural comes from an external source, and masks the fact that it is in fact a singular. Unlike Chomsky, her global rule is both morphological and semantic. She proposes that if, as suggested by Link, a plural DP is a sum of the relevant referents of the head noun, such that *unicycles* denotes the sum of unicycles,

[6] Roberts attributes the term to Barbara Partee.

[7] This is not the only problem with Chomsky's proposal. As noted in Partee (1975), Chomsky's rule applies to the entire VP. But take the following sentence:

(i) John gave the girls nickels.

(i) has a dependent reading, since it is true if each girl only got one nickel. However, note that this cannot be a case of agreement as the subject is singular. Chomsky's rule has no way to account for this reading.

and VPs denote sets of individuals that have a property, then plural VPs can be taken as denoting the set of sums whose parts have the relevant property. In informal terms, she paraphrases (32) as (34):

(34) The sum of unicycles is a member of the set {X: X is a sum of things that are members of the set {y:y has a wheel}}.

After presenting this analysis, Roberts proceeds to explain why she is unsatisfied with it as an explanation of dependent plurality. First, she points out that this theory has no way to account for adverbial-antecedent examples such as (22) above. This is because the theory crucially relies on the element which the plural VP applies to have a DP denotation.

The second objection she raises is that her Link-based theory, just like Chomsky's suggestion, provides plurality by appealing to a source completely independent to the dependent plural itself. But that would require that (35) be interpreted as in (36):

(35) The men married wives who are similar.

(36) The sum of the men is a member of the {X: X is a sum of things that are members of the set {y:y married a wife who is similar}}.

But (36) is nonsensical, as there is no such set as {y:y married a wife who is similar}, as can be seen by the oddity of (37):

(37) * Bob married a wife who is similar.

This argument shows that treating bare plurals as number neutral should not be equated with treating them as singular. There must still be a relevant difference that allows them to meaningfully license adjectives such as *similar* or *different*.

Spector (2003) offers a different approach to the behavior of bare plurals. Like Chomsky and Roberts, Spector argues that the plural in dependent readings shares a denotation with the singular. Where it differs is in the conditions for its use. Like the aforementioned Bosvald-de Smet (1998) and de Swart (2006), Spector does not actually discuss English bare plurals but rather French *des* plurals. Spector suggests that *des* plurals bear a licensing requirement, in that they are only acceptable if they appear in the scope of a (non-*des*) plural, which can be either a DP or a quantificational adverb. This requirement, he argues, is akin to the licensing requirement of negative polarity items (thus leading to his awkward naming of *des* plurals "plural polarity items"). Unfortunately for this parallelism, he himself notes that it is perfectly possible to have sentences in French that feature a *des* DP outside of such a context:

(38) Je veux acheter des chemises qui sont en vente dans ce magasin.
I want buy indef$_{pl}$ shirts which are on sale in this shop
'There are several shirts which are sold in this shop that I want to buy.'

Faced with the problem of accounting for such sentences, Spector proposes that the *des* DP can acquire a multiplicity condition and therefore license itself as a last resort if no potential licensor is available.

In essence, Spector's proposal predicts that only *des* plurals that take matrix scope may have a multiplicity condition[8]. He does note the existence of the overall multiplicity condition of dependent plurals, but cannot account for it, instead suggesting that it must be stipulated as an independent condition. He provides no suggestion as for how this could be done. A similar situation can be found in Kamp and Reyle (1993), who provide a treatment of dependent plurality in the DRT framework. They argue that plurals themselves introduce a number-neutral discourse referent, but that in non-dependent contexts a non-atomicity condition is added, ruling out singular reference. Like Spector, they recognize the overall multiplicity condition in dependent plural contexts but have no suggestion of how to account for it.

[8]Spector makes a specific point of arguing that *des chemises* must outscope the attitude verb *veux* due to the indicative mood of the lower clause.

2.2.2.2 Other number-neutral theories

What the accounts just surveyed share in common is that they focus on the fact that bare plurals are denotationally number-neutral. None of them offer an account of the overall multiplicity condition. There is, however, a second body of literature, including Krifka (2004), Sauerland et al. (2005) and Spector (2007), that independently argues for a number-neutral account of bare plurals. This literature does not consider dependent plurals, but rather is concerned with the behavior of existential bare plurals in downwards entailing and question contexts.

To see the basic problem in question, recall that the main reasoning for the hypothesis that bare plurals contain multiplicity as part of their denotation is that in positive contexts, they seem to act much like indefinite plural DPs. For example, the following two sentences appear to be synonymous:

(39) The UN envoy met senior government officials on his latest visit to the region.

(40) The UN envoy met more than one senior government official on his latest visit to the region.

But not all sentences involving existential bare plurals behave this way. As observed by Krifka (2004) and Sauerland et al. (2005), negating these sentences gives rather different results:

(41) The UN envoy did not meet senior government officials on his latest visit to the region.

(42) The UN envoy did not meet more than one senior government official on his latest visit to the region.

The sentence in (42) is a straightforward negation of (40); if the envoy met exactly one senior official in his visit, (40) is false and (42) is true. But while (39) is also quite inappropriate in that state of affairs, (41) is no better. What seems to be negated is not the assertion that the envoy met more than one official, but the claim that he met any.

A similar effect can be seen in other downwards entailing environments:

(43) If the UN envoy meets senior government officials on his latest visit to the region, he will be surprised.

(44) If the UN envoy meets several senior government officials on his latest visit to the region, he will be surprised.

The bare plural sentence (43) suggests that the UN envoy does not expect to meet any senior officials, while (44) indicates that he expects to meet exactly one. Here too, the multiplicity condition does not seem to have made its way into the antecedent of the conditional.

A third environment of which similar behavior holds is questions. Take the following dialogue:

(45) Did you see bears during your hike?

(46) a. # No, I saw one.

b. Yes, I saw one.

If I had gone on a hike yesterday, during which I saw a single bear, it would be quite bizarre for me to respond to (45) with (46a). A natural answer is instead (46b). But since seeing one bear is sufficient for an affirmative answer, it follows that the question was not about seeing more than one bear. Compare this to the following:

(47) Did you see several bears during your hike?

(48) a. No, I saw one.

b. # Yes, I saw one.

In the same scenario, if I were asked (47), I would most probably answer with (48a). It is thus not a property of all plural-containing questions that they can be answered affirmatively with a singular; rather, this is a special property of bare plurals.

Finally, the same phenomenon happens in certain modal environments. For example:

(49) Sherlock Holmes should question local residents to find the thief.

Given (49), it does not follow that Holmes needs to question the residents in groups of two or more; nor does it follow that if the first resident that he questions happens to be the thief, he must nonetheless question a second one.

Based on this set of observations, the authors mentioned above all conclude that bare plurals in themselves do not denote multiplicity. Krifka (2004), whose main focus is the relationship between the existential reading of bare plurals and kind readings, does not attempt to account for where the multiplicity meaning in positive sentences such as (39) comes from. Both Sauerland et al. (2005) and Spector (2007), on the other hand, offer detailed theories of the multiplicity, both arguing that it is in fact a conversational implicature. In this they share much with my own conclusion in the matter, as argued for below in section 2.4.2. However, neither paper considers data from dependent plurals; Sauerland et al. focus entirely on sentences with only one plural NP, and makes no mention of the phenomenon. Spector makes a brief mention of dependent plurals in a footnote, arguing that his arguments for an implicature are compatible with, but not dependent in any way upon, the arguments for an implicature-based account of dependent plurals presented in an earlier version of my own work (Zweig 2005)(but also with the opposing, cumulativity + multiplicity view). Unlike the present work, he considers dependent plural readings and the number-neutral behavior of bare plurals in downwards entailing environments to be independent of each other. Both Sauerland et al. and Spector offer mechanisms for the calculation of the multiplicity implicatures that are very different from each other, as well as from my own proposal. Chapter 6, which presents my own theory, also contains an elaborate discussion of their respective mechanisms in section 6.3.

Also advocating a number-neutral account of bare plurals is Farkas (2006), though Farkas herself uses the term "number-neutral" in a different way than I have been using it. According to Farkas, there is a default rule of argument interpretation that states that arguments only range over atoms. Morphologically singular DPs are unmarked for any number information, and are interpreted under this rule. Bare plurals, on the other hand, explicitly override this rule, allowing for multiple/sum reference. Thus, in Farkas's terminology, it is the singulars (which contribute nothing directly to the number interpretation) which are number neutral, and the plurals (which contribute a default override) which are not.

However, Farkas does distinguish between what she calls **inclusive** plurals, and **exclusive** plurals. Inclusive plural discourse referents can be atomic – in other words, they are number neutral in my sense. Farkas argues along lines very similar to Sauerland et al. (2005). A major difference for her, however, is that she argues that the number neutral interpretation is anomalous, even in the environments where it is possible. She discusses the following contrasts:

(50) a. Do you have children?
b. # Do you have wives?

(51) a. (to a shopkeeper) Do you sell brooms?
b. (to a friend you are helping with a cleaning task) # Do you have brooms?

The relative oddity of (50b) compared to (50a), and of (51b) versus (51a), leads Farkas to argue that *wives* and *brooms* are not interpreted as number neutral in the degraded sentence. Number neutrality, she argues, can only exist if pragmatic considerations such as the context of utterance, the relevance of plurality to the discussion, and world knowledge bias towards it.

While I agree with Farkas's observation that the plural is sometimes degraded in contexts where the singular is ok, and that this seems to be correlated with pragmatic factors, I disagree with her conclusion. The oddity of (50b) and (51b) is not an indication that the plurals in them mean *more than one*. Compare:

(52) Do you have fewer than four children?

(53) # Do you have fewer than four wives?

In a monogamous society, (53) is also odd, even though (52) is fine. But no-one would argue that *fewer than four* means 'two or three' except if the possibility of 'one' is licensed. Similarly, if a friend asks you to help him clean, you would not ask him:

(54) Do you have at least one broom?

The oddity of (54) is comparable to (50b), but it is obviously not because in (54) *at least one broom* means 'more than one broom'. In other words, (53) and (54) show that similar pragmatic considerations hold even when the argument does not exclude the singular, and that these contrasts are not evidence against a universal number neutrality of bare plurals[9].

In conclusion, we have seen that quite a few different authors have argued that bare plurals are inherently number-neutral. However, all of the previous work in this vein has *either* looked at dependent plurals, *or* at downwards entailing contexts. Because they do not consider both types of data together, as well as more complex cases which shall be discussed below, it is perhaps not surprising that their proposed accounts can only explain some of the data.

[9]A related phenomenon is discussed in Spector (2007), who dubs it **the modal presupposition** of the plural. It is explained in greater detail in section 2.4.2 below.

2.2.2.3 Ambiguity or true number-neutrality?

A question that has been left somewhat obscure in the above discussion of number neutral theories is whether the number neutral reading of bare plurals is the only (existential) reading of bare plurals, or whether they are ambiguous, possessing both the number-neutral reading but also the 'more than 1' reading that most people's intuitions tend to associate with them. Given a sentence like (55), it may be that there are two ways of interpreting *apples*, such as, for example, the ones illustrated in (56a) and (56b):

(55) Three men ate apples.

(56) a. $\exists Y[|Y| = 3 \,\&\, \textsc{men}(Y) \,\&\, \forall y {\in} Y[\exists X[|X| > 1 \,\&\, \textsc{apples}(X) \,\&\, \textsc{ate}(y)(X)]]]$

b. $\exists Y[|Y| = 3 \,\&\, \textsc{men}(Y) \,\&\, \forall y {\in} Y[\exists x[\textsc{apple}(x) \,\&\, \textsc{ate}(y)(x)]]]$

Under this view, (56a) is the traditional distributive reading, where (55) means that each man ate more than one apple. (56b) is the dependent plural reading, which only requires that each man ate a single apple to be true.

Indeed, some accounts of dependent plurality, such as Chomsky (1975), Roberts (1990) and Spector (2003), seem to take for granted that bare plurals are ambiguous. Other accounts, such as Kamp and Reyle (1993), treat bare plurals as always contributing a number neutral meaning. But the matter is decided by the number-neutral theories that look at downwards entailing environments, which provide conclusive evidence against ambiguity. If bare plurals were ambiguous between a number-neutral and a 'more than 1 N' reading, then, when embedded under negation (57), the resulting sentence would be itself ambiguous between a 'not more than 1 N' (58b) and 'no N' reading (58a):

(57) John did not eat apples.

(58) a. $\# \neg\exists X[|X| > 1 \ \&\ \textsc{apples}(X) \ \&\ \textsc{ate}(\mathit{John})(X)]$

b. $\neg\exists x[\textsc{apple}(x) \ \&\ \textsc{ate}(\mathit{John})(x)]$

But clearly, (58a) is not a reading of (57). The same holds for other downwards-entailing environments, as seen above. Thus, there seems to be a solid argument that if (57) is to be explained by appealing to a number-neutral interpretation of bare plurals, then this should be the only reading available to them.

Note that this is a separate question from whether *sentences* that contain bare plurals in the scope of another plural, such as (55) above, are ambiguous between a dependent plural reading and a non-dependent reading. This question will be discussed again in chapter 6, where it will be shown that while many sentences that allow a dependent plural interpretation are indeed ambiguous, the source of ambiguity lies not with the bare plural but with the other plural DP in the sentence.

2.2.3 Section summary

In this section, I have outlined the two major approaches to the semantics of existential bare plurals which attempt to explain why they participate in dependent plural readings. The first approach maintains that bare plurals contain 'more than one' as part of their denotation, and that dependent plurality is a type of cumulativity. The second approach argues that bare plurals do not directly contribute a multiplicity condition to the truth conditions, but rather are associated with a separate multiplicity condition, probably an implicature.

In the following section, I will introduce additional data to the discussion, with two goals. The first is to show that, once we look beyond the basic cases discussed in previous literature, there is clear evidence against the multiplicity + cumulativity account, and for a number neutrality + implicature account. The second goal is to show that, by looking at enough data, it is possible to explain both the nature of the implicature, and how it arises.

2.3 A Closer Look at the Data

Below, I will discuss five different types of data. First, in section 2.3.1, I will provide data that argues directly against cumulativity as the sole explanation of dependent plurality. Section 2.3.2 will show that nonetheless, there is a sense in which dependent plural readings are cumulative. Next, in section 2.3.3, I will re-consider the downwards entailing and other environments discussed by Krifka (2004) and Sauerland et al. (2005) as they relate to dependent plurality. In section 2.3.4, I will discuss sentences which feature bare plural arguments yet lack dependent readings, and explain their significance. Finally, in section 2.3.5 I will discuss the behavior of bare plurals in sentences featuring more than one other DP[10].

2.3.1 Non-cumulative contexts

In section 2.2.1, I presented the view that takes bare plurals to be inherently similar in their interpretation to plural indefinites such as *several* phrases or numerical DPs. The explanation for dependent plurality was that it is simply a subcase of cumulative readings, which plural indefinites are known to participate in. However, there is one major problem with this hypothesis: dependent plural readings have a far wider distribution than cumulative readings generally do. One environment in which the former can be found, but not the latter, is in the scope of the quantifiers *most* and *all*. In both the following pairs, the first sentence lacks a cumulative reading but the second sentence allows for a dependent plural reading:

(59) a. Most students read thirty papers. $\not\Rightarrow$

Most students read at least 1 paper, and a total of 30 papers were read

[10]Earlier versions of the discussion in 2.3.1, 2.3.3 and 2.3.5 can be found in Zweig (2005).

overall.

b. Most students read papers. $\Rightarrow$

Most students read at least 1 paper, and more than 1 paper was read overall.

(60) a. All the students read thirty papers. $\not\Rightarrow$

All the students read at least 1 paper and a total of 30 papers were read overall.

b. All the students read papers. $\Rightarrow$

All the students read at least 1 paper and more than 1 paper was read overall.

A second environment in which dependent plural readings can be found but cumulative readings do not exist is sentences where the other plural denoting element in the sentence is not a quantified DP but rather an adverbial. (61b) (adapted from de Mey 1981) is an example of a dependent reading with an adverbial element; (61a) does not have a parallel cumulative reading. (62b) and (62a) show the same for a locative adverbial:

(61) a. Three trains leave every day to Amsterdam from this station. $\not\Rightarrow$

At least 1 train leaves every day, and a total of 3 trains is involved overall.

b. Trains leave every day to Amsterdam from this station. $\Rightarrow$

At least 1 train leaves every day, and more than 1 train is involved overall.

(62) a. Three king sized beds can be found in every room. $\not\Rightarrow$

At least 1 bed in every room, and a total of 3 beds is involved overall.

b. King sized beds can be found in every room. $\Rightarrow$

At least 1 bed in every room, and more than 1 bed is involved overall.

It is important to note what this data does and does not show. The *all/most* cases, as well as the adverbial cases, are not arguments against dependent plural readings sharing a semantic form with cumulative readings. Indeed, I will show in the next section that exactly this is the case. What is argued against by this data is the view that cumulative semantics are, in and of themselves, an *explanation* of the phenomenon. In order for a theory which insists that plurals denote ‘more than one’ to properly account for the data, it is not sufficient for them to just show that a multiplicity + cumulativity gives the right meaning, they still have to provide some explanation of what is different between a ‘more than one’ denoting bare plural and a ‘more than one’ denoting DP such as *several men*, such that the former can participate in cumulative readings where the latter cannot. To the best of my knowledge, no such explanation has been proposed in the relevant literature.

2.3.2 Cumulative properties of dependent plural readings

Let us begin by establishing some basic facts. The following two sentences can both be taken to be true statements about the world:

(63) a. Prince wrote a song called “America”.

b. Simon and Garfunkel wrote a song called “America”.

However interesting (63a) is as a piece of music trivia, it is not of much interest from a semantic perspective. (63b), on the other hand, is somewhat more interesting, as it is ambiguous. It can be read distributively, which would mean that Simon wrote a song called “America”, and Garfunkel wrote a different song with the same title[11]. This interpretation happens to be false. The second reading is the collective one: the two wrote a single song called “America” together. This is true fact about the world.

[11] Or possibly, by some strange accident, they each came up with the same song independently of each other. I will ignore this possibility in what follows, as it is presumably ruled out by world knowledge.

Now consider the following sentence:

(64) Simon, Garfunkel and Prince wrote a song called “America”.

This sentence also has two readings. The collective reading, wherein the three musicians collaborated, is false. The distributive reading, wherein each of them wrote a song called “America” on their own, is likewise false. Indeed, (64) cannot be truthfully used in this world. What is missing is a cumulative reading, one which would allow for Simon and Garfunkel to collaborate on a song, and Prince to write a second song with the same title. This is the true state of affairs, but it cannot be described by (64).

Now compare:

(65) Simon, Garfunkel and Prince wrote songs called “America”.

(65) is judged to be true. Note that it is a dependent reading, as none of the parties involved wrote multiple songs named “America”. But we see that the cumulative reading which was not available to (64) is now available[12].

For some variations of the number-neutral theories, this data is surprising. If bare plurals are to be given essentially the same semantics as the singular, there should be no difference between the interpretations available to (64) and (65). A proponent of these theories might object to this data by arguing that it is not a fact about the interpretation of the bare plural, but rather a fact about the interpretation of the subject. “Simon and Garfunkel”, after all, is the official name of the singing duo. Perhaps, even though it appears to be a three-way conjunction, readers parse the subject of (65) as a two way conjunction:

(66) [Simon & Garfunkel] and Prince wrote songs called “America”.

[12]The availability of the cumulative reading was first observed by Gillon (1987, 1990), who uses it to argue for cover-based explanations of cumulative readings, and the contrast with the singular case was first observed by Winter (2001), who uses it to argue against cover-based theories. Both authors are primarily concerned with the interpretation of the subject, not of the object.

(66) can receive a distributive reading just like the singular sentence, which would mean that the pair of Simon and Garfunkel wrote a song, and Prince wrote a song, as is the actual fact.

But note that this explanation relies entirely on the nature of the subject, and is independent of the plurality of the object. If the conjunction can be interpreted as a two-way conjunction in (65), it should also be analyzable as a two-way conjunction in (64), allowing that sentence the very reading it lacks. Furthermore, this explanation relies entirely on the fact that the names *Simon* and *Garfunkel* follow each other in their canonical order. A simple way to test whether (65) is truly cumulative, therefore, is to scramble the order of names:

(67) Simon, Prince and Garfunkel wrote songs called "America".

My informants, while finding (67) a bit strange, were unanimous in accepting it as true[13].

This seems like a victory to the multiplicity + cumulativity theorists described in section 2.2.1; it is, after all, exactly what they predict.

Things are not quite so simple, however. This is not a defeat for the number-neutral hypotheses; rather, it is only a problem for its "global plurality" branch, which treats dependent plurals as singulars in disguise, as well as for the licensing-based theory in Spector (2003)[14]. What is needed for a viable number-neutral theory, therefore, is that bare plurals should not be treated as semantically identical to singulars; the only constraint being that the difference cannot be that the former denote 'more than one'.

[13]The strangeness, I believe, raises from a pragmatic consideration. People know that Simon and Garfunkel are a pair, and that the normal order of presentation is in that order, with nothing intervening. The order in (67) is unusual, flouting the Gricean maxim of manner. As a result, the speaker expects the scrambled order to have a particular significance.

[14]Kamp and Reyle (1993) do not provide any means of accounting for cumulative readings in their framework. Thus, it is not clear how what implications this data has on their analysis of dependent plurals.

2.3.3 Dependent readings in downwards entailing (and other number-neutral) contexts

In section 2.2.2.2, I discussed literature that argues for a number-neutral interpretation of bare plurals based not on dependent plurality, but rather on their behavior in downwards entailing contexts. I noted that to a large extent, this literature and the dependent plural literature do not overlap, instead each focusing on one type of data.

But the results from these strands of research are not unrelated. On the one hand, it is well established that if an existential bare plural is in the scope of another plural, the 'more than one' meaning associated with it does not get distributed over, but rather it seems to apply as an overall multiplicity condition. On the other hand, if a bare plural is in a downwards entailing environment or in a question, the 'more than one' meaning seems to go away completely.

It is natural, then, to ask: what happens when a bare plural is both in the scope of another plural *and* in a downwards entailing environment?

The answer is perhaps not surprising given the previous discussion. What happens is that the bare plural neither contributes a 'more than one' condition in its own scope, nor is there an overall multiplicity condition. Take, for example, the following example:

(68) Few linguistics majors dated chemistry majors.

(69) a. Few linguistics majors are such that they dated a chemistry major.

b. # Few linguistics majors are such that they dated more than one chemistry major.

c. # Few linguistics majors are such that they dated a chemistry major, and more than one chemistry major was dated overall.

(68) is quite readily paraphrased as (69a), with a singular substituted for the bare

plural. The non-dependent reading in (69b) is flat out unavailable; (69b) would be true if many linguistics majors dated a chemistry major but only few date two, but there is no possibility for (68) to be true in that case. Nor is the paraphrase in (69c), which is modeled after dependent plural readings in upwards entailing environments, appropriate. (68) is true if only one chemistry major was ever dated by a linguistics major. The overall multiplicity requirement seen earlier in examples such as (17a) is missing.

The same holds true of all the other environments where a bare plural on its own exhibits number neutral behavior:

(70) Israel's olympic team almost never won medals.

(71)
a. Israel's olympic team almost never won even one medal.
b. #Israel's olympic team almost never won more than one medal.
c. #Israel's olympic team almost never won even won a medal, but they won more than one overall.

(72) Only if all my opponents crash into trees, I will win the ski competition.

(73)
a. For me to win the ski competition, it is necessary for each of my opponents to crash into a tree.
b. #For me to win the ski competition, it is necessary for each of my opponents to crash into more than one tree.
c. #For me to win the ski competition, it is necessary for each of my opponents to crash into a tree, and I will not win if they all crash into the same tree.

(74) You must consult relevant articles.

(75)
a. You must consult at least one relevant article.
b. #You must consult more than one relevant article.

(76) Do all your friends like cooking shows?

(77) a. #No, they all like the same one: ‘The Frugal Gourmet’.

b. Yes, they all like the same one: ‘The Frugal Gourmet’.

All these examples demonstrate the same behavior: the overall multiplicity condition associated with dependent plurals goes away in exactly the same environment as the multiplicity condition of bare plurals in non-dependent sentences such as the ones discussed in section 2.2.2.2.

The number-neutrality of bare plurals in downwards entailing contexts poses a severe problem for the theories that attempt to explain dependent plurality as nothing more than a case of cumulativity. In a downwards entailing environment, cumulative readings and dependent readings no longer resemble each other:

(78) John denied that two carpenters built tables.

(79) John denied that two carpenters built at least two tables.

Imagine that John was giving evidence in a trial where a pair of carpenters are being sued for breach of contract. The two sentences above make different claims about John’s testimony. For (78) to be true, John must have claimed that no tables at all were built by the carpenters. However, on the cumulative reading of (79), John allowed that they may have built one table between them; perhaps not enough to satisfy their employers, but proof that they did not forsake their duties completely. But the cumulative hypothesis states that in both sentences, John is denying the same clause.

To maintain the cumulativity account, it would be necessary to argue that the behavior of bare plurals in downwards entailing contexts is totally independent of their behavior in dependent contexts. For example, it could be possible to argue that bare plurals are a case of systematic ambiguity. $Tables_1$ is a positive polarity item than means 'more than one table', while $tables_2$ is a negative polarity item than means 'any table'. It is not clear whether there is any evidence for such a systematic ambiguity, nor why would a 'more than one' meaning correlate with polarity in this fashion. It would fall on the cumulativity theorist to account for this. It seems to me that while this is not conclusive evidence against such a theory, it does make them seem considerably less plausible.

For the proponents of number neutral theories, on the other hand, this data actually simplifies matters. The burden on a number-neutral theories is to explain why is it the case that, if *apples* means 'at least one apple', (80a) means (80b) and (81a) means (81b):

(80) a. I saw John eating apples.

b. I saw John eating more than one apple.

(81) a. I saw the boys eating apples.

b. I saw the boys each eating at least one apple, and more than one apple was eaten overall.

The fact that the multiplicity requirements in both sentences go away under the same conditions, however, means that it is likely to be one and the same phenomenon in both sentences. In other words, it raises the possibility that (80a) should more accurately be paraphrased as (82), which just happens to be equivalent to (80b):

(82) I saw John eating at least one apple, and more than one apple was eaten overall.

Thus, the data in this section supports the hypothesis that bare plurals are inherently number neutral, and that, in suitable environments, they are accompanied by an overall multiplicity condition. In sentences such as (80a), 'more than one overall' ends up being the same as 'more than one for John' due to the lack of another plural element.

2.3.4 Singular quantifiers

So far, I have discussed sentences involving a bare plural and another plural DP, and have shown that these sentence can get dependent plural readings. However, this is not the case of every sentence with a bare plural in the scope of another DP.

As noted already in de Mey (1981), bare plurals in the scope of singular quantified DPs are not interpreted in the same manner. He observed that while DPs that are headed by *all* allow for dependent readings, those headed by *every* or *each* do not[15]:

(83) a. All dentists have scary chairs.

b. Every dentist has scary chairs.

The sentence in (83a) has a dependent reading of the type that should already be familiar; it is perfectly true if each dentist owns a single scary chair. (83b), on the other hand, requires that every dentist owns more than one scary chair. From de Mey's (1981) discussion, it is not clear whether he considers this to be a fact about universals, or about a contrast between singular and plural subjects in general. To see that it is the latter, one need only consider the following minimal pair:

(84) a. More than two dentists own Porsches.

b. More than one dentist owns Porsches.

Here, too, (84a) states that more than two dentists are such that each owns a Porsche. (84b) requires that there are at least two dentists that own multiple Porsches each.

In other words, where the quantified plural subjects did not distribute over the 'more than one' meaning of the bare plurals, the quantified singular subjects do.

[15]Strictly speaking, de Mey makes the point about Dutch *elke*, which he glosses as *each*, but can be translated as *every* with equal validity (Suzanne Dikker p.c.). The first explicit mention of *every* not giving rise to dependent readings is in Kamp and Reyle (1993).

At first blush, this data seems to support the inherent multiplicity + cumulativity hypotheses. After all, DPs headed by *every*, as well as those headed by *more than one*, do not participate in cumulative readings. (83b) is exactly what we would expect if the multiplicity condition was part of the bare plural's denotation and it happened to fall under the scope of the universal. However, recall the data in 2.3.1, where other DPs that do not participate in cumulative readings, such as *all*, do give rise to dependent readings. Thus, it would be incumbent on whoever is arguing for the cumulativity explanation to further explain why the two cases differ in this regard. Of course, the same obligation lies upon those who advocate the number-neutral hypotheses. It seems, then, that the lack of dependent readings for singular quantifiers poses a problem for both types of theories, that needs to be addressed for a full explanation.

2.3.4.1 Subject/Object asymmetry

While the fact that *every* in subject position does not create dependent readings has been well known, there is an additional complication, which has so far gone unobserved in the literature, that makes the problem this creates more acute. Compare the following two sentences:

(85) In last night's chess tournament, every left-handed player won games.

(86) In last night's chess tournament, left-handed players won every game.

As seen above, (85) does not allow for a dependent reading, but can only mean that each left handed player had won multiple games. But compare this with (86). First, note that in (86) the most natural reading is one where *every game* takes wide scope; it does not mean that there were left-handed players who each won every game. But also note that it does not require that any game was won by more than one left handed player. In other words, in both (85) and (86), a bare plural is in the scope of a universal. But in (85), there is no dependent reading, while in (86) there is. That this is not a result of our world knowledge (after all, no chess match can be won by more than one player), can be seen by similar examples:

(87) In the school trip to the zoo, every ten year old saw pandas.

(88) In the school trip to the zoo, ten year olds saw every panda.

There is obviously no pragmatic constraint on how many ten year old children may see a given panda, yet the same pattern as (85)-(86) holds.

2.3.5 Ditransitives

One property of previous research on dependent plurality, regardless of the overall approach taken, is that it focuses on dependent plurality as a relationship between two DPs. As a result of that, almost all sentences under discussion feature a bare plural and another plural DP, or an adverb. The behavior of bare plurals in sentences involving more than one additional DP has not gotten much discussion[16]. In this section, I will bring forth new data from ditransitives, that will provide crucial information about how bare plurals interact with both plural and singular quantified DPs.

I will start by looking at the case where a bare plural appears in a sentence with two quantified plural DPs:

(89) Two boys told three girls secrets.

[16]There are a few exceptions to this. The first is Partee (1975), who uses a ditransitive sentence with a dependent reading to argue against Chomsky's (1975) view that the plural morphology is a meaningless reflex of a syntactic rule. She does not, however, consider any additional implications. Kamp and Reyle (1993) consider sentences where the dependent plural is embedded within a second DP, such as (i):

(i) a. The women bought cars which had automatic transmissions.

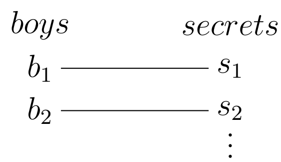
They do not, however, consider ditransitive cases such as those discussed below. Finally, de Mey (1981) suggests that there needs to be a syntactic hierarchy between the dependent plural and the other plural DP, and implies that this needs to be investigated in sentences involving more than just a subject and object; he does not, however, attempt such an investigation himself.

Let us first establish some background facts. Both of the non-bare arguments in (89) are of a type that can normally form dependent readings with *secrets*:

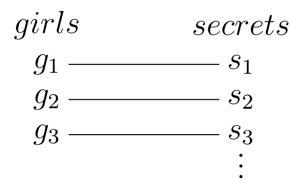
(90) a. Two boys told secrets.

b. Three girls were told secrets.

(91) a.



b.

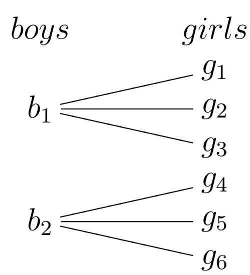


Since the readings for ditransitive sentences are going to be quite complex, I will use diagrams to represent the various readings rather than English paraphrases. We can represent the dependent reading of (90a) as (91a), and that of (90b) as (91b)[17].

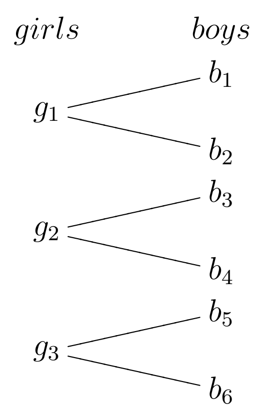
Next, we can see that a sentence involving just *two boys* and *three girls* has at least two scopal possibilities[18]:

(92) Two boys confided in three girls.

(93) a.



b.



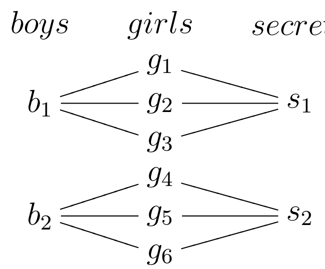
[17]None of the diagrams in this section are supposed to represent the *only* scenario in which the sentences they correspond to may be true. Instead, they represent a sufficient scenario for them to be true, one which can differentiate between the different possible readings available. For example, (90a) is of course true if each boy told more than one secret; however, that scenario would make the sentence true whether or not it has a dependent reading, and thus it is not explicitly shown.

[18]For the sake of simplicity, I am ignoring collective and cumulative readings of the two numerical DPs here; suffice it to say that they pose no additional challenges to the data below. The place of these readings in the overall analysis will be discussed in both chapters 5 and 6.

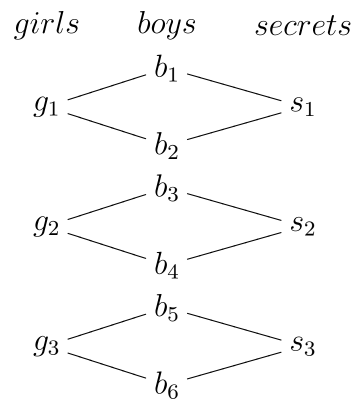
Now let us return to (89). Like (92), it is ambiguous between two scopal options for *two boys* and *three girls*[19]. Does either scope affect the availability of a dependent reading for *secrets*?

(89) Two boys told three girls secrets.

(94) a.



b.



The answer is no. If *two boys* takes wide scope, as in (94a), we can see that *secrets* gets a fully dependent reading; in fact, each boy in (94a) only tells one secret, and each girl is only told one secret. The same happens when *three girls* takes wide scope (94b).

It is worth noting that the availability of the dependent reading is not contingent on the double object construction. Changing the recipient to a *to* PP does not affect the available readings:

(95) Two boys told secrets to three girls.

Here two, there are two possible scopal relationships between *three girls* and *two boys*, and the sentence can be true in either (94a) or (94b).

A slightly more complicated situation arises in ditransitives where the bare plural is the recipient rather than the theme:

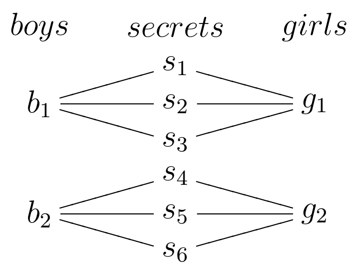
[19]For now, I simply assume, following the tradition of Carlson (1977), that the bare plural itself takes narrowest scope. This assumption is justified in chapter 3, section 3.1.

(96) Two boys told girls three secrets.

(97) Two boys told three secrets to girls.

Both (96) and (97) allow a dependent reading in their surface scope:

(98)



Just like the parallel scenario in (94a), each boy in (98) only tells secrets to one girl, and each secret is told to only one girl. But for both sentences, the inverse scope (there are three secrets such that each was told to girls by two boys) seems to be missing altogether. This, however, does not seem to be directly related to the presence of a bare plural argument, as can be seen by the fact that neither of the following sentences allows the theme to take wide scope either:

(99) Two boys told me three secrets.

(100) Two boys told three secrets to me.

The availability of the dependent readings to the ditransitives discussed above is not surprising. After all, we have phrased the multiplicity condition as stating that there has to be more than one secret overall. This is true in all the scenarios detailed above. So, on their own, these sentences seem to support our previous observations, but they do not add anything new.

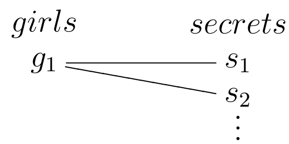
Now let us turn to a sentence with one plural DP and one singular DP:

(101) Two boys told a girl secrets.

We've seen above (91a) that a sentence with *two boys* as a subject allows for dependent readings. A sentence with a singular subject does not:

(102) A girl was told secrets.

(103)

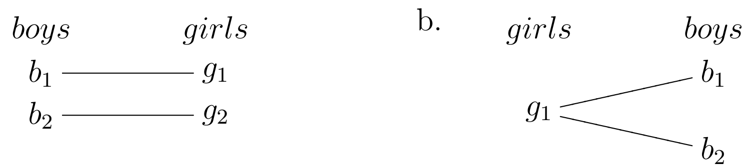


This, again, is not surprising; there has to be more than one secret overall, and with only one girl involved, she must hear all of them.

Just like in the case of the two plurals, *two boys* and *a girl* have two possible scopal orderings:

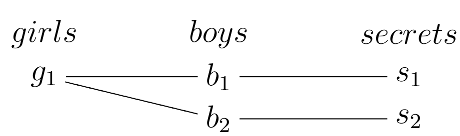
(104) Two boys confided in a girl.

(105) a. b.



Let us first consider the wide-scope reading of *a girl* in (101). The multiplicity condition, as we know it, states that there must be more than one secret overall. This is satisfied in the following scenario:

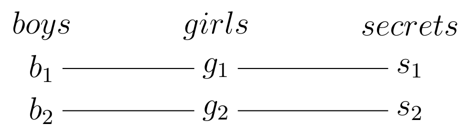
(106)



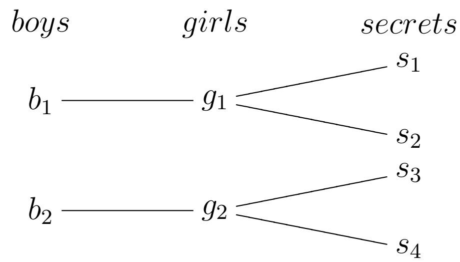
The reading depicted in (106) conforms with our expectations so far. It is a dependent reading in that there only has to be one secret per boy, but there has to be more than one secret overall. Since only one girl is involved, that means she must have told both secrets.

But what of the surface-scope reading of (101)? Based on what we have seen so far, it is a logical expectation that (101) would be true in the following scenario:

(101) Two boys told a girl secrets.

(107) #


The situation in (107) is equivalent to (94a): each boy tells one secret, each girl is told one secret, and more than one secret is told overall. The problem is that (102) is actually false in (107). Rather, in its surface-scope reading, it requires a situation such as the following:

(108)


In other words, there have to be multiple secrets *per girl*.

Here, too, the same results hold when the recipient is a *to* PP:

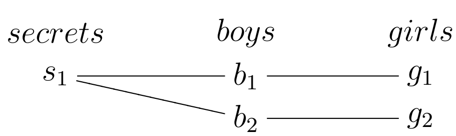
(109) Two boys told secrets to a girl.

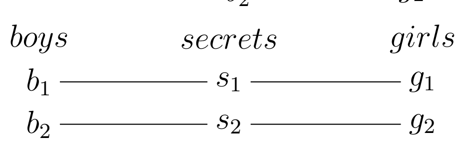
If *a girl* takes wider scope than the subject, (109) is true in (106), but if the subject takes wider scope, it too is false in (107) and true in (108).

The same pattern holds if the theme is singular and the bare plural is the recipient:

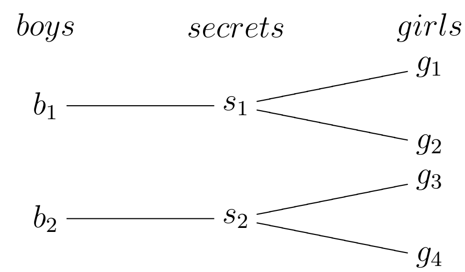
(110) Two boys told girls a secret.

(111) Two boys told a secret to girls.

(112) a.


b. #


c.



Both (110) and (111) can be true in (112a) and (112c), but not in (112b). Here too, the availability of a dependent reading is contingent on whether the singular DP scopes between the bare plural and the subject, not on what their syntactic position or semantic role is.

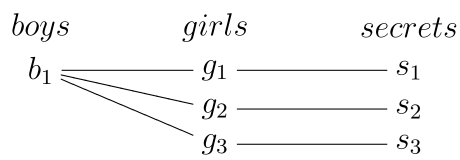
This effect of singular DPs on dependent readings is extremely important for any account of dependent plurality, especially in light of the data discussed in section 2.3.4. In that section, it appeared that when a quantified singular distributes over a bare plural, it also distributes over the multiplicity condition. Here, we see that a singular DP "traps" the multiplicity condition in its scope even though the singular DP in question does not itself introduce co-variance, but rather varies with a plural DP that would otherwise allow dependent plurality. In other words, singular DPs do not only distribute over the multiplicity condition, they also act as interveners.

One possible question at this point is whether this effect is purely scopal, or whether it is influenced by the surface order of the singular and plural DPs. After all, *a girl* is between *2 boys* and *secrets* in the sentence's surface order. Perhaps the reason that *a girl* does not block the dependent reading in (106) is related to the fact that it had to undergo movement for that reading to be achieved. It is easy, however, to show that this is not the case, by examining the following sentence:

(113) A boy told three girls secrets.

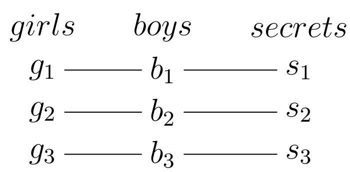
In (113), the reading where the singular DP takes wide scope is the surface scope, rather than the inverse scope as it was in (101). Just like in (106), *secrets* can act as a dependent plural:

(114)

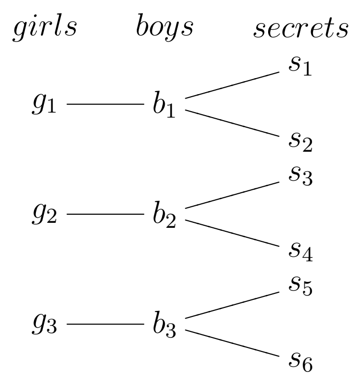


Similarly, the inverse scope reading of (113) acts just like the surface order reading of (101), being true in (115b) but not in (115a):

(115) a. #



b.



Thus, (113) shows that singular DPs act as interveners based on their scope, regardless of their surface position.

2.3.6 Section Summary

In this section, I have provided a detailed exploration of the behavior of dependent plurals in various environments. I have shown that multiplicity + cumulativity based accounts have a difficult task of explaining the possibility of dependent plurals in contexts that do not allow cumulative readings, and also cannot explain the behavior of bare plurals in downwards entailing contexts. At the same time, I have shown that dependent plurals do share some properties with cumulative readings that prevent them from being treated as truly identical to singulars. Finally, I discussed a variety of facts that show that the overall multiplicity condition informally posited in section 2.1 shows complex behavior in various environments, getting "trapped" below singular quantifiers, including both singular indefinites and universals, as well as disappearing completely in downwards entailing and question contexts.

2.4 The Meaning of Bare Plurals

The previous section showed how the multiplicity condition associated with bare plurals exhibits behavior that cannot be accounted for by simply making it part of their truth conditional contribution, and that cumulativity only provides a very partial explanation. At the same time, existing theories that split the meaning of bare plurals to a number-neutral component and a multiplicity condition also offer only a very partial explanation of the data.

Nonetheless, I believe that the basic approach behind the two-part meaning theories remains sound. The problem with existing theories, as discussed in sections 2.2.2.1-2.2.2.2 is that they either are aimed at explaining too small a section of the data, or that they go too far in equating bare plurals to singulars.

The task, then, is to provide a two-part meaning theory that explains the full range of data. In this section, I will lay out the basic principles behind such a theory, setting the scene for its formalization later on in the dissertation.

2.4.1 Bare plurals are number neutral, not singular

The first part of the theory is simple. We have seen that bare plurals, in many environments, do not behave as if they denote 'more than one'. I take this to be convincing evidence that they do not contain a multiplicity condition as part of their truth conditional contribution, as argued for by the two-part theories discussed in section 2.2.2. Where some of the existing theories, especially those of the "global plurality" school, go wrong, is that they assume that this must mean they are identical to the singular.

Instead, I will argue that only plurals are truly number-neutral. Singular noun phrases contribute singular reference; they can only refer to one thing. Of course, in many cases, a predicate can be true of several things while at the same time being true of any one of them, which explains the normal reason why sentences containing singulars in upwards entailing environments end up having number-neutral entailments. This is not a new idea; it is implemented, to various degrees, in many of the frameworks that deal with the difference between singular and plural reference (see Chapter 4 for details on some of these). Explicit versions of this idea are developed by Sauerland et al. (2005) and Farkas (2006) . Chapter 5 shows my own implementation of singulars and plurals, based to a larger extent on the framework of Landman (2000) as well as ideas by Chierchia (1998) and Krifka (2004).

2.4.2 The Multiplicity Condition as a Scalar Implicature

The second part of the proposed two-part meaning theory is accounting for the multiplicity condition. It is not only necessary to explain what it is and how it relates to the bare plural it is associated with, but also why it behaves in the complex ways that it does: in some contexts, such as in the scope of *every*, the condition seems to share a distributive scope with the bare plural. In dependent contexts, it seems to have a different scope. And in some environments, it goes away altogether.

As it turns out, explaining this behavior also explains the basic nature of the condition. As also noted by Sauerland et al. (2005) and Spector (2007), there is a straightforward observation about the environments in which the multiplicity condition goes away: they are the same environments in which scalar implicatures are absent. This is easily demonstrated by taking two well-known examples of scalar implicatures: the 'exactly' implicature carried by numerals, and the 'not all' implicature that is arrived at by the use of *some*. These implicatures are demonstrated below:

(116) Most men saw three movies $\Rightarrow_{impl}$

Most men saw exactly 3 movies.

(117) Most men saw some movies $\Rightarrow_{impl}$

Most men saw some but not all of the movies.

In the environments where bare plurals lose their multiplicity condition, these implicatures are also unavailable[20]:

(118) a. Few linguistics majors dated three chemistry majors. $\not\Rightarrow_{impl}$

Few linguistics majors dated exactly three chemistry majors.

b. Israel's olympic team almost never won three medals. $\not\Rightarrow_{impl}$

Israel's olympic team almost never won exactly 3 medals.

c. You must consult three relevant articles. $\not\Rightarrow_{impl}$

You must consult exactly 3 relevant articles.

d. You must consult some relevant articles. $\not\Rightarrow_{impl}$

You must consult some (but not all) of the relevant articles.

e. If my opponents crash into two trees, I will win the ski race. $\not\Rightarrow_{impl}$

If my opponents crash into exactly 2 trees, I will win the ski race.

f. Do all your friends like two cooking shows?

No, some of them like more than two.

Yes, and some of them even like more than two.

g. Did those men share some pizzas?

No, they shared all of the pizzas.

Yes, they shared all of the pizzas.

Non-monotone environments also provide evidence for the analysis of the multiplicity condition as a scalar implicature. First, note that such environments give rise to both scalar implicatures (as in (119)) and to dependent plurals (120):

(119) Exactly three guests ate two steaks. $\Rightarrow_{impl}$

Exactly 3 guests ate exactly 2 steaks.

[20]This is somewhat of an oversimplification; a more correct claim is that in these environments the scales are reversed (Horn 1972, 2004). Chapter 6 explains why scale reversal leads to the disappearance of the multiplicity condition.

(120) Exactly three guests ate steaks. $\Rightarrow_{impl}$

More than 1 steak was eaten overall

Furthermore, as first noted by Spector (2007), scalar implicatures in this environment show an interesting behavior, that is mirrored in the multiplicity condition. Take the following sentence:

(121) Exactly one student solved some difficult problems.

(121) implies that the student in question did not solve all the difficult problems, consistent with the normal implicature of *some*. However, it does not have the same meaning as (122):

(122) Exactly one student solved some, but not all, difficult problems.

To see this, note that (122) can be paraphrased as (123):

(123) There exists one student that solved some, but not all of the difficult problems, and there is no other student that solved some, but not all, of the difficult problems.

However, (121) is paraphrased as (124):

(124) There exists one student that solved some, but not all, of the difficult difficult problems, and there were no other students that solved any difficult problem.

To see the difference between the two readings, imagine a scenario wherein Bill and Mary are both students. Mary solved all the difficult problems, and Bill solved three of them. No other students solved any difficult problems. In this scenario, (122)/(123) are true but (121)/(124) are false.

More generally, a sentence that says "exactly one student did X" can be paraphrased as "there was one student that did X and no other student did X". But if X triggers a scalar implicature that enriches its meaning to X', the paraphrase is not "there was one student that did X' and no other student did X'", but "there was one student that did X' and no other student did X". The scalar implicature does not apply to the negative part of the meaning of *exactly*[21].

Now, let us look at sentence involving a bare plural:

(125) Exactly one student solved difficult problems.

It is clear that there is a multiplicity condition associated with *difficult problems* in (125). If only one student solved a problem, and that student solved only one, (125) is inappropriate. But we cannot paraphrase (125) as (126) either:

(126) Exactly one student solved more than one difficult problem.

The reason here is the same as with the *some* sentence in (121). (126) is true if Bob solved one difficult problem and Mary solved two (and no one else solved any); but (125) is false in that circumstance. An appropriate paraphrase is (127):

(127) There exists one student who solved more than one difficult problem, and there was no other student than solved even one difficult problem.

The multiplicity condition extends to the positive part of the paraphrase, but not the negative part. In this, the behavior of the multiplicity condition in a non-monotone environment mirrors that of traditional scalar implicature.

It seems, then, that the behavior of the multiplicity condition in these environments gives strong reason to suspect that it is a scalar implicature. The same is true of the behavior under quantifiers such as *every*. As was first observed Gazdar (1979), and explored in more recent work such as Chierchia (2004, 2006) and Fox (2006), scalar implicatures will embed under the scope of certain operators, universal quantifiers included:

[21] This is true for all sentences headed by *exactly* DPs, not just *exactly one*.

(128) Every boy ate some of the cookies. $\Rightarrow_{impl}$

Every boy ate some, but not all, of the cookies.

In addition to its behavior in these linguistic environments, the multiplicity condition is similar to other conversational implicatures in that it passes what is perhaps the most traditional test for implicature status: pragmatic cancelation (Grice 1975, Sadock 1978). For example, both *some*'s implicature in (129), and the multiplicity condition in (130) are overridden in a context where it is natural to assume the speaker did not intend them:

(129) [*FBI investigator:*] Some suspects live in big cities, perhaps even all of them.

(130) [*FBI investigator:*] All the suspects live in big cities, perhaps even the same big city.

Another argument for the implicature status of the multiplicity condition is given in Spector (2007). Spector observes that even in contexts where a scalar implicature does not arise, it is not without effect on the meaning of the sentence. In a context in which it is impossible for the implicature to be true, using the relevant scalar item, even negated, feels odd. Spector's own example involves the exclusivity implicature of disjunction. In a positive context, *or* implies "not both", while in a downwards entailing context it does not bear that meaning:

(131) Mary spent the evening with Peter or Jack $\Rightarrow_{impl}$

Mary did not spend the evening with both Peter and Jack.

(132) Mary did not spend the evening with Peter or Jack $\not\Rightarrow_{impl}$

Mary either spent the evening with both Peter and Jack, or with neither.

In a normal situation, (132) simply states that Mary spent the evening without either Peter or Jack. However, Spector suggests a scenario in which Peter and Jack are in fact conjoined twins. It is impossible to spend any amount of time with one without also spending time with the other. In such a context, it would be infelicitous to say (131), as the implicature associated with the sentence cannot be true. Since no such implicature arises in (132), however, it may be expected that this sentence would be fine. Surprisingly, though, (132) is equally infelicitous, even if it is known for a fact that Mary spent the evening alone. Rather, *and* would be used even in the negative sentence[22].

Spector calls this effect a **modal presupposition**: the use of a scalar term in a sentence makes the sentence presuppose that it is possible for the implicature associated with said scalar term to be true. Spector does not offer an explanation of this phenomenon, but rather proposes using it as a diagnostic for scalar implicature. He then observes that the same phenomenon holds for bare plurals:

(133) a. Jack doesn't have a brother.

b. Jack doesn't have brothers.

c. Jack doesn't have a father.

d. # Jack doesn't have fathers.

Both (133a) and (133b) are perfectly sensible sentences, which mean the same thing: Jack has no brothers. If Jack is an orphan, (133c) may quite naturally be said of him. But (133d) is extremely odd. Spector argues that the reason (133b) is a natural way to paraphrase (133a) while (133d) is terrible as a paraphrase of (133c) is because it is possible to have multiple brothers, but not multiple fathers. Thus, the negation of the bare plural creates a modal presupposition of the possibility of multiplicity.[23].

[22]For a useful discussion of the semantics of *not and* and *not or*, see Szabolcsi and Haddican (2004).

[23]Spector's discussion is not without problems. First, it is arguable whether it is correct to discuss this in terms of presupposition. It is unclear whether (132) lacks truth value if Peter and Jack are conjoined twins. Furthermore, it is not clear that possibility of the implicature being true is the correct criteria to distinguish the good and the bad cases. Recall the discussion above of Farkas (2006); if you want to help me with cleaning and ask me for something to wipe the floor with, it would be infelicitous for me to say:

One final set of evidence comes from an acquisition study reported in Sauerland et al. (2005). This study is based on a backdrop of several studies (Gualmini et al. 2001, Noveck 2001, Papafragou and Musolino 2003) that explore the development of conversational implicatures in children. Papafragou and Musolino (2003), for example, describe a study where children and adults were shown images of horses jumping over a log. In the critical trials, all the horses were shown jumping over the log. Both groups were then asked to judge the truthfulness of statements such as "Some of the horses jumped over the log"[24]. While over 90% of adults rejected the statements, only 10% of children aged 5 did. Similar results were achieved in the studies reported in Noveck's (2001) and Gualmini et al.'s (2001) for a variety of different scalar items. Based on this data, Sauerland and his co-authors created a study in which a puppet, pretending to be a space alien that needs to be taught about life on Earth, asked 14 children ranging in age from 3 to 6 questions from three categories; the first was questions like (134a), which would be rejected by adults because girls have exactly one nose. The second was questions such as (134b), which would be rejected because fish have no legs. And the final category was questions such as (134c), that an adult would accept:

(134) a. Does a girl have noses?

b. Does a fish have legs?

c. Does a cat have feet?

The results achieved were very clear. For questions such as (134b) and (134c), the

(i) #I don't have brooms.

But it is hardly impossible for me to own more than one broom. Furthermore, as pointed out to me by Anna Szabolcsi (p.c.), the following sentence is perfectly felicitous:

(ii) This circle doesn't have angles.

Even though clearly it is impossible for a circle to have angles, by definition. Nonetheless, the basic observation that there is a parallelism here between the multiplicity condition and scalar implicatures holds, regardless of how the explanation needs to be refined.

[24] The actual study was done using in Greece with the Greek equivalents of these sentences.

children's answers matched expected adult responses 97% of the time. On the other hand, children matched adult-like answers in the (134a) category in only 4% of the trials ($p < .00001$ in an unpaired, two-tailed t-test). In other words, the children responded to the questions as if the plurals meant 'one or more', not 'more than one'. While this data is hardly conclusive (in none of the studies is there any data about what age children start responding like adults, for example), it does show that children who are too young to compute scalar implicatures also fail to compute the multiplicity condition, matching the expected result if the latter is an example of the former[25].

It seems, then, that there is plenty of evidence pointing towards the multiplicity condition being a scalar implicature. But this is meaningless unless it meets another basic test laid out by Grice (1975) for implicature status: it must be calculable. And, since I have claimed it shows the properties, not just of a conversational implicature, but of a scalar implicature, this calculation should involve scalar comparison. The nature of this calculation, and how it follows from the difference in meaning between singulars and bare plurals, is the topic of chapter 6.

2.5 Chapter Summary

This chapter discussed bare plurals in their existential reading, and discussed the ways in which they differ from plural indefinites such as *several men*. It was shown that, when in the scope of another plural element, they form a dependent reading. Singular DPs were discussed, revealing that not only do quantified singulars fail to give rise to dependent readings, but that singulars can act as interveners, blocking

[25] A somewhat different result was achieved in a preferential looking study by Kouider et al. (2006), where children were shown two screens, one displaying a single object and the other displaying multiple objects, and given instructions such as "look at the blickets". This study found that at 24 months, children do not make a distinction between singular or plural nouns in object position, while at 36 months they do. However, the relative complexity of the task might well explain the later age required for adult-like behavior. It is worth noting that there are no studies testing the processing of other scalar implicatures in preferential looking tasks.

a bare plural from forming a dependent reading with a higher-scoping plural DP. Furthermore, in downwards entailing environments and questions, bare plurals act as if they are completely number-neutral.

Two approaches to this problem were discussed. The first argues that the intuition that plurals mean 'more than one' is correct, and that dependent readings are a type of cumulative reading. It was shown, however, that this approach cannot account for much of the data. The second approach states that bare plurals are inherently number neutral, and that they are coupled with a separate multiplicity condition. This approach was argued to be correct, as long as number-neutrality is not confused with singularity. Finally, a set of evidence suggesting that the multiplicity condition is in fact a scalar implicature was provided.

CHAPTER 3
OTHER PROPERTIES OF BARE PLURALS

3.0 Overview

In chapter 2, I provided a detailed discussion of the behavior of bare plurals in their existential readings, focusing especially on the fact that they give rise to dependent readings, as well as to other number-neutral readings. The literature discussed so far, however, represents only a subsection of the overall body of semantic work that deals with bare plurals. Indeed, starting with Carlson (1977), the focus of most bare plurals literature has not been on the existential reading itself, but rather on the other readings of bare plurals, particularly the kind reading. In this chapter, I will survey some of this literature, focusing on work that explicitly tries to relate the existential readings to the other readings of bare plurals. Doing so will reveal properties of bare plurals that will prove essential for the formal account of dependent plurality.

3.1 The Obligatorily Low Scope of Bare Plurals

This section describes one of the most basic properties of bare plurals. Regardless of their interpretation, they do not seem to participate in the scope system the way other nominal arguments do. In chapters 5 and 6, this will be shown to be a crucial part of their behavior, important to the explanation of much of the data in chapter 2.

It was Carlson (1977) who first observed that bare plural arguments do not exhibit the full range of readings that other indefinites do in their position. Specifically, in contexts where singular and plural indefinites are free to take wide scope over other elements in the sentence, bare plurals are unable to do so.

Carlson demonstrates this fact in several environments. The first is being in the scope of negation; he points out that (135) is ambiguous between two readings, the first being that there is a spot that John missed, and the second that there were no spots that John noticed:

(135) John didn't see a spot on the floor.

A similar ambiguity is seen with plural indefinites:

(136) John didn't see some spots on the floor.

(137), however, can only mean that there were no spots that John noticed, and it cannot mean that there were spots that John missed (even though he may have noticed other spots):

(137) John didn't see spots on the floor.

Similarly, bare plural objects cannot take a wider scope than the subject. (138) is ambiguous between a reading where *a book on giraffes* takes wide scope (so there is a book that was read by everyone), and a reading where it takes narrow scope (so every person read a possibly different book). A similar ambiguity can be found with the indefinite plural in (139). (140), on the other hand, has no reading in which there are books that everyone read; it must mean that, for each person, there are books that he read:

(138) Everyone read a book on giraffes.

(139) Everyone read some books on giraffes.

(140) Everyone read books on giraffes.

A third case discussed by Carlson is that of bare plurals inside clausal arguments of attitude verbs. Carlson presents the following example[1]:

(141) Jenny wants to meet a policeman.

(141) has two readings. The first, **transparent**, reading is one where there is a particular policeman that Jenny wishes to meet. In this reading, the sentence may be followed as in (142):

(142) Jenny wants to meet a policeman. He is a local hero and she wants to interview him for her paper.

The second, **opaque**, reading is that in which there is no particular policeman that Jenny cares about; rather, any policeman will satisfy her:

(143) Jenny wants to meet a policeman. She needs to report the theft of her wallet.

Carlson adapts a common way of addressing this issue, which is to take it to be a scope distinction. (142) gets a reading in which the existential quantifier takes wider scope than the attitude verb, while in (143) it takes narrow scope:

(144) a. $\exists x[\textsc{policeman}(x)\ \&\ \textsc{wants}(Jenny)(\textsc{meet}(Jenny)(x))]$

b. $\textsc{wants}(Jenny)(\exists x[\textsc{policeman}(x)\ \&\ \textsc{meet}(Jenny)(x)])$

As before, plural indefinites show a similar ambiguity:

[1] I changed the gender of the subject from Carlson's actual example to avoid unnecessary pronoun reference ambiguities in the examples below

(145) Jenny wants to meet some policemen.

(146) a. Jenny wants to meet some policemen. They foiled a complicated robbery yesterday and she wants to congratulate them.

b. Jenny wants to meet some policemen. She is thinking of joining the local police force and wants to get advice.

However, bare plurals again are unambiguous:

(147) Jenny wants to meet policemen.

(148) a. * Jenny wants to meet policemen. They foiled a complicated robbery yesterday and she wants to congratulate them.

b. Jenny wants to meet policemen. She is thinking of joining the local police force and wants to get advice.

As can be seen by the inappropriateness of the continuation in (148a), (147) only has the opaque reading. This, again, corresponds to the narrow scope reading.

3.1.1 Partee (1985): a potential problem with transparent readings

While most of Carlson's observations have stood the test of time, some of them were challenged by later research. Partee (1985) discusses a counter-example to the claim that bare plurals can only get opaque readings when embedded under an attitude verb. Specifically, she argues that in dependent plural contexts, bare plurals seem to receive transparent readings.

Partee adds an additional sentence, (149), to the contrast between (141) and (147):

(141) Jenny wants to meet a policeman.

(147) Jenny wants to meet policemen.

(149) All the boys wants to meet policemen.

What Partee observes is that (149) has a reading where for each boy, there is a specific policeman that the boy wants to meet. For example, imagine that each boy was given a prearranged list of local dignitaries, of which he had to meet one as part of a school assignment. The list consists of policemen, firemen, and local assemblymen. The boys do not particularly care what the job of the person they meet is, but rather each wants to meet the person who works closest to their home, for the sake of convenience. By happenstance, it turns out that for each boy the closest local dignitary was a policeman. (149) is true in this scenario. This means that it must have a transparent reading.

This data is not only a problem for Carlson's observation but it poses a problem to my approach to dependent plurality. I have argued in chapter 2 that dependent readings do not have special status, but rather arise from the general principles of the interpretation of existential bare plurals. Partee, however, appears to have found a property of dependent plurals that does not seem to be shared with bare plurals in other contexts, and which is not straightforwardly related to the behavior of the multiplicity condition. Indeed, Partee's own conclusion is that there are two types of bare plural: the first being so-called "Carlsonian" bare plurals which include kind readings and existential readings in non-dependent contexts, and the second being dependent plurals.

However, there are several considerations that indicate that the situation is more complex than Partee's (1985) paper assumes, and that, while still puzzling, the contrast between (147) and (149) is not a strong argument against a unified treatment of all existential readings.

The first observation is that, contra both Carlson and Partee, sometimes sentences that involve bare plurals in a non-dependent reading can get transparent readings. This has been first observed in Kratzer's (1980) response to Carlson, which offers the following example from German:

(150) Hans wollte Tollkirschen in den Obstsalat tun, da er sie mit
Hans wants Belladonna in the fruit salad do, since he them with
richtigen Kirschen verwechselte.
correct cherries confounded
'Hans wants to put Belladonna berries in the fruit salad, since he confused them with cherries.'

(150) is a perfectly sensible statement, in English as well as in German, but it clearly does not mean that Hans wishes to poison himself. Rather, *Belladonna berries* is interpreted in a transparent fashion: it is the particular berries that Hans believes are cherries but are in fact Belladonna that Hans wants to put in the salad. Yet there is clearly no dependent plural reading involved in (150). The same point can be made in the following example:

(151) *In a video rental store*

Little boy: So, what movies do you want to get?

Little girl: How about *Alien*? Or *Silence of the Lambs*? Or *American Pie*?

Little boy: Mom! Mary wants to see R-rated movies!

In (151), *R-rated movies* is a bare plural in a non-dependent context, yet the little boy's claim could clearly be taken to be about his sister's desire to see the actual movies on the list she just provided, as opposed to a general desire to see movies in a certain category.

In other words, it seems that Carlson's observation about the interaction of attitude verbs with bare plurals, while a strong tendency, is not iron-clad.

But this does not completely eliminate the problem, as there is still a clear distinction between (147) and (149). While (150) and (151) show that it is sometimes possible to get transparent readings with non-dependent bare plurals, it is considerably easier to do so in the dependent case. But while Carlson may have overstated his generalization, as both Partee and Kratzer's data reveals, Partee also does not correctly characterize the environments which enable the transparent readings. Partee explicitly ties this behavior to whether the bare plural is interpreted as a dependent plural. But note the following sentence:

(152) I want all the boys to meet policemen.

Just as *policemen* got a dependent reading in (149), the same is true of *policemen* in (152); (152) can be true if I desire that each boy meet a single policeman. If, indeed, bare plurals were ambiguous between a reading that means 'more than one' and disallows transparent readings, and a dependent reading that means 'one or more' and allows transparent readings, it would follow that (152) should allow a transparent reading as well, where I have a particular policeman in mind for each boy. But (152) is false in that case – just like (147) indicates that Jenny wants to meet some policemen but does not care which, (152) requires that I hold a desire that each boy meet some policeman or other.

It seems, then, that the transparent reading of (149) cannot be explained by appealing to an ambiguity in the bare plural, as it is not enough that it is interpreted as a dependent plural, but rather that other plural element involved in the dependent reading must lie across the attitude verb.

It is possible, however, to imagine a counterargument by a semanticist who wishes to hold on to an ambiguity account. Perhaps the bare plural is ambiguous, but the interpretation of dependent plurals requires that they raise covertly to the scope of the other plural DP. In other words, perhaps the reason (149) rescues the transparent reading is that it forces the bare plural to outscope the attitude verb. This is a tenuous line of reasoning at best, as (149) is not obligatorily transparent – it has an opaque reading as well, wherein each boy simply desires to meet one or more policemen, and do not care which policemen they meet. This is still a dependent reading;

thus, the movement must either not be obligatory (in which case, its connection to the dependent reading becomes harder to motivate), or some sort of reconstruction mechanism needs to be postulated. Both of these options make such a theory appear far less attractive from a theoretical perspective. But there is also empirical evidence against it. Consider (153):

(153) I want three boys to meet policemen.

Syntactically, (153) resembles (152), but unlike *all the boys*, it is possible to differentiate between a transparent and an opaque reading of *three boys*. But while (153) easily receives an interpretation wherein *three boys* is transparent and *policemen* is opaque – so that there are specific three boys for whom I hold the desire that they meet some policeman or other, there is no reading wherein they are both transparent (wherein there are three boy/policeman pairs that I have in mind). But if the explanation for the availability of the transparent reading of *policemen* in (149) is that the dependent plural can share a scope with the other plural, then *three boys* outscoping *want* should allow *policemen* to outscope want as well.

What the above discussion indicates is that while the contrast that Partee observed is real, it should not be taken as an argument against a unified analysis of bare plurals. It is neither true that non-dependent bare plurals never get transparent readings, nor that dependent plurals always do. Rather, it seems that a sentence that involves a high plural DP, a low bare plural, and an attitude verb between them makes the transparent reading a lot easier to get than it is otherwise. Note that this configuration seems to support, rather than challenge, Carlson's observation that the bare plural cannot outscope the attitude verb.

Indeed, there are independent reasons to believe that quantificational scope and opacity need to be at least partially disassociated, following the work of Farkas (1997), who argues that the descriptive content of DPs can be indexed to discourse elements lying outside their scopal position. The fact that Farkas's observations may apply directly to the data at hand is highlighted by the following example from Szabolcsi's (2007) summary of Farkas's article:

(154) Some boy imagined that two or more violinists had one arm.

Imagine a scenario in which the boy sees several figures (draped in cloaks, so that their arms are not visible) walking into a local clinic for people missing limbs. The boy thinks that they are patients, but in fact they are violinists providing entertainment for the evening.

Given this scenario, someone might truthfully utter sentence (154). Clearly, the sentence is not appropriate under the opaque interpretation which would mean the boy imagines that the number of one-armed violinists in the world is no lesser than two, but has no particular notion of who they are. Instead, this appears to be a transparent reading. This is a problem for the scopal account of opacity, as modified numeral DPs such as *two or more violinists* are bound by island constraints and cannot scope out of a finite clause. Thus, in (154) the subject of the lower clause is trapped under the scope of *imagine*, and only the opaque reading should be available.

Farkas's (1997) explanation is that the descriptive content of *two or more violinists* can be indexed to the world of the speaker, so that what the sentence really means is "Some boy imagined that two or more people (that, according to the speaker, are violinists) had one arm". In other words, the boy has an opaque notion that there are two or more people that have one arm; the fact that they are violinists comes from the speaker.

This example is important to us in a twofold manner. First, it provides clear evidence that transparent readings are available even for elements that cannot take wide quantificational scope, in cases that have nothing to do with dependent plural readings. Second, Farkas's account may be applied to the dependent plural cases ¿as well. The transparent meaning of (149) may in fact arise from indexing the descriptive content of *policemen* to the speaker, resulting in the interpretation "All the boys want to meet (one or more) people that, according to the speaker, are policemen".

Of course, neither the observation that dependent plurals are not the only cases where a lot-scoping element seems to get a transparent reading, nor Farkas's proposal, are sufficient to fully explain the data discussed in this section. It is still unclear why transparent readings are so much more difficult in Carlson's original examples, and in sentences such as (153), than they are in (149) or (154). Certainly, there is call for further exploration of the relationship between bare plurals and attitude verbs, and a full explanation of Partee's observation shall remain a task for future research. For our current purposes, however, it is sufficient to note that whatever the explanation is, it is not that dependent plurals are somehow different than other bare plurals; and especially, they do not have different scopal possibilities.

3.1.2 Section Summary

In this section, I explained Carlson's observations that show that bare plurals can only take narrow scope. As shall be seen in chapter 5, this property is crucial in explaining some of the puzzling aspects of their behavior. I then discussed in some detail a counter-example to Carlson by Partee (1985) that was originally taken to show that dependent plurals are inherently different than other bare plurals in that they allow transparent readings. However, in light of both novel evidence to do with embedding entire dependent plural sentences in the scope of an attitude verb, as well as the observations of Kratzer (1980) and Farkas (1997), it is safe to say that this conclusion was premature and that a unified analysis of existential bare plurals is still feasible.

3.2 The other readings of bare plurals

As was mentioned in the section overview, the major focus of much of the bare plural literature has been the readings in which they are not interpreted as existential statements over individuals. Before I discuss how these readings relate to the existential readings, it is necessary to provide a brief description of their nature, which I shall do below.

3.2.1 Kind readings

The first, and arguably still the most influential, detailed examination of the semantics of bare plurals was Carlson (1977). Carlson argued that bare plurals do not denote existential statements, but rather they are referential, and what they refer to is kinds. A kind is an entity of type e, that corresponds to a whole species or type of thing[2]. In the ensuing thirty years, there has been much debate about the extent to which Carlson was correct. For example, many generic interpretations of bare plurals, which Carlson attributed to reference to kinds, have been since analyzed as existential bare plurals within the scope of a generic operator. Nonetheless, there remain many cases which still seem to argue for a kind interpretation:

(155) a. Rats are common in the New York Subway.

b. Dodos are extinct.

Properties such as being extinct and being common are not properties of individuals; nor are they properties of arbitrary groups of individuals the same way being a class-

[2]Readers who are familiar with Landman (2000) will notice that kinds are similar in this respect to groups, which — as shall be discussed in greater detail in chapter 5 — are atomic entities that correspond to sums. Indeed, there are approaches who treat kinds as groups that correspond to the sums of all members of a particular species, such that the kind reading of *dogs* denotes $\uparrow\sqcup\{x : \textsc{dog}(x)\}$. However, this may lead to strange results when discussing kinds such as *unicorns* and *dragons*, since both would denote whatever group corresponds to the sum of the empty set. This may be resolved by adding intensionality to the system, or by other means. For more on this topic, see Chierchia (1998) and Ojeda (1993).

mate is. Instead, they seem to be properties only of entire species or kinds of things. One clear difference between kind readings and collective readings is what happens when a quantifier is added:

(156) a. Some students met.

b. Some rats are common.

A collective predicate such as *met* with a non-bare subject such as (156a) can only mean that there was a group consisting of some students that met. (156b), on the other hand, is most readily interpreted as saying that there are several species of rat, each of which is common. In other words, in (156b), *are common* seems to denote a distributive predicate over kinds rather than a collective predicate of any sort. Thus, kind predication and collective predication are not the same.

In the context of this dissertation, it is worth noting that bare plurals under their kind reading do not seem to denote 'more than one' in any obvious way. First, note that if (156b) is a distributive statement about several subspecies of rats, (155a) seems to be a statement about just one kind. It certainly does not imply that there are two or more kinds of rats, each of which is common in New York. Second, there is also no multiplicity condition about the members of the species that the kind corresponds to. If all but one of the few remaining Sumatran Rhinos were killed by poachers, (157) would certainly not become false:

(157) Sumatran rhinos are nearly extinct.

As shall be discussed in section 3.3 below, there are various different views on the relationship between the kind and existential readings. While some believe that bare plurals are just systematically polysemous, most current theories say that there is some sort of derivational relationship between the two readings. The fact that kind readings do not contain an inherent multiplicity condition does not help decide between different theories of this relationship. Rather, it indicates that a two-part meaning theory of dependent plurality may be true regardless of which view of kinds is closest to being correct.

3.2.2 Quasi-universal readings

Condoravdi (1992) introduces a third interpretation of bare plurals, that has some properties which differ from the two readings already discussed. In this interpretation, which is named **quasi-universal** by Dobrovie-Sorin (1997), the bare plurals seem to refer to all the contextually salient entities of the relevant type. For example, using a sentence from Condoravdi (1992):

(158) In 1985, a ghost was haunting the campus. Students were aware of the danger.

The bare plural *students* second sentence does not seem to have an existential interpretation; the sentence does not mean that some students were aware of the danger. Nor does it seem to be about the kind students. It is specifically the local students at 1985 who were aware of the danger. In fact, as Condoravdi notes, the closest paraphrase for (158) is (159), where the bare plural is replaced by a definite:

(159) In 1985, a ghost was haunting the campus. The students were aware of the danger.

The status of quasi-universal readings in the literature is more tenuous than either the existential or kind readings. Indeed, the basic consensus is that these readings can be reduced to a special case of one of the other two readings, though there is less agreement on which reading, nor how to do so. There are three main approaches. Condoravdi (1992) herself ends up assimilating them to existential readings, and argues that bare plurals differ from other indefinites in that they are felicitous under weaker novelty conditions. Dobrovie-Sorin (1997) also argues that they are existential readings, but accounts for their special properties by arguing that they are under the scope of a generic operator. A different view is found in Krifka (2004), who argues that they are examples of a kind-reading which refer to an *ad-hoc* kind determined by context and licensed by the fact that the bare plural is in topic position.

These readings are worth describing, partially because the basic disagreement about their nature is an indication that the differences between them and the other readings are not trivial. Nonetheless, determining which is the correct approach goes beyond the scope of this dissertation, and I will not discuss this question further. What is worth noting for current purposes, however, is that these readings also fail to exhibit a multiplicity condition under negation. In (160), it is not the case that the mayor thought that exactly one student was aware of the danger, but rather that he doubted that any were:

(160) In 1985, a ghost was haunting the campus. The mayor doubted that students were aware of the danger.

Thus, whatever the true explanation of the quasi-universality of these plurals, they share with the regular existential bare plurals the property that they do not mean 'more than one', and thus, similarly to the kind readings, they do not pose a problem to the number-neutral account argued for in this thesis.

3.2.3 Section summary

In this section, I gave brief descriptions of the two interpretations that bare plurals have been argued to have in addition to the existential reading discussed in chapter 2. While it is only possible for me to briefly touch on the various problems and questions that these readings raise, it was shown that neither of them seems to contribute a 'more than one' meaning in a way that would make their existence problematic for my account of dependent plurality.

3.3 Approaches to Bare Plurals and Their Readings

So far in this chapter, we have seen two aspects of bare plurals that do not relate directly to whether or not they denote 'more than one'. The first is that they obligatorily take low scope. The second is that they have a range of several readings available to them, most notably the existential and kind readings. One of Carlson's (1977) main conclusions was that these two facts of the nature of bare plurals are not unrelated. This approach has remained influential over the past thirty years, and is still at the core of theories such as Chierchia (1998) and Krifka (2004), even though they differ from Carlson in the details of implementation.

Carlson's (1977) account hinges on the notion that bare plurals always denote kinds. The existential reading is derived by the interpretation of the verb, and is tied to the distinction between stage level predicates and individual level predicates. As mentioned above, kinds are a special type of individual. Individual level predicates denote properties of individuals. If such a predicate is applied to a bare plural (as in (161)), Carlson argues, it will be interpreted as being a generic property of members of the kind:

(161) Policemen are intelligent.

Stage-level predicates, however, denote a condition that states that for their argument individual, there are stages in which they apply. So, (162) means that there are stages that John is available in:

(162) John is available.

Carlson then argues that the stages of a kind are in fact the stages of all the individuals belonging to the kind. This means that for a stage level predicate, providing a kind as an argument entails that there are members of the kind that have stages at which the predicate applies:

(163) Policemen are available.

What (163) is argued to mean is that there are stages of policemen of which it is true that those policemen are available. Thus, the existential reading is actually achieved from the existential statement over stages that is supplied by the verb. This, according to Carlson, explains the low-scope behavior of existential readings of bare plurals. The bare plural itself may take any scope, but the existential statement over stages is the one that does the actual semantic work and it will always takes scope with the verb.

Unfortunately, this analysis was quickly shown to make incorrect predictions. The stage versus individual distinction in the predicates does not always predict whether a bare plural will be interpreted in a kind or existential reading. For example, take the following sentence[3]:

(164) Typhoons rise in this part of the Pacific.

This sentence is ambiguous between a reading where it is typical of typhoons that they rise in this part of the Pacific ocean (thus, the subject is interpreted as a kind). But it also has a reading where it is typical of this part of the Pacific that typhoons rise in it. In that reading, the verb is still interpreted as individual-level, but *typhoons* is interpreted existentially. See Kratzer (1995) for further discussion of this issue and its consequences.

A refinement of Carlson's theory, that explicitly does away with the notion of stages the deciding factor between the readings of bare plurals, has been developed by Chierchia (1998). Chierchia also updates Carlson's theory to be able to account for cross-linguistic variation in whether or not bare arguments are available. Like Carlson,

[3] This sentence originates in Milsark (1974).

Chierchia takes kind readings to be the basic meaning of bare plurals. Unlike Carlson, existential readings are not created by the interpretation of predicate, but rather by a set of type-shifters that change the semantics of the bare noun itself.

First, Chierchia posits that there is a simple mapping between kinds and the properties they denote. He proposes two type-shifters, the "down" operator $\cap$, and the "up" operator $\cup$, whose relation to each other can be illustrated below:

(165) $P \underset{\cup}{\overset{\cap}{\rightleftarrows}} K$

In other words, the kind denoted by the *dogs* is equal to $\cap\{x : \textsc{dog}(\textsc{x})\}$, and the predicate DOG can be represented as $\cup dogs$.

To get the existential readings of bare plural arguments, Chierchia introduces a more complex type shifting rule he calls **Derived Kind Predication**, or DKP, which is defined as follows:

(166) **Derived Kind Predication (DKP):** If P is a predicate that selects for non-kind individuals, and k denotes a kind, then $P(k) = \exists x[{}^{\cup}k(x) \;\&\; P(x)]$

In other words, giving a kind-denoting argument (i.e., a bare plural) to a predicate that does not expect it will result in the insertion of an existential quantifier over members of the kind. Thus, instead of relying on the distinction between stage and individual predicates, Chierchia introduces a sortal distinction on predicates, and introduces a rule that fixes sortal mismatches by introducing an existential operator. This rule must apply locally, ensuring the low scope of existential readings of bare plurals.

Unfortunately, the use of the DKP has some disadvantages. As pointed out by Krifka (2004), it differs from all other type-shifting operators used by Chierchia in that it is considerably more complex and is not meaning preserving. More problematically, the DKP is in direct competition, in the sense that it takes the same type of input and returns the same type of output, with existential closure, which is independently needed by Chierchia, and is considerably simpler. As a result, there is never a case where DKP can be motivated by a type-logical mismatch, but rather it can only be motivated by a conceptual mismatch. In other words, there is nothing in Chierchia's system that prevents the sentence "Dogs barked outside my window last night" from meaning "There was a species of dogs that barked outside my window last night" except world knowledge that tells us that species do not bark, only individual dogs do.

To remedy this, Krifka proposes that neither the kind nor the existential reading is more basic than the other. Rather, bare plurals denote predicates, and both the kind and existential reading are derived by type-shifting. The choice of which type-shifter applies is conditioned by the predicate in question.

What is common to both Chierchia and Krifka's approaches is that the proposed type shifter, be it from kind to existential or from predicate to existential, must apply as locally as possible; i.e. when the predicate tries to combine with the verb denotation (or with the role predicate in a Neo-Davidsonian system). This essentially ensures the low-scope behavior of existential bare plurals. Just like in Carlson's original system, the type-shifter will always assign the bare plural the same scope as the verb[4].

Krifka's proposal that bare plurals denote predicates is formulated to address flaws in Chierchia (1998), but the basic idea is not original to him. Heim (1982) and Kamp (1981) first developed the idea that indefinites do not denote quantifiers but rather introduce a variable and a predicate that restricts it. The original approach, however, does not distinguish between bare plurals and other indefinites and thus cannot explain the properties observed by Carlson. However, Heim and Kamp's theories, coupled with cross-linguistic research, led to the development of theories of **semantic incorporation**. This notion was introduced by Van Geenhoven (1998),

[4]See chapter 5 section 5.2 for a formal implementation of such a type-shifter

who shows that the behavior of incorporated nouns in Kalaallisut[5] displays much of the same behavior that Carlson originally noticed for bare plurals in English. Van Geenhoven's (1998) basic proposal is similar to that of Krifka (2004), except that she has the type-shifting affect the meaning of the verb rather than that of the plural itself. Another closely related approach can be found in McNally's (2004) investigation of Spanish bare plurals, and Chung and Ladusaw's (2004) investigation of Maori, who, instead of positing a type-shifter, implement semantic incorporation as a rule of composition.

The differences between the various approaches mentioned above are not particularly important for this dissertation. Considerably more important is what they have in common: the fundamental idea that the narrow scope behavior of bare plurals is explained by the hypothesis that they denote predicates, and that the method that allows them to combine with verbs will only give them a very narrow existential scope. None of these theories are directly affected by whether bare plurals contain a multiplicity condition in their denotation or not.

However, the same is not true of Farkas and de Swart (2003). In this book, the authors take the tradition of semantic incorporation and reformulate it in a DRT framework, based primarily on Hungarian data. In this theory, multiplicity is closely tied to the narrow scope behavior of bare plurals. Farkas and de Swart note that in Hungarian, it is possible to tell whether a noun phrase is incorporated or not by its syntactic position. Both bare singulars and bare plurals are available as incorporated nouns, and in that position, they will take narrow scope due to the nature of the incorporation rule. However, bare plurals can also appear as non-incorporated nouns. Contrary to the expectation of theories that explain narrow scope behavior by semantic incorporation, non-incorporated bare plurals act similarly to English bare plurals and cannot take wide scope. The explanation offered by Farkas and de Swart has to

[5]More commonly known as West Greenlandic.

do with presupposition accommodation. They argue that multiplicity for bare plurals is a presupposition[6]. Using a theory of accommodation based on van der Sandt (1992), they argue that presuppositions can be accommodated by essentially adding them to the assertion. This creates a new discourse referent, which is equivalent to existential closure in a static framework. However, accommodation can normally occur late in the derivation of the sentence, which would make it possible for bare plurals to get wide scope. This forces Farkas and de Swart to stipulate that the multiplicity presupposition is unique in that it must be accommodated locally.

In other words, the low scope of non-incorporated bare plurals ends up as being entirely stipulated in this theory. Without this stipulation, there would be no relationship between the purported multiplicity of bare plurals and their scope. Furthermore, it is important to note that what drives this proposal is the fact that bare plurals have a presupposition. The fact that it is identified as a multiplicity presupposition is totally irrelevant to the behavior it induces. To see why this is an issue, let us take the bare plural *cars*. Farkas and de Swart argue *cars* bears a presupposition that there is more than one car involved, and this accounts for its low-scope behavior. If, however, *cars* presupposed that there are only whole cars involved (after all, "John owns cars" is infelicitous if John owns many car parts but not complete cars), the same accommodation mechanism would also result in low scope. Thus, even if Farkas and de Swart (2003) is correct about the role of accommodation, it seems to me that it cannot be taken as convincing evidence against a number-neutral theory of bare plurals.

[6]Strictly speaking, presuppositions are not part of the denotation. However, they are still lexically, rather than pragmatically, specified, and therefore I treat this theory as opposing my own.

3.4 Chapter Summary

In this chapter, I have discussed properties of bare plurals beyond those covered in the previous chapter. I have discussed the non-existential readings of bare plurals, as well as the fact that existential bare plurals must take narrow scope. I have then provided a summary of approaches to these facts, showing that there is a large body of work that argues that bare plurals denote properties, and that they various readings are derived via type-shifting of one sort or another. This explains both the variety of readings and the fact that bare plurals do not have the scopal possibilities of full DPs.

Also, I have mentioned two potential problems to the view argued for in this dissertation: Partee's (1985) argument that dependent plurals have properties other existential bare plurals do not, and the argument for a multiplicity presupposition in Farkas and de Swart (2003), and have argued that neither is a convincing argument against a number-neutral + multiplicity implicature approach.

CHAPTER 4

THEORETICAL BACKGROUND

4.0 Overview

The goal of this chapter is to provide an overview of the theoretical backdrop against which the remainder of this dissertation rests. In order to build any formal semantic theory that is sensitive to the distinction between singulars and plurals, such as the one that will be developed in the following section, it is necessary to make several decisions. The first decision is how plural predication and reference will be represented in the logic. This question, and the ontological debate it sparked in both the linguistic and the philosophical literature, is discussed in section 4.1. A second decision regards the role of events in the semantics of plurality. In the past fifteen years, event semantics have become intimately tied with the semantics of plurality. The reasons behind this relationship, and some of the motivations, are explained in section 4.2.

It is worth mentioning at the outset that these two sections do not have equal standing in relationship with the rest of this dissertation. The goal of section 4.1 is not only to explain the different frameworks for representing plural reference, but also to show that the distinction between number neutral bare plurals and singulars is in fact compatible with all these frameworks. On the other hand, events will play a crucial role in the explanation of the behavior of bare plurals given in chapters 5 and 6. Section 4.2, therefore, is intended to provide independent motivation for their use.

4.1 The Logical Representation of Plurality

As stated above, this section explains the problem of plural predication and reference, and provides a brief overview of the different approaches intended to solve it, and the points of contention between them.

4.1.1 First order logic and (the lack of) plural predication

It is common practice in model-theoretic semantics to use predicate logic as a representation of sentence meaning. However, standard first-order predicate logic cannot properly account for plural meaning. The normal interpretation of first order logic predicates, for example, is to take them to be sets of individuals. This allows us to translate (167a) as (167b):

(167) a. Andrea is a student.

b. $\textsc{student}(Andrea)$.

Translating (168a) is slightly trickier, but possible. The common way of doing so is to first translate it into (168b); this, now, can be straightforwardly interpreted as (168c):

(168) a. Andrea and Amy are students.

b. Andrea is a student and Amy is a student.

c. $\textsc{student}(Andrea)$ & $\textsc{student}(Amy)$

The reason (168b) is an acceptable translation of (168a) is because the property of being a student is distributive. If several entities are students, that means that each of them is a student. Since all first order predicates are sets of individuals, they are by nature distributive.

However, the same is not true of all natural language predicates. Take (169a):

(169) a. Andrea and Amy are classmates.

b. # Andrea is a classmate and Amy is a classmates.

c. # $\textsc{classmate}(Andrea)$ & $\textsc{classmate}(Amy)$

How can (169a) be translated into predicate logic? Translating it into (169b) is clearly the wrong way to go. It makes no sense to talk of a set of classmates, that Amy and Andrea happen to be members of. Note that if there was a set of such classmates, than (170a) would be a valid inference, as demonstrated by the validity of (170b):

(170) a. Andrea and Amy are classmates, and Dan and Violeta are classmates. Therefore, Andrea and Violeta are classmates.

b. $\textsc{classmate}(Andrea)$ & $\textsc{classmate}(Amy)$ & $\textsc{classmate}(Dan)$ & $\textsc{classmate}(Violeta) \Rightarrow$
$\textsc{classmate}(Andrea)$ & $\textsc{classmate}(Violeta)$

One possible solution is to treat *classmate* as a relation. Instead of being a set of individuals, it is possible to treat it as a set of pairs of individuals, and translate (169a) as (171):

(171) $\textsc{classmate}(Andrea)(Amy)$

But what should be done then of (172)?

(172) Andrea, Amy and Marcos are classmates.

One idea is to distribute *classmate* over all possible pairs, interpreting (172) as (173):

(173) $\textsc{classmate}(Andrea)(Amy)$ & $\textsc{classmate}(Amy)(Marcos)$ & $\textsc{classmate}(Andrea)(Marcos)$

But (173) can be true even if (172) is not; say that Andrea and Marcos are both taking semantics together, Amy and Marcos are both attending a statistics class, and that Andrea and Amy are both taking an afternoon knitting class together (and no other classes are being taken by any of them). Any two of them are classmates, so that (173) is true, but it is not true that all three of them are classmates.

One possible solution is to take *classmate* to be ambiguous between a two-way relation and a three-way relation. But of course, it is possible to add more and more people:

(174) a. Andrea, Amy, Marcos and Tuuli are classmates.

b. Andrea, Amy, Marcos, Tuuli and Jason are classmates.

c. Andrea, Amy, Marcos, Tuuli, Jason and Kara are classmates.

d. Andrea, Amy, Marcos, Tuuli, Jason, Kara and Kevin are classmates.

e. ...

As this is a potentially infinite progression, *classmate* would have to be infinitely ambiguous. And not just classmate, but many other predicates; *meet*, *dance*, *lift a piano*, and so forth. This is unappealing from a parsimony viewpoint. One solution to the problem of infinite ambiguity is allowing the logic to contain predicates with variable poliadicity. However, this introduces its own problems. For example, take the following sentences (the situation in question may be some sort of party game, where several people lie on a bedsheet and their friends attempt to lift them all at once):

(175) a. Andrea and Amy lifted Marcos.

b. Andrea and Amy lifted Marcos and Tuuli.

c. Andrea, Amy, and Kara lifted Marcos, Tuuli, and Jason.

d. Andrea, Amy, Kara and Marcos lifted Tuuli, and Jason.

e. ...

In (175), both lifters and liftees can be arbitrarily larger collections. This means that in addition to allowing LIFT to take a variable amount of arguments, the logic must afford a mechanism that distinguishes which of these arguments are lifters and which are liftees, such that it is possible to distinguish (175c) and (175d). In addition, it is not clear how either an ambiguity or a variable polidacity account can handle sentences such as (176):

(176) All the girls are classmates.

Here too, a common way to interpret plural subjects like *the girls* in standard predicate logic is by distributing over the girls:

(177) a. All the girls are students.

b. $\forall x[\textsc{girl}(x) \rightarrow \textsc{student}(x)]$

But obviously, doing the same for *classmates* returns us to square one:

(178) $\forall x[\textsc{girl}(x) \rightarrow \textsc{classmate}(x)]$

The relation-based account of *classmate*, then, is incapable of handling quantified subjects.

From the examples above it can be seen that the proper treatment of plurals is out of the reach of classic predicate logic. What is necessary is to extend predicate logic to include plurals. There have been two main approaches to how to do so.

The first approach seeks to solve the problem while keeping the basic structure of predicate logic intact. Since predicate logic is designed to work with singular objects, this approach reduces all statements about plurals to statements about abstract entities that are themselves singular, but can stand in for the plural. The second approach is more radical. It abandons first order predicate logic completely in favor of second order predicate logic. This approach no longer needs an intermediary between the plural and its predicate, but its increased power comes at the cost of simplicity.

4.1.2 Reducing plural predication to singular predication

By far the most common approach taken in the semantic literature to the problem of plural predication is finding a way to represent the plural as a singular. This approach is appealing on several levels. First, it proposes a solution that relies on concepts that are already well understood by most researchers in the field. Perhaps more importantly, it can be relatively conservative in the amount of expressive power it adds to existing first order frameworks. And finally, it is remarkably effective as an overall approach in solving the basic problems detailed above.

But, perhaps because of the popularity of the idea of reducing plural predication to singular predication, there is disagreement on how best to implement this. Two main variations can be found in recent literature, similar in their goals but different enough to be worth discussing on their own merits. The first variant, which uses sets, is discussed in section 4.1.2.1, while its competitor, which is built on the notion of part/sum relationships, is discussed in section 4.1.2.2.

4.1.2.1 Set based theories

If one wishes to find a way to treat a plural entity as a singular, there is no need to look beyond the set of tools already available from standard set theory. A set, after all, is a single thing, but it may have many elements. Thus, accounting for plural predication can be as simple as taking plurals to denote sets, and non-distributive predicates are taken to be predicates of sets of individuals. This has been the approach taken by a wide range of plural literature, including Scha (1981), Hoeksema (1983), Gillon (1987, 1990), Lasersohn (1995) and Schwarzschild (1996). In this view, we can give sentence

(172) (repeated below) the semantics in (179):

(172) Andrea, Amy and Marcos are classmates.

(179) $\textsc{classmates}(\{Andrea, Amy, Marcos\})$

Plural quantifiers can be taken to be quantifiers over sets, so that (180a) can be interpreted as (180b):

(180) a. Three students met.

b. $\exists X[x \subset \textsc{student}\ \&\ |X| = 3\ \&\ \textsc{met}(X)]$

In (180b), X is a variable over sets. (180a) thus is taken to mean "there's a set, such that it's a set of students and it has three members, and that set met". Distributive reference can also be achieved easily, by adding a distributivity operator, that applies a predicate to each member of the set. For example, using the operator in (181)[1], we can interpret (182a) as (182b)[2].

(181) ${}^{D}\phi_{\langle e,t\rangle} = \lambda X \forall x \in X[\phi(x)]$

(182) a. Three students jumped.

b. $\exists X[x \subset \textsc{student}\ \&\ |X| = 3\ \&\ {}^{D}\textsc{jumped}(X)] =$

$\exists X[x \subset \textsc{student}\ \&\ |X| = 3\ \&\ \forall x \in X[\textsc{jump}(x)]]$

The set-based theories of plurality, then, offer a way around the basic problem of plural predication. And they do so only with tools that were already in use in stan-

[1] This operator is based on Link (1987).

[2] This discussion glosses over a major theoretical debate in the early days of set-based theories: whether the distinction between distributivity and collectivity reading should be achieved by modifying the predicate, as with the ^{D} operator in (181), or whether it should be done by making *three students* ambiguous between the set of three students and a distributive quantifier. The latter view was the one taken by some of the earlier work on the topic, such as Scha (1981) and Gillon (1987). The debate was mostly resolved in Lasersohn (1995), using examples where the same DP can be interpreted both collectively and distributively in the same sentence, which can only be explained if the difference lies in the predicate:

(i) The students closed their notebooks, left the room, and gathered in the hall after class.

dard model-theoretic semantics, which explains its popularity. However, they are not without their detractors.

4.1.2.2 Part/sum based theories

One of the best known criticisms of set-based theories is a metaphysical one. Its most famous articulation comes from Link (1998). Imagine that the following sentence is true under the collective construal:

(183) Link's daughters made a mess in the living room.

For (183) to be understood, says the set-based theory, it needs to be paraphrased as (184):

(184) The set of Link's daughters made a mess in the living room.

But note that (184) entails (185):

(185) A set made a mess in the living room.

Herein lies a basic problem. For after all, a set is an abstract entity. How could it do something as concrete as make a mess in a room?

Link's complaint, in other words, is that sets are too abstract an object to serve as a mediator between a plurality and a predicate[3]. Instead, he argues for a theory based on the notion of sums (also known as a mereological theory). The intuition behind sums is that of standard part/whole relations. Take, for instance, a book. A book is an entity; it is normal to talk of it as a singular, and to conceive of it as a "thing". But a book also has parts: a cover, and pages. If I open a book and point to a page, I can talk of the page as an entity on its own. The book and its page may have different properties; the book, for instance, may be heavy, even though the page

[3]Some researchers agree that (185) is entailed by (183) but do not accept that this is a problem. See Landman (1989) for an example of a response to Link which argues that *Link's daughters* is not concrete in the same sense that each of the daughters is.

is light. The book and page, then, are examples of how two things in the world can be conceived of as entities, yet stand in a part/whole relation to each other.

The sum-based theory of plurality extends this view to all elements. If we can talk of an object α and another object β, we can talk of their sum $\alpha \sqcup \beta$. α and β are parts of $\alpha \sqcup \beta$, but $\alpha \sqcup \beta$ is itself a thing in the world. It is possible to attribute things to it. For example, Andrea and Amy are entities, and therefore Andrea$\sqcup$Amy is also an entity[4]. This entity may have properties that neither Andrea or Amy have; for example, the property of meeting. Thus, instead of plural entities referring to sets, they are taken to refer to sums.

It is worth noting, however, that the metaphysical assumptions of the sum theory are not entirely innocuous. Oliver and Smiley (2001) point out, for instance, that if the sum relation is taken to be a purely nominalistic relation, defined only in terms of spatio-temportal coincidence, unwelcome results arise. For instance, for any particular point in time, the sum of Russell and Whitehead coincides spatially with the sum of the molecules that comprise Russell and Whitehead. But that means that the following inference holds[5]:

(186) a. Russell and Whitehead are logicians. $\Rightarrow$

b. LOGICIANS$(Russel \sqcup Whitehead) \Rightarrow$

c. LOGICIANS$(\sqcup\{x{:}x$ is a molecule & $x \leq Russell \sqcup Whitehead\}) \Rightarrow$

d. The molecules that comprised Russell and Whitehead are logicians.

But this inference is clearly invalid. Oliver and Smiley argue that this means that a notion of sum that is not purely spatiotemporal must be adopted; but going down this road may lead right back to the type of statements over abstractions it was designed to avoid. A sum-theorist might reply that the problem is with the treatment of the

[4]Perhaps the first application of the sum operator to discrete individuals such as humans in this manner can be found in Massey (1976).

[5]Assuming all the sentences refer to the same time instant.

predicate LOGICIANS; perhaps it does not distribute down to the level of molecules. But such a solution requires a mechanism that will let predicates tell apart different types of parts, which ends up reintroducing the same problem.

Beyond the metaphysical point, there is an additional attraction to the sum-based theories in that there is no type-distinction between parts and their sums. While most sum-based theories make a sortal distinction between atoms (which have no smaller parts) and non-atoms (which do), both are of type e. Set-based theories, however, face an option; they can assign singulars type e and plurals type $\langle e, t \rangle$, which means that predicates such as *dance*, which can either apply to singulars or plurals, need to be construed as ambiguous or otherwise type-shifted. Otherwise, individuals are also taken to be singleton sets, which seems like an unintuitive complexity for sentences not involving plurals[6]. Sum-based theories do not need to posit such an ambiguity.

Generally, sum-based theories are quite similar to set-based theories in their implementation; most results formulated in one type of theory are easily carried over to the other. Because of this, there are those who deny that there is a substantial difference between the two, including most critics of both views, and also some of those who adopt them, such as Schwarzschild (1996) and Landman (2000). Nonetheless, sum-based theories are probably the most common today. In addition to the highly influential work by Link, other sum-based theories include Hoeksema (1988), Krifka (1990), Moltmann (1997), Winter (2002) and Landman (2000), which will form the basis of my own formal framework.

4.1.2.3 Criticism of set-based and sum-based theories

Despite their popularity, theories that attempt to reduce plural reference to singular reference have faced criticism. McKay (2006), for example, argues that both theories are vulnerable to a variant of Link's criticism of set-based theories. Specifically, by

[6] Nonetheless, this is the favored approach for most recent set-based theories. See especially Schwarzschild (1996) for discussion of this point.

reducing the subject to a singular, both theories make the following inference true, contrary to standard intuition:

(187) a. The students surrounded the building. $\Rightarrow$

b. Some entity surrounded the building.

McKay does not consider this a knock-down argument against the theories *per-se* but rather against the claim that either plurals-as-sets or plurals-as-sums are entirely natural and intuitive, as the inference in (187) is neither.

A more severe problem has been first observed by Boolos (1984, 1985, 1987), and further elaborated upon in Schein (1993, 1995) and Higginbotham (1998). Take the following sentence:

(188) The pets that do not own themselves are numerous.

It is very easy to represent (188) in a set-based theory, as shown below:

(189) $\textsc{numerous}(\{x : x \text{ is a pet that does not own itself}\})$

But now compare (190):

(190) The sets that do not contain themselves are numerous.

According to the plural based theory, (190) requires the predicate NUMEROUS to apply to the set of sets that do not contain themselves. But such a set cannot exist; to allow it would introduce Russell's paradox into the logic.

For sum-based theories, the situation is a bit more subtle. It is easy to come up with a sentence similar to (190) in sum-theoretic terms:

(191) The sums that are not part of themselves are numerous.

But note that by the standard definition of the part-of relation every sum is a part of itself. This means that the DP *the sums that are not part of themselves* refers to a non-existent sum, triggering presupposition failure and making sentences including it indeterminate for truth, rather than invoking Russel's paradox. Schein (1995), though, notes that this does not resolve the issue. He argues that sum-based theories are still subject to a different, but in his eyes equally fatal, problem, which is a version of the problem already noted above with Russell, Whitehead, and their molecules. First, in a sum-based theory, *the atoms* denotes the sum of all atoms, and *the plural objects* denotes the sum of the plural objects. But since the plural objects are themselves nothing but sums of atoms, and the sum operation is associative, commutative, and idempotent, then the sum of all plural objects is the same as the sum of all atoms. Therefore, (192) must be true:

(192) The plural objects are the atoms.

But this causes a paradox, as, by definition, the plural objects are not the atoms. Unlike the example involving Russell and Whitehead, this paradox cannot be resolved by refining the sum operator so as to differentiate between an entity and the sum of its physical components, as the sum operator is involved on both sides of the equation[7].

4.1.3 Monadic second order logic

Both the set-based and the sum-based theories maintain the basic framework of first-order logic, and solve the problem of non-distributive predication by introducing a singular counterpart to the plurality in question. Some researchers, however, consider this approach problematic, either because of the problems noted in the previous section, or because they think plural predication and reference should be as direct as singular predication and reference. Instead, they turn to monadic second order logic, inspired by an observation in Boolos (1984). Boolos, in discussing the paradox

[7]This is a somewhat simplified version of this criticism, and there are some obvious ways around it as presented above, such as denying that the English DP *the atoms* may be used to refer to the sum of all atomic entities. See Schein (1995) and Higginbotham (1998) for more articulated versions of this criticism of sums and further discussion of its consequences.

inherent in (190), argues that it is possible to use a second order variable even when the objects it over which it ranges do not form a set[8]. Taking their cue from this argument, several researchers, including Schein (1993), Higginbotham (1998), Pietroski (2005) and McKay (2006), developed a theory of plurality based on a variant of monadic second order logic where the variables are not directly related to sets.

The basic notion behind these theories is that a single argument slot may be multiply filled. Returning to sentence (172), the semantics proposed is that in (193):

(172) Andrea, Amy and Marcos are classmates.

(193) $$\textsc{classmates}\begin{pmatrix} Andrea \\ Amy \\ Marcos \end{pmatrix}$$

What makes (193) different from the first order theories is that it does not imply that there is a sort of singular entity which is an argument of (193). It is thus possible to use (193) without committing to the existence of either a set or a sum; it is only necessary to make a commitment to the existence of Andrea, Amy and Marcos.

This introduces complications that the first order theories do not face. The axioms and rules of interpretation have to be carefully formulated to ensure that an argument being multiply filled by Andrea, Amy and Marcos is different from being distributively filled by each of Andrea, Amy, and Marcos, and also that being multiply filled by Andrea, Amy and Marcos does not entail being multiply filled by just Andrea and Amy. I refer the reader to Schein (1993) and McKay (2006) for detailed examples of such theories.

Just as argument positions can be multiply filled, second order theories allow for variables that have more than one referent. To translate (194), a logical form like (195) is used:

[8] This is contra his earlier position in Boolos (1975).

(194) Some girls are classmates.

(195) $\exists X[\forall x[x \textit{ is-one-of } X \rightarrow \textsc{girl}(x)] \ \& \ \textsc{classmates}(X)]$

In (195), X does not stand for any particular thing, but rather it stands for several girls at once. A serious problem of second order theories, and one that has prevented them from gaining more ground in the formal semantic literature, is that this is a difficult notion to grasp; it is far easier to read X as standing for a single thing, be it set or sum, than it is to think of it as a stand in for multiple entities. Since, for the purposes of most semantic work (including this dissertation), the ontological commitments are only a secondary concern, it is common to just go ahead with a set or sum based theory.

4.1.4 Number neutrality and plural reference

Above, I presented three basic approaches to plural reference. All three approaches provide a form of variable that can refer to plural entities, whether it is a first order variable over sets or sums, or a second order variable. What is important to realize is that nothing about these variables inherently encodes multiplicity.

This is perhaps most obvious in the set based theories. A singleton set, containing only one member, is still a set. Thus, a variable ranging over sets is inherently number neutral unless a specific condition to exclude singleton sets is added.

Similarly, in the second order theories, while a second order variable is one that *can* be multiply filled, there is nothing that requires it to refer to more than one entity. What separates first order variable from second order variables is that the former *cannot* refer to more than one thing.

For sum-based theories, number neutrality is perhaps the most difficult to implement, as all variables refer to entities. Encoding a difference between singular and plural variables in such a theory requires appealing to the notion of atomicity. Once this notion is established, it is possible to define a singular variable as ranging only over atomic entities; but there is no necessity to restrict the plural variables to non-atoms. Here, as in the second order theories, plural variables can refer to the same things as singular variables, they just are not limited to them.

4.1.5 Section summary

In this section I gave a summary of the basic approaches to plural predication and reference in the semantic literature. Three variations were discussed: set based theories, sum based theories, and second order logic based theories. All attempt to augment standard predicate logic in order to account for the possible meaning of plural DPs, and, for the most part, all three versions are successful. As should be clear from the above discussion, the differences between them lie less in their ability to handle semantic phenomena and more in what metaphysical concessions the people working within those frameworks are willing to make. Fortunately, much of the work in the different frameworks is easy to translate from one to another.

One final point is worth mentioning: while the initial motivation for all three frameworks is the ability to solve the problem of non-distributive predication, the use of the tools created by these frameworks extends far beyond this purpose. As shall be made explicit in chapter 5, in this dissertation I will adopt a sum-based approach — specifically, that of Landman (2000) — as the basis of my formal implementation of bare plural meaning. This should not be taken as a wholehearted adoption of the mereology-based metaphysics, or a dismissal of the criticisms of such approaches mentioned above. Rather, I wish to remain agnostic on the question of what is the best approach to plurality; as shown in section 4.1.4, all three approaches allow for number-neutral plural variables, and thus it should be possible to reformulate this dissertation in any of them. In chapter 6 it will be made clear that, even though existential bare plurals do not normally participate in non-distributive readings, the distinction between plural and singular variables is crucial in explaining their properties.

4.2 Plurals and Events

In the 40 years since Davidson (1967), events have taken a prominent role in natural language semantics. One of the domains in which they have proven to be of extreme importance is the study of plurality. In particular, the Neo-Davidsonian theory developed in Parsons (1990) has become an integral part of most research on plurals. Indeed, events play an important role in my own analysis of bare plural arguments.

The current tradition of event semantics dates back to Davidson (1967), which offers an account of action verbs, designed to explain the semantics of adverbial modification. Davidson's proposal is that verbs have an event argument, which can then be modified:

(196) a. Jones buttered the toast in the bathroom with a knife at midnight.

b. $\exists e[\textsc{butter}(e)(Jones)(the\ toast)\ \&\ \textsc{in}(e)(the\ bathroom)\ \&$ $\textsc{with}(e)(a\ knife)\ \&\ \textsc{at}(e)(midnight)]$

One advantage of the Davidsonian approach is that it can explain entailment relations between sentences that are otherwise opaque. For example, (197a) entails (197b), and (197c); both of them in turn entail (197d):

(197) a. Brutus stabbed Caesar in the back with the knife.

b. Brutus stabbed Caesar with the knife.

c. Brutus stabbed Caesar in the back.

d. Brutus stabbed Caesar.

The classic way of accounting for (197a) would be to posit a 4-way relation STAB, that is a relation between Brutus, Caesar, the back, and the knife. (197b) would be a 3-place relation between Brutus, Caesar, and the knife, and so-forth:

(198) a. $\textsc{stab}_1(Brutus)(Caesar)(\textit{the back})(\textit{the knife})$

b. $\textsc{stab}_2(Brutus)(Caesar)(\textit{the knife})$

c. $\textsc{stab}_3(Brutus)(Caesar)(\textit{the back})$

d. $\textsc{stab}_4(Brutus)(Caesar)$

But note that there is nothing in the form of (198a) that says it is related to (198b). The entailment relation would have to come from lexical knowledge about $\textsc{stab}_1$ and $\textsc{stab}_2$. But since modification of this type is relatively free, this would mean that each verb would have to have a whole set of denotations with complex lexical entailment relations between them. In comparison, the Davidsonian framework offers a far more elegant pattern:

(199) a. $\exists e[\textsc{stab}(e)(Brutus)(Caesar)\ \&\ \textsc{in}(e)(\textit{the back})\ \&\ \textsc{with}(e)(\textit{the knife})]$

b. $\exists e[\textsc{stab}(e)(Brutus)(Caesar)\ \&\ \textsc{with}(e)(\textit{the knife})]$

c. $\exists e[\textsc{stab}(e)(Brutus)(Caesar)\ \&\ \textsc{in}(e)(\textit{the back})]$

d. $\exists e[\textsc{stab}(e)(Brutus)(Caesar)]$

Not only do all of (199a)-(199b) share the same predicate, eliminating the need for massive redundancy in the lexicon, but the entailment relation follows straightforwardly from the logic.

This idea was later extended in Parsons (1990) into what is now called the Neo-Davidsonian framework. Parsons took the framework one step further. For him,, the verbal predicate is no longer a relation between an event and entities but a one-place predicate of events; all arguments are added conjunctively, normally through the use of relations denoting thematic roles. In a Neo-Davidsonian framework (196a) would get a logical form as in (200):

(200) $\exists e[\textsc{butter}(e)\ \&\ \textsc{agent}(e)(Jones)\ \&\ \textsc{theme}(e)(\textit{the toast})\ \&$
$\textsc{in}(e)(\textit{the bathroom})\ \&\ \textsc{with}(e)(\textit{a knife})\ \&\ \textsc{at}(e)(\textit{midnight})]$

The Neo-Davidsonian framework has one important consequence, which was first seriously developed in Schein (1993). If arguments are related to verbs through a series of role predicates which are conjoined with each other, then there is no scope relation between them. This allows for the generation of scopeless readings, such as the cumulative and cover readings, in sentences where eventless theories do not have a way of doing so. Before giving the examples where events are really needed, however, let us look at a simple sentence, such as sentence (201):

(201) Five elephants sat on a thousand mice.

It is easy to see that (201) has a cumulative reading in which five elephants sat, and one thousand mice were sat on, in total. In classic generalized quantifier theory, as laid out by Barwise and Cooper (1981), in order for the predicate SAT to be related to the two DPs *five elephants* and *a thousand mice*, it must fall in the scope of both, and the only way for that to happen is if one outscopes the other, as schematically represented below:

(202) a. [5 elephants]$(x) \gg$ [1000 mice]$(y) \gg \textsc{sat}(x)(y)$

b. [1000 mice]$(y) \gg$ [5 elephants]$(x) \gg \textsc{sat}(x)(y)$

Neither (202a) nor (202b) properly represent the cumulative account; (202a) states that a total of five thousand mice was sat on, while (202b) states that a total of five thousand elephants were sitting. In a Neo-Davidsonian theory, however, there is no need for the predicate to fall under the scope of either DP. As a result, there is no need for a scopal relationship between the DPs either. Instead, we get the following reading:

(203) $\exists e[\textsc{agent}(e)(5\ \textit{elephants})\ \&\ \textsc{theme}(1000\ \textit{mice})\ \&\ \textsc{sat}(e)]$

Unlike (202a) and (202b), (203) captures the cumulative reading of (201) in a straightforward manner.

But while events are one method of achieving a scopeless reading for (201), they are hardly the only one. There are quite a few other methods which can achieve similar results for sentences with two arguments, such as by splitting the quantifier from its restriction (perhaps using a type-shifter like the ** operator (Beck 2000), or adding a layer of degree quantification (Ferreira 2007)) or branching quantification (Sher 1990). In addition, the use of any of the theories of plural predication described in section 4.1, which make distributivity a property of the predicate rather than of the DP denotation, can easily be appealed to for a solution[9]. For example, branching quantification would allow for a logical form such as the following:

(204) [5 *elephants*](x)
SAT(x)(y)
[1000 *mice*](y)

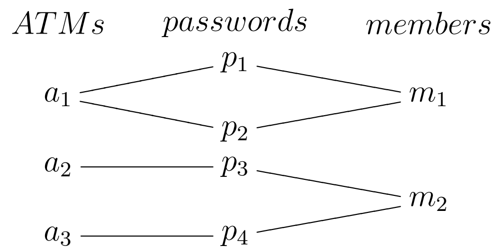
What Schein (1993) observed, however, is that sentences with more than two quantifiers make the problem far more acute. He argues that only by using events is it possible to account for all the possible readings of such sentences. Schein's full discussion includes a detailed analysis of many different cases, aimed at providing counterexamples to a large variety of possible alternative theories; here, I will only illustrate a single example that gives a taste of his arguments:

(205) Three ATMs gave two new members each exactly two passwords.

This sentence has many possible readings. The one of interest at the moment is the one where *three ATMs* and *two members* are unscoped with regard to each other. *Exactly two passwords*, on the other hand, is distributed over by *two new members* but not by *three ATMs*. This reading is true, for example, in the following scenario:

[9]While many of these solutions face some difficulty in accounting for cumulative readings of downwards and non-monotone quantifiers, the same is true of event-based solutions as well. Properly addressing this aspect of the cumulativity problem is beyond the scope of the current work. See Sher (1990), Schein (1993) and Landman (2000) for discussion of the problem with non-upwards monotone quantifiers in scopeless readings, and Ferreira (2007) as an example of recent, event-less theory aimed at addressing these problems as they pertain to sentences with two DPs.

(206)



Note that in the above diagram, there are three ATMs involved, and two members, and that each member got two passwords. All the non-event based methods listed above either allow, or can be modified to allow, for an arbitrary amount of DPs to be scopeless with respect to each other. But they offer no way to make two elements scopeless with respect to each other, without also making them have the same scopal relationship to every other element in the sentence. Scopal asymmetries such as those in (205) are not possible to capture in these theories.

In a neo-Davidsonian event theory, however, it is possible to do so:

(207) $\exists e[\textsc{give}(e)\ \&\ \exists X[3\ \mathit{ATMs}(x)\ \&\ \textsc{agent}(e)(X)]\ \&\ \exists Y[2\ \mathit{members}\ \&$
$\textsc{to}(e)(Y)](Y)\ \&\ \forall y \in Y[\exists Z[2\ \mathit{passwords}](Z)\exists e \in e'[\textsc{theme}(e')(Z)]]]$

This property of the Neo-Davidsonian framework makes it very appealing to theories attempting to account for the full range of readings that plural DPs offer in a systematic manner. As mentioned above, it forms the basic starting point for the theory presented in Schein (1993). It also is a key feature of Landman (2000). Pietroski (2005) takes this approach to a radical extreme, arguing that conjunction is the basic meaning of syntactic merger. But it is worth noting that there are still some who argue against this basic view. Both Bayer (1996) and McKay (2006) use theories that involve more complex rules for interpreting distributivity, basically introducing multiple ambiguity into the denotation of distributive operators to allow them to create asymmetric configurations. But the criticisms tend to focus on the use of role relations rather than on the use of events themselves: while McKay (2006) develops a totally event-free theory that is supposed to account for the same range of data as

Schein (1993), he also concedes that this is mostly of interest from the formal point of view, and that since events can be motivated on independent grounds, an event-based theory may be better suited as a general theory of natural language. Bayer (1996) argues for a Davidsonian, rather than a Neo-Davidsonian theory, accepting the use of events but not of role predicates. An intermediate position can be found in Kratzer (2003), who accepts the need for agent role predicates, but argues that other role predicates are not well motivated.

While I do not attempt to directly address these criticisms within this dissertation, the treatment of bare plurals does add a new argument for the use of events. Specifically, it will be shown in chapter 6 that quantification over events plays a crucial role in the calculation of the multiplicity implicature, and that without them, it is not possible to properly account for the data discussed in chapter 2. Thus, somewhat indirectly, dependent plurality provides yet more support for the use of events in the linguistic analysis of plurals.

4.3 Chapter Summary

In this chapter, I have summarized the main issues within two aspects of plurality that underlie all semantic literature on the topic: the treatment of plural predication and reference, and the role of events in the analysis of plural quantification. In doing so, I have provided the basic tools necessary to establish the theory of bare plurals that will be developed over the next two chapters.

CHAPTER 5

THE FORMAL SYSTEM

5.0 Overview

In the previous chapter, I presented a brief summary of the major approaches for implementing plurality, and of the arguments for tying plural semantics to event semantics. In this chapter, I give a detailed formal system of events and plurality, based to a large extent on the account of plural readings given by Landman (2000). A detailed recounting of the relevant parts of Landman's theory is given in section 5.1. Section 5.2 extends this theory to include bare plurals. The resulting theory will provide the necessary tools which will be used in chapter 6 to explain and formalize the derivation of the multiplicity condition and thereby explain the data from chapter 2.

5.1 Landman's (2000) Theory Of Plural Readings

5.1.1 Basic Principles

The theory of plural readings offered in Landman (2000) has several strengths that make it ideal for use as a background for the analysis of dependent plural readings. The first is its power; it is a theory that can account for a wide range of different readings in a principled way. The second reason for my adoption of Landman's framework is its simplicity; though it can account for much, it does so by a simple combination of two basic ideas.

The first basic idea that Landman's theory makes strong use of is Neo-Davidsonian event structure. Much of the power of Landman's theory is based on the observation by Schein (1993) that events and role predicates can be used to generated scopeless readings (as explained in chapter 4, section 4.2). Landman derives scopeless readings by first creating a property of events that he calls the **event type**. The verb denotation, plus the denotation of each DP that is interpreted *in-situ*, are found within the event type, and therefore do not form scopal dependencies on each other[1]. In addition to scopeless readings, a scope mechanism allows DPs to scope out, in which case the entire event type will fall in their scope. Like in standard predicate logic, the scope process is inherently distributive. If a DP such as *two boys* scopes over an event type, that means that there must be an event that meets the description for each boy.

The second fundamental part of Landman's theory is his particular implementation of a mereology based account (See chapter 4, section 4.1.2.2). Landman dif-

[1]We shall see in the next chapter that once Landman's theory is extended to account for DPs such as *all the/most boys*, there will be some scopal dependencies that take place within the event type. Crucially, however, it will still be the case that it is possible to generate scopeless readings by keeping DPs *in-situ*.

ferentiates two ways of talking about plurals: as sums, or as groups. A sum is the normal mereological notion of a non-atomic entity composed of parts which are also entities. A group, on the other hand, is an atomic entity that stands in a one-to-one correspondence to the sum. Every sum can be mapped onto a group (though not every atom corresponds to a sum). Using groups allows us to talk about a plurality in two different ways. One is as the sum of its parts, while the other is as a unit. For example, take the Beatles. We can talk of the Beatles as the sum of the band's members: John, Paul, George and Ringo. In this usage, we talk of the non-atomic entity $john \sqcup paul \sqcup george \sqcup ringo$. We can also talk about the band as an entity; in doing so, we refer to the group entity $\uparrow(john \sqcup paul \sqcup george \sqcup ringo)$[2].

Landman argues that predication over sums is inherently distributive, while collective readings are achieved by predication over groups. Coupled with the distinction between scopal and *in-situ* readings, he has at his disposal three ways of interpreting a DP argument: scoped distributivity, scopeless distributivity, and collectively. By the interactions between these possibilities, a wide range of readings is accounted for.

5.1.2 Formal system

5.1.2.1 The basic system

Ontology The first thing in our model is Δ, the domain for entities. I will define the sum operator $\sqcup$ as a function from sets of entities to entities such that for every non-empty set ϕ such that $\phi \subset \Delta$, $\sqcup X \in \Delta$. Similarly to Landman, I will write $X \sqcup Y$ for $\sqcup\{X, Y\}$. The part-of relation $\leq$ is defined as follows: $X \leq Y$ iff $X \sqcup Y = Y$. $\leq$ is a partial ordering over Δ.

An atom is an element $x \in \Delta$ such that there is no element $Y \in \Delta$ such that $Y \leq x$ and $Y \neq x$. We can define Δ_a to be the subset of Δ that includes all and only the atoms. I will use lower case letters x, y, z for variables that range over Δ_a, and

[2] See below for formal definition of the $\sqcup$ and $\uparrow$ operators.

upper case letters X, Y, Z for variables that range over all of Δ (including Δ_a).

We can define the cardinality operator $||$ over members of Δ as follows: for any X, $|X|$ is the number of members in the set $\{x \in \Delta_a : x \leq X\}$. In other words, $|X|$ is the number of atoms that make up X.

Δ has the following properties:

1. $\langle \Delta, \sqcup \rangle$ is an **i-join semilattice**. This means that for any $X, Y \in \Delta$ there is also $Z \in \Delta$ such that $X \sqcup Y = Z$, and there is no $W \in \Delta$ such that $X \leq W$ and $Y \leq W$, unless $Z \leq W$. In other words, for every two elements in Δ, the smallest element of which X and Y are both parts must also be in Δ[3].

2. In addition to being an i-join semilattice, Δ is also distributive, which means that if $X \leq Y \sqcup Z$, then either $X \leq Y$, or $X \leq Z$, or $\exists Y' \leq Y$ & $\exists Z' \leq Z$ such that $X = Y' \sqcup Z'$. In other words, if X is part of the sum of Y and Z, every part of X is part of Y or part of Z.

3. Δ also has the property of being witnessed. If $X \leq Y$ and $X \neq Y$, then $\exists Z \leq Y$ such that there is no W such that $W \leq X$ and $W' \leq Z$. Informally, if X is a proper part of Y, then the rest of Y is also an element of Δ.

4. The final property that Δ has is that it is atomic. This means that if there is more than one element in Δ, then there is no element 0 such that for every element $X \in \Delta$, $0 \leq X$. This means that if there is more than one element in Δ, then there is more than one atom.

Taken together, these properties mean that $\langle \Delta, \sqcup \rangle$ is a **mereology** (or, using Landman's terminology, a **part-whole** structure). It is equivalent to a complete boolean algebra with the 0 cut off.

In addition to entities, the ontology includes events. The domain of events is Σ. A sum operator $\sqcup$ is also defined over events, and $\langle \Sigma, \sqcup \rangle$ is a mereology that shares

[3]See Landman (1991) for a more detailed discussion of i-join semilattices.

all the properties of Δ listed above. The domain of atomic events is Σ_a. I will write variables that range over Σ_a as e, e', e'' and so forth, and variables over Σ as E, E', E''.

Events and individuals are related via **role predicates**, such as agent (AG) or theme (TH). Role predicates are partial functions from events to atomic entities. If x is the agent of e, then Landman writes $\text{AG}(e) = x$. Unlike Landman, I will follow the more traditional notation introduced by Parsons (1990), writing $\text{AG}(e)(x)$ instead of $\text{AG}(e) = x$. I will use Θ as a variable over role predicates. Like Landman, I assume role uniqueness: if $\Theta(e)(x)$ is true, then there is no y such that $y \neq x$ and $\Theta(e)(y)$ is true.

Verbal predicates are taken to be sets of events. Nominal predicates denote sets of individuals.

Type shifters Landman makes use of several type shifters in his theory, most of which are not directly relevant for current purposes. However, a couple of the more basic type shifters are necessary in order to derive basic sentence meanings. The first is the argument lifting type shifter LIFT, which comes in several versions:

(208) a. **Intransitive LIFT:** $\lambda X \lambda E[...] \Rightarrow \lambda \psi_{\langle\langle e,t\rangle,t\rangle} \lambda E[\psi(\lambda X[...])]$

b. **Transitive LIFT:** $\lambda X \lambda Y \lambda E[...] \Rightarrow \lambda \psi_{\langle\langle e,t\rangle,t\rangle} \lambda Y \lambda E[\psi(\lambda X[...])]$

In addition, we need a rule of existential closure over events:

(209) **Existential Closure (EC):** $\lambda E[....] \Rightarrow \exists E[....]$

Group formation One of the crucial elements in Landman's theory is the group-making operators $\uparrow$. For every element X in Δ, there is an element x in Δ_a such that $\uparrow X = x$, with the special provision that iff $X \in \Delta_a$, $\uparrow X = X$.

Landman (2000), following Schwarzschild (1992, 1996), actually has a more complex version of $\uparrow$ than I have given above, which is designed to disallow iterative group formation (i.e., the group forming operator is not defined over sums that include a group atom among their parts, such as $\uparrow(x\sqcup \uparrow(y \sqcup z))$. For simplicity's sake, I will not concern myself with this issue here. Nothing that follows hinges on whether or not iterative group formation is possible.

Pluralization The second important tool is the *, or pluralizing, operator. The star operator takes a set of entities or events and returns its closure under sum. For example, $^*\{x, y, z\} = \{x, y, z, x \sqcup y, x \sqcup z, y \sqcup z, x \sqcup y \sqcup z\}$.

The * operator is extended to apply to role predicates, creating what Landman calls plural roles. To extend * to relations, we can define a sum operation over roles $\sqcup\sqcup$ as follows: $\langle E, X\rangle \sqcup\sqcup \langle E', Y\rangle = \langle E \sqcup E', X \sqcup Y\rangle$. $^*\Theta$ is the closure of Θ under $\sqcup\sqcup$. It is worthwhile noting that while Landman uses the singular roles in the definition of the plural roles, he never uses them in the actual semantics of sentences. Rather, as he points out, if x and e are atoms, then $^*\Theta(e)(x) = \Theta(e)(x)$.

By the assumption that thematic roles are unique, and since any two elements only have one sum, it follows that uniqueness also holds for pluralized roles: if $^*\Theta(E)(X)$ is true, then there is no Y such that $Y \neq X$ and $^*\Theta(E)(Y)$ is true.

5.1.2.2 Accounting for the readings of plural indefinites

Unscoped Readings Because of the way they are defined, the plural roles are inherently cumulative. For any X and E, iff $^*\Theta(E)(X)$, then $\forall x \leq X \exists e \leq E[\Theta(e)(x)]$ & $\forall e \leq E \exists x \leq X[\Theta(e)(x)]$. This property of role predicates, as well as the use of the group operator, is used by Landman to account for the range of readings that plural indefinites get. To see this, let us look at the following sentence:

(210) Two boys walked.

Landman gives the following lexical entry for *walk*:

(211) $[\![walk]\!] = \lambda X \lambda E[^*\textsc{walk}(E) \ \& \ ^*\textsc{ag}(E)(X)]$

two boys, however, is ambiguous between two interpretations[4]:

(212) a. $[\![two\ boys]\!]_1 = \lambda\phi_{\langle e,t\rangle}\exists X[|X|{=}2\ \&\ {}^*\textsc{boy}(X)\ \&\ \phi(X)]$

b. $[\![two\ boys]\!]_2 = \lambda\phi_{\langle e,t\rangle}\exists X[|X|{=}2\ \&\ {}^*\textsc{boy}(X)\ \&\ \phi(\uparrow X)]$

Using these lexical entries, we can derive two meanings for the sentence. From (212a) we can derive the distributive reading[5]:

(213) a. **Distributive:** $\exists E\exists X[|X|{=}2\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{walk}(E)\ \&\ {}^*\textsc{ag}(E)(X)]$

b.
$$\begin{array}{ccc} X & & E \\ x_1 & \text{———} & e_1 \\ x_2 & \text{———} & e_2 \end{array}$$

While (212b) gives the collective reading:

(214) a. **Collective:** $\exists E\exists X[|X|{=}2\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{walk}(E)\ \&\ {}^*\textsc{ag}(E)(\uparrow X)]$

b.
$$\begin{array}{ccc} X & & E \\ \uparrow(x_1 \sqcup x_2) & \text{———} & e_1 \end{array}$$

Both interpretations are very similar. They both assert the existence of a plural event E that is a member of the set ${}^*\textsc{walk}$; in other words, it is a sum of events such that each of its parts is a walking event, and allowing for the possibility of it being made of only one part and therefore an atomic walking event. Both interpretations also assert the existence of a sum of entities X that is the set ${}^*\textsc{boy}$, and has a cardinality of two. This is only possible if X is a sum of two boys. The difference between the two lies solely in the arguments of the agent predicate that relates E to X. In the distributive interpretation (213a), the ${}^*\textsc{ag}$ relation holds between E and X. By the definition of ${}^*\textsc{ag}$, that means that every boy in X is the agent of a walking event, and every walking event in E has a boy in X as its agent. In other words, if $E = e_1 \sqcup e_2$,

[4]The reader may recall that in the previous chapter, fn. 2, I had presented a well-known argument that the distributivity/collectivity ambiguity must lie in the verbal predicate rather than in the DP. Landman is well aware of this, and achieves it by the use of an ungrouping operator $\downarrow$, which is applied to the role predicates associated with distributive predicates. See Landman (2000) for more details.

[5]Step-by-step derivations of these two examples can be found in appendix A.

then the sentence is true if one of the boys in X is the agent of e_1, and the other is the agent of e_2. An example of such a mapping is given in (213b). The collective reading in (214a), on the other hand, has the relation *AG hold between E and the group $\uparrow X$. Since $\uparrow X$ is an atom, this can only be true if every event in E has $\uparrow X$ as its agent; in other words, E is made up of one or more events of the two boys walking together. This is demonstrated by (214b).

Obviously, for a transitive verb with two indefinite arguments, each of which can be interpreted in two ways, this system gives four readings:

(215) Two boys met three girls

(216) a. $\exists E \exists X \exists Y[|X|=2 \;\&\; {}^*\textsc{boy}(X) \;\&\; |Y|=3 \;\&\; {}^*\textsc{girl}(Y) \;\&\; {}^*\textsc{met}(E) \;\&\; {}^*\textsc{ag}(E)(\uparrow X) \;\&\; {}^*\textsc{th}(E)(\uparrow Y)]$

b.
$$\begin{tikzcd}[arrows=dash] X & E & Y \\ \uparrow(x_1 \sqcup x_2) \arrow[r] & e_1 \arrow[r] & \uparrow(y_1 \sqcup y_2 \sqcup y_3) \end{tikzcd}$$

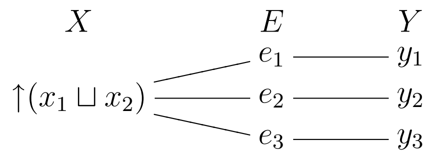
The LF in (216a) provides the collective/collective reading: the two boys, as a group, met the three girls, as a group. Since both the agent and the theme are atomic groups, this interpretation can be satisfied by an atomic event representing a single meeting, as in (216b).

(217) a. $\exists E \exists X \exists Y[|X|=2 \;\&\; {}^*\textsc{boy}(X) \;\&\; |Y|=3 \;\&\; {}^*\textsc{girl}(Y) \;\&\; {}^*\textsc{met}(E) \;\&\; {}^*\textsc{ag}(E)(X) \;\&\; {}^*\textsc{th}(E)(\uparrow Y)]$

b.
$$\begin{tikzcd}[arrows=dash] X & E & Y \\ x_1 \arrow[r] & e_1 \arrow[dr] & \\ x_2 \arrow[r] & e_2 \arrow[r] & \uparrow(y_1 \sqcup y_2 \sqcup y_3) \end{tikzcd}$$

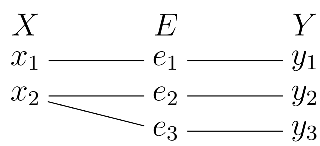
In (217a) we have the distributive/collective reading. The theme, $\uparrow Y$, is an atom and cannot be broken apart, so each of the meeting events must be a meeting of all three girls, as a group. The agent is a sum, which means that for each of it members, there must be a meeting event. Thus, there have to be at least two meetings, one for each boy. This can be seen in (217b).

(218) a. $\exists E \exists X \exists Y[|X|=2\ \&\ {}^*\textsc{boy}(X)\ \&\ |Y|=3\ \&\ {}^*\textsc{girl}(Y)\ \&\ {}^*\textsc{met}(E)\ \&\ {}^*\textsc{ag}(E)(\uparrow X)\ \&\ {}^*\textsc{th}(E)(Y)]$

b. 

Similar in nature to (217a), (218a) is the collective/distributive reading. The two boys, as a group, met the three girls in at least three different meetings (218b).

(219) a. $\exists E \exists X \exists Y[|X|=2\ \&\ {}^*\textsc{boy}(X)\ \&\ |Y|=3\ \&\ {}^*\textsc{girl}(Y)\ \&\ {}^*\textsc{met}(E)\ \&\ {}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)]$

b. 

The most interesting of the readings is (219a), in which both arguments are interpreted as sums. In this case, E must be such that it is made up of meeting events, such that for each of the boys, there is an event that he is the agent of, and for each of the girls, there is an event she is the theme of. In other words, this is the cumulative reading. It would be true, if there was an event e_1 such that the first boy met one girl, an event e_2 such that the second boy met another girl, and an event e_3 such that either boy met the third girl. (219b) demonstrates this reading.

Scoped Readings So far, I have shown how the theory in Landman (2000) can generate a variety of different scopeless readings for (215). In these readings, there is no direct relationship between the two verbal arguments; they are only related to each other indirectly through the relationship of each to E. But these readings only represent a subset of the available readings for (215). For example, it is well known that it is possible to use (215) to mean that each boy met three, possibly different, girls. To achieve such a reading, it is necessary to augment the system given so far with a second form of distributivity, which allows for a scopal relationship between the a scope mechanism. The details of Landman's exact implementation of scope readings are unimportant for current purposes[6]. What is important is that scopal readings are inherently distributive. We achieve this by adding an explicit statement that the property in the scope of a DP applies to each atomic part of that DP's denotation.

We can generate six scopal readings for (215), which are listed below, followed by diagrams that represent their truth conditions:

(220) a. $\exists X[|X|=2 \;\&\; {}^*\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists Y[|Y|=3 \;\&\; {}^*\textsc{girl}(Y) \;\&\; {}^*\textsc{met}(E) \;\&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(Y)]]$

b.
$$\begin{array}{ccccc}
X & & & & \\
x_1 & \text{———} & E_1 & & Y_1 \\
 & & e_1 & \text{———} & y_1 \\
 & & e_2 & \text{———} & y_2 \\
 & & e_3 & \text{———} & y_3 \\
x_2 & \text{———} & E_2 & & Y_2 \\
 & & e_4 & \text{———} & y_4 \\
 & & e_5 & \text{———} & y_5 \\
 & & e_6 & \text{———} & y_6
\end{array}$$

The first reading, (220a), scopes out the subject and interprets the object distributively as a sum. This will be true in the situation shown in (220b).

(221) a. $\exists X[|X|=2 \;\&\; {}^*\textsc{boy}(X) \;\&\; \forall x \leq X \exists Y[|Y|=3 \;\&\; {}^*\textsc{girl}(Y) \;\&\; \forall y \leq Y \exists E[{}^*\textsc{met}(E) \;\&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(y)]$

[6] Landman uses a storage system modeled after Cooper (1983), but this is just one of many implementations that have been discussed by the relevant literature. See Szabolcsi (2007) for a summary of the current state of the art of scope research.

b.

$$\begin{array}{lllll}
X & & & & \\
x_1 & \text{———} & Y_1 & & \\
 & & y_1 & \text{———} & E_1 \\
 & & y_2 & \text{———} & E_2 \\
 & & y_3 & \text{———} & E_3 \\
x_2 & \text{———} & Y_2 & & \\
 & & y_4 & \text{———} & E_4 \\
 & & y_5 & \text{———} & E_5 \\
 & & y_6 & \text{———} & E_6
\end{array}$$

A very similar result to (220a) is achieved by scoping out both arguments with the subject taking wide scope (221a)/(221b).

(222) a. $\exists Y[|Y|\!=\!3\ \&\ {}^{*}\textsc{girl}(Y)\ \&\ \forall y\!\leq\!Y\exists E\exists X[|X|\!=\!2\ \&\ {}^{*}\textsc{boy}(X)\ \&$
$\quad {}^{*}\textsc{met}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)\ \&\ {}^{*}\textsc{th}(E)(y)]]$

b.

$$\begin{array}{lllll}
Y & & & & \\
y_1 & \text{———} & E_1 & & X_1 \\
 & & e_1 & \text{———} & x_1 \\
 & & e_2 & \text{———} & x_2 \\
y_2 & \text{———} & E_2 & & X_2 \\
 & & e_3 & \text{———} & x_3 \\
 & & e_4 & \text{———} & x_4 \\
y_3 & \text{———} & E_3 & & X_3 \\
 & & e_5 & \text{———} & x_5 \\
 & & e_6 & \text{———} & x_6
\end{array}$$

In (222a) we see the inverse of (220a), in that the object scopes out, while the subject is interpreted distributively *in-situ*. (222b) shows a scenario that makes this reading true.

(223) a. $\exists Y[|Y|\!=\!3\ \&\ {}^{*}\textsc{girl}(Y)\ \&\ \forall y\!\leq\!Y\exists X[|X|\!=\!2\ \&\ {}^{*}\textsc{boy}(X)\ \&$
$\quad \forall x\!\leq\!X\exists E[{}^{*}\textsc{met}(E)\ \&\ {}^{*}\textsc{ag}(E)(x)\ \&\ {}^{*}\textsc{th}(E)(y)]$

b.

$$
\begin{array}{lllll}
Y & & & & \\
y_1 & \rule{3em}{0.4pt} & X_1 & & \\
 & & x_1 & \rule{3em}{0.4pt} & E_1 \\
 & & x_2 & \rule{3em}{0.4pt} & E_2 \\
y_2 & \rule{3em}{0.4pt} & X_2 & & \\
 & & x_3 & \rule{3em}{0.4pt} & E_3 \\
 & & x_4 & \rule{3em}{0.4pt} & E_4 \\
y_3 & \rule{3em}{0.4pt} & X_3 & & \\
 & & x_5 & \rule{3em}{0.4pt} & E_5 \\
 & & x_6 & \rule{3em}{0.4pt} & E_6
\end{array}
$$

Just as (221a) is very similar to (220a), scoping out both arguments with the object taking wider scope, as in (223a) and (223b), gives a similar result to (222a). In fact, if there are no other scope-taking elements in the sentence, it is not clear how to distinguish a reading where both arguments scope out and a reading where one scopes out and the other is interpreted as a sum.

(224) a. $\exists X[|X|=2 \;\&\; {}^{*}\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists Y[|Y|=3 \;\&\; {}^{*}\textsc{girl}(Y) \;\&\; {}^{*}\textsc{met}(E) \;\&\; {}^{*}\textsc{ag}(E)(x) \;\&\; {}^{*}\textsc{th}(E)(\uparrow Y)]]$

b.

$$
\begin{array}{lllll}
X & & & & \\
x_1 & \rule{3em}{0.4pt} & E_1 & & \quad\; Y_1 \\
 & & e_1 & \rule{3em}{0.4pt} & \uparrow(y_1 \sqcup y_2 \sqcup y_3) \\
x_2 & \rule{3em}{0.4pt} & E_2 & & \quad\; Y_2 \\
 & & e_2 & \rule{3em}{0.4pt} & \uparrow(y_4 \sqcup y_5 \sqcup y_6)
\end{array}
$$

A different option is available in (224a), wherein the subject scopes out and the object is interpreted collectively, as shown in (224b).

(225) a. $\exists Y[|Y|=3 \;\&\; {}^{*}\textsc{girl}(Y) \;\&\; \forall y \leq Y \exists E \exists X[|X|=2 \;\&\; {}^{*}\textsc{boy}(X) \;\&\; {}^{*}\textsc{met}(E) \;\&\; {}^{*}\textsc{ag}(E)(\uparrow X) \;\&\; {}^{*}\textsc{th}(E)(y)]]$

b. $$\begin{array}{lllll} Y & & & & \\ y_1 & \text{———} & E_1 & & X_1 \\ & & e_1 & \text{———} & \uparrow(x_1 \sqcup x_2) \\ y_2 & \text{———} & E_2 & & X_2 \\ & & e_2 & \text{———} & \uparrow(x_3 \sqcup x_4) \\ y_3 & \text{———} & E_3 & & X_3 \\ & & e_3 & \text{———} & \uparrow(x_5 \sqcup x_6) \end{array}$$

Finally, (225a) has the object take wide scope and the subject be interpreted collectively (225b).

5.1.2.3 Singular DPs

The treatment of singular indefinites in this system is relatively straightforward. They are similar to plural indefinites, except that the existential statement ranges over atoms. This of course means that there is no meaningful sum/group ambiguity, giving only one meaning per singular DP:

(226) $[\![\textit{a boy}]\!] = \lambda\phi_{\langle e,t\rangle}\exists x[\textsc{boy}(x)\ \&\ \phi(x)]$

Using the same tools as before, we can generate the following readings for (227)[7]:

(227) A boy met three girls.

(228) a. $\exists E\exists x\exists Y[\textsc{boy}(x)\ \&\ |Y|{=}3\ \&\ {}^*\textsc{girl}(Y)\ \&\ {}^*\textsc{met}(E)\ \&$
$^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(Y)]$

b. $$\begin{array}{lllll} & & E & & Y \\ & & e_1 & \text{———} & y_1 \\ x & \begin{array}{l} / \\ \text{—} \\ \backslash \end{array} & e_2 & \text{———} & y_2 \\ & & e_3 & \text{———} & y_3 \end{array}$$

(229) a. $\exists Y[|Y|{=}3\ \&\ {}^*\textsc{girl}(Y)\ \&\ \forall y{\leq}Y\exists E\exists x[\textsc{boy}(x)\ \&\ {}^*\textsc{met}(E)\ \&$
$^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(y)]]$

[7]This is obviously only a subset of the readings available. Specifically, since a singular taking wide scope does not introduce co-variation, there is no effect of scoping *a boy* out in this sentence. This should not be taken as an indication that the scope mechanism cannot apply to singular indefinites. It can.

b.
$$\begin{array}{ccccc} & & E & & Y \\ x & \text{———} & e_1 & \text{———} & \uparrow(y_1 \sqcup y_2 \sqcup y_3) \end{array}$$

(230) a. $\exists E \exists x \exists Y[\textsc{boy}(x) \;\&\; |Y|{=}3 \;\&\; {}^*\textsc{girl}(Y) \;\&\; {}^*\textsc{met}(E) \;\&$
$\quad {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(\uparrow Y)]$

b.
$$\begin{array}{ccccc} y_1 & \text{———} & E_1 & & \\ & & e_1 & \text{———} & x_1 \\ y_2 & \text{———} & E_2 & & \\ & & e_2 & \text{———} & x_2 \\ y_3 & \text{———} & E_3 & & \\ & & e_3 & \text{———} & x_3 \end{array}$$

Singular universals (*every boy*, *each boy*) pose a more interesting problem. I assume that they have standard semantics, as in (231):

(231) $[\![\textit{every boy}]\!] = \lambda\phi_{\langle e,t\rangle}\forall x[\textsc{boy}(x) \rightarrow \phi(x)]$

Landman (2000) stipulates a rule called **the event type principle**, which lays out what different types of DPs can do. According to this rule, *every* DPs cannot be entered into event types, while other DPs, such as indefinites and non-quantificational DPs like proper names, can. This means that the only interpretive option for quantificational DPs is the scopal reading[8]. Thus, (232) has exactly four possible readings:

(232) Every boy met three girls.

(233) a. $\forall x[\textsc{boy}(x) \rightarrow \exists E \exists Y[|Y|{=}3 \;\&\; {}^*\textsc{girl}(Y) \;\&\; {}^*\textsc{met}(E)$
$\quad \&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(Y)]]$

b.
$$\begin{array}{ccccc} X & & & & \\ x_1 & \text{———} & E_1 & & Y_1 \\ & & e_1 & \text{———} & y_1 \\ & & e_2 & \text{———} & y_2 \\ & & e_3 & \text{———} & y_3 \\ x_2 & \text{———} & E_2 & & Y_2 \\ & & e_4 & \text{———} & y_4 \\ & & e_5 & \text{———} & y_5 \\ & & e_6 & \text{———} & y_6 \\ \vdots & & \vdots & & \vdots \end{array}$$

[8] A similar constraint, though formulated in a very different theory, can be found in Schein (1993).

(234) a. $\forall x[\textsc{boy}(x) \rightarrow \exists E \exists Y[|Y|=3\ \&\ {}^*\textsc{girl}(Y)\ \&\ {}^*\textsc{met}(E)$
$\&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(\uparrow Y)]]$

b.
$$\begin{array}{lllll}
X & & & & \\
x_1 & \text{———} & E_1 & & Y_1 \\
 & & e_1 & \text{———} & \uparrow(y_1 \sqcup y_2 \sqcup y_3) \\
x_2 & \text{———} & E_2 & & Y_2 \\
 & & e_2 & \text{———} & \uparrow(y_4 \sqcup y_5 \sqcup y_6) \\
\vdots & & \vdots & & \vdots
\end{array}$$

(235) a. $\forall x[\textsc{boy}(x) \rightarrow \exists Y[|Y|=3\ \&\ {}^*\textsc{girl}(Y)\ \&\ \forall y \leq Y \exists E[{}^*\textsc{met}(E)$
$\&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(y)]]]$

b.
$$\begin{array}{lllll}
X & & & & \\
x_1 & \text{———} & Y_1 & & \\
 & & y_1 & \text{———} & E_1 \\
 & & y_2 & \text{———} & E_2 \\
 & & y_3 & \text{———} & E_3 \\
x_2 & \text{———} & Y_2 & & \\
 & & y_4 & \text{———} & E_4 \\
 & & y_5 & \text{———} & E_5 \\
 & & y_6 & \text{———} & E_6 \\
\vdots & & \vdots & & \vdots
\end{array}$$

(236) a. $\exists Y[|Y|=3\ \&\ {}^*\textsc{girl}(Y)\ \&\ \forall y \leq Y \forall x[\textsc{boy}(x) \rightarrow \exists E[{}^*\textsc{met}(E)$
$\&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(y)]]]$

b.
$$\begin{array}{lllll}
Y & & & & \\
y_1 & \text{———} & x_1 & \text{———} & E_1 \\
 & & x_2 & \text{———} & E_2 \\
 & & \vdots & & \vdots \\
y_2 & \text{———} & x_1 & \text{———} & E_3 \\
 & & x_2 & \text{———} & E_4 \\
 & & \vdots & & \vdots \\
y_3 & \text{———} & x_1 & \text{———} & E_5 \\
 & & x_2 & \text{———} & E_6 \\
 & & \vdots & & \vdots
\end{array}$$

While Landman later goes on to revise and justify the part of the event type principle that allows non-quantificational DPs to be interpreted *in-situ*, he never provides an explanation for the prohibition on *in-situ* universals. However, the system given so far does in fact give a good reason against *it-situ* readings of *every* DPs arising. To see this, let us look at a simpler sentence:

(237) Every boy walked.

An *in-situ* reading of (237) would be as given in (238a). It would be true in the situation shown in diagram (238b):

(238) a. $\exists E \forall x[\textsc{boy}(x) \rightarrow^{*} \textsc{walk}(E)\ \&\ {}^{*}\textsc{ag}(E)(x)]$

b.
$$\begin{tikzcd} x_1 \arrow[dr, dash] & \\ x_2 \arrow[r, dash] & E \\ x_3 \arrow[ur, dash] & \\ \vdots & \end{tikzcd}$$

But note that the only way an atomic entity like x_1 can be the agent of E is if every part of E has x_1 as its agent. Since roles are required to be unique, this means that it is impossible for both x_1 and x_2 to be both, separately, the agents of E, as (238a) requires. Thus, leaving *every boy in-situ* leads to a contradiction except for the special case where there is exactly one boy.

It is not necessary, therefore, to have a special constraint to rule out (238a); rather, it is possible to assume it is just a highly marked reading that is never actually used, when the more appropriate scopal readings are readily available.

5.1.3 Section summary

In this section, I detailed some of the key features of Landman's (2000) theory of plurality. But Landman does not address bare plurals. I will extend the theory to account for them in the next section.

5.2 Adding Bare Plurals

In chapter 3, section 3.3, I have shown that much of the literature on bare plurals treats them as denoting predicates, and derives their existential force either from a time-shifter or from a composition rule that provides (low-scope) existential closure. I will take a similar approach here.

Let us take (239) as a simple example of a sentence involving an existential bare plural argument:

(239) Boys walked.

The meaning of *walk* has already been given above:

(211) $[\![walk]\!] = \lambda X \lambda E[{}^{*}\textsc{walk}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)]$

Let us say, then, that the denotation of *boys* is a predicate, as follows:

(240) $[\![boys]\!]$ (first attempt) $= \lambda x[\textsc{boy}(x)]$

Obviously, the two cannot combine by functional application. We therefore need a type-shifter that will change the meaning of (240) via existential closure. But standard existential closure will give the wrong result:

(241) **Bare Plural Existential Closure, first attempt:**

$\lambda x[\phi(x)] \Rightarrow \lambda\psi_{\langle e,t\rangle}\exists x[\phi(x)\ \&\ \psi(x)]$

The simple reason is that this type-shifter ends up giving us an existential statement about atoms. Using it, (239) would get the LF in (242) (after event existential closure applies as well, of course):

(242) $\exists E \exists x[\textsc{boy}(x)\ \&\ {}^{*}\textsc{walk}(E)\ \&\ {}^{*}\textsc{ag}(E)(x)]$

In other words, this gives bare plurals identical semantics to singular indefinites. But we have already seen in chapter 2 that an approach that argues that bare plurals are identical to singulars cannot account for the full range of data. Instead, I suggest that bare plurals denote pluralized predicates. Instead of (240), *boys* denotes (243):

(243) $[\![boys]\!]$ (second attempt) $= \lambda X[^{*}\textsc{boy}(X)]$

The type shifter will also need to be changed appropriately[9]:

(244) **Bare Plural Existential Closure, second attempt:**

$\lambda X[^{*}\phi(X)] \Rightarrow \lambda\psi_{\langle e,t\rangle}\exists X[^{*}\phi(X)\ \&\ \psi(X)]$

Now, we get the following LF for (239):

(245) $\exists E \exists X[^{*}boy(X)\ ve^{*}\textsc{walk}(E)\ \&\ ^{*}\textsc{ag}(E)(X)]$

This approach has a few immediate advantage over the semantics in (242). The first is that it allows us to explain Roberts's (1990) observation about phrases such as *similar wives*. *similar* can be taken to be a predicate that ranges only over non-atoms[10]. Giving *boys* a denotation such as (240) would cause *similar boys* to denote the empty set. (243), on the other hand, would be the set of all non-atomic sums of similar boys.

Furthermore, a semantics such as (243) explains the patterns shown in chapter 2, section 2.3.2. By giving bare plurals the same semantic form as *in-situ* distributive indefinites (minus a multiplicity condition), it is predicted that as long as all other plurals are interpreted in this fashion, a cumulative reading shall arise.

In the next chapter, it will be shown how it is exactly these semantics for bare plurals that cause the derivation of the multiplicity implicature.

[9] It is also possible that the bare plural itself denotes a predicate over individuals like in (240), but that the type shifter introduces the * operator. I cannot see any advantage of doing it that way, and giving *boys* the denotation in (243) opens the possibility of decomposing it further into a singular predicate *boy* and a pluralizer *-s*, and therefore seems like the superior option.

[10] Though see Barker (To Appear).

5.3 Chapter Summary

In this chapter, I presented a formal system, based on Landman (2000), for the semantics of plurals. I have shown how this system derives a wide array of readings. I have then shown how to extend this system to include bare plurals, by having them denote pluralized predicates. Combined with a local type-shifter, this gives them only one possible interpretation, which is always interpreted *in-situ*, and is number-neutral, but at the same time of the same semantic type as non-bare plurals. This allows them to combine with adjectives such as *similar*, and also explains why they form cumulative readings. It will also form the basis for the theory of the multiplicity implicature given in the next chapter.

CHAPTER 6

CALCULATING THE MULTIPLICITY IMPLICATURE

6.0 Overview

In chapter 2, section 2.4.2, I have shown that the multiplicity condition displays the behavior of a scalar implicature. Now that we have a formal framework in hand, it is time that we have assigned a semantics to the bare plural, and show how this implicature is calculated.

This chapter is divided into three parts. In 6.1, I lay out a theory of scalar implicature, which is based to a larger extent on Chierchia (2004) and Chierchia (2006). Section 6.2 shows how the combination of this theory with the formal framework developed in chapter 5 gives rise to the multiplicity condition and explains its behavior. This section also discusses the implications this has on the semantics of the DPs with which the bare plurals interact, such as DPs headed by *all*, *most*, and *every*. Finally, section 6.3 compares this theory to the theories proposed by Sauerland et al. (2005) and Spector (2007), who also argue that the multiplicity condition is an implicature, but offer different means of calculating it, arguing that my theory can explain a wider range of data than either.

6.1 A theory of implicature

The notion of scalar implicature was first introduced by Horn (1972) as an elaboration of the Gricean theory of implicature (Grice 1975). A scalar implicature is a conversational implicature that is calculated on the basis of the first clause of Grice's maxim of quantity, which states that speakers should be maximally informative. It involves the following reasoning: if two sentences can be compared on some specified scale of informativeness, it is preferable to state the stronger, or more informative, sentence. Thus, if a speaker utters the weaker (less informative) of the two sentences, it is because they are unable to truthfully state the stronger one. In most cases, the conclusion is that this is because the stronger sentence is false. For example, compare the following two statements:

(246) a. Some of the apples are rotten.

b. All of the apples are rotten.

The sentence in (246a) is underspecified. It contains no information as to exactly how many apples are rotten; any amount would make it true. (246b), however, is only true when all the salient applies are rotten. Thus, if it is indeed true that all the apples are rotten, both (246a) and (246b) can be uttered truthfully; in this case, (246b), being more informative, is the more cooperative choice. Under the assumption that the speaker is maximally cooperative, then, an utterance of (246a) implies that choice was not available, and thus that (246b) must be false. This is the scalar implicature.

There are many different implementations of the calculation of scalar implicatures, and it is beyond the scope of this paper to survey them[1]. Instead, I will focus on one system, inspired almost entirely by Chierchia (2004, 2006), though somewhat simplified.

[1]See Horn (2004, 2005) for a broader view than presented here, though neither article is a complete survey.

What makes Chierchia's approach particularly suited for current purposes is that it is based on the notion that scalar implicatures are computed both recursively and compositionally, in conjunction with the computation of asserted meaning. Instead of being calculated just at the end of semantic computation, they are calculated at various points in the semantic derivation. According to Chierchia, the relevant points are the scope sites – before the addition of each scoping operator. Later, we will see that an addition calculation point occurs before the application of existential closure of events.

At each calculation site, the current logical form is compared against its alternatives. At any such point, it is determined which of the alternatives are weaker (and thus entailed by) the logical form at hand, and which alternatives are stronger. By choosing to use a particular alternative, the speaker signals that he believes that *only* it, and the alternatives weaker than it, are true, and none of the stronger alternatives are.

To demonstrate this system, it is easiest to use a simple scale. Below, I will use numerals. For the sake of this example, let us focus on only three elements in the scale (obviously, this is an oversimplification, but it is all that is necessary for demonstrating the principles of Chierchia's system that will be relevant later):

(247) one $\ll$ two $\ll$ three

For instance, take (248a). It can be represented, somewhat informally, by the LF in (248b):

(248) a. Two men laughed.

b. $\exists E \exists X[|X| \geq 2 \;\&\; {}^{*}\textsc{men}(X) \;\&\; {}^{*}\textsc{laugh}(E) \;\&\; {}^{*}\textsc{ag}(E)(X)]$

Using the scale in (247), it is possible to calculate the following alternative set for (248b):

(249) $[\![\exists E \exists X[|X| \geq 2 \;\&\; {}^*\textsc{men}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(X)]]\!]^{ALT} =$
$\{\exists E \exists X[|X| \geq 3 \;\&\; {}^*\textsc{men}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(X)],$
$\exists E \exists X[|X| \geq 2 \;\&\; {}^*\textsc{men}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(X)],$
$\exists E \exists X[|X| \geq 1 \;\&\; {}^*\textsc{men}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(X)]\}$

By uttering the sentence (248a), the speaker signals that she thinks all the alternatives in (248b) stronger than (248b) are false. There is one such alternative, the one which states $|X| \geq 3$. Thus, its negation is added, by conjunction, to (248b), giving the following enriched meaning:

(250) $\exists E \exists X[|X| \geq 2 \;\&\; {}^*\textsc{student}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(X)] \;\&$
$\neg \exists E \exists X[|X| \geq 3 \;\&\; {}^*\textsc{student}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(X)]$

Of course, (248a) is a relatively simple case. It only features a DP and a predicate, and thus does not allow for any scopal interactions. The true strength of Chierchia's system is how it handles the more complex cases. For example, let us consider (251):

(251) Every student laughed at two professors.

Sentences such as (251) imply that each student laughed at exactly two of his professors. In Chierchia's system, this fact follows straightforwardly from the fact that, as seen in the previous chapter, *every student* must be interpreted via a scopal mechanism. According to Chierchia, the alternatives are compared before each scopal element, as well as at the root level. What makes Chierchia's approach unique is that it does not simply calculate the implicature multiple times. Rather, at each scopal point, the semantic derivation splits to two branches.

The first comparison point is the logical form we have just before *every student* is applied. At this point, we have a LF as given in (252):

(252) $\lambda y \exists E \exists X[|X| \geq 2 \;\&\; {}^*\textsc{prof}(X) \;\&\; {}^*\textsc{laugh}(E) \;\&\; {}^*\textsc{ag}(E)(y) \;\&\; {}^*\textsc{at}(E)(X)]$

At this point, the calculation path splits. The first path involves calculating the alternative set here. Again, the scalar element here is *two*, and the scale in (247) will serve for illustration purposes. The alternative set for (252) is as follows:

(253) $[\![\lambda y \exists E \exists X[|X| \geq 2\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh}(E)\ \&\ {}^{*}\textsc{ag}(E)(y)\ \&$
$^{*}\textsc{at}(E)(X)]]\!]^{ALT} =$
$\{\lambda y \exists E \exists X[|X| \geq 3\ \&\ {}^{*}\textsc{prof}(X) \ldots],$
$\lambda y \exists E \exists X[|X| \geq 2\ \&\ {}^{*}\textsc{prof}(X) \ldots],$
$\lambda y \exists E \exists X[|X| \geq 1\ \&\ {}^{*}\textsc{prof}(X) \ldots]\}$

Here we are dealing with predicates rather than sentence meanings, but they still can be compared on a scale. The denotation of the alternative involving *two* is a superset of the alternative involving $|X| \geq 3$, and the $|X| \geq 1$-alternative is a superset of the $|X| \geq 2$-alternative. Thus, the $|X| \geq 3$-alternative is a stronger meaning than the utterance, and must be ruled out, giving the enriched meaning in (254):

(254) $\lambda y \exists E \exists X[|X| \geq 2\ \&\ \neg(|X| \geq 3)\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh}(E)\ \&\ {}^{*}\textsc{ag}(E)(y)\ \&$
$^{*}\textsc{at}(E)(X)]$

Now it is time to apply *every student* to the enriched meaning, giving the LF in (255):

(255) $\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 2\ \&\ \neg(|X| \geq 3)\ \&\ {}^{*}\textsc{prof}(X)\ \&$
$^{*}\textsc{laugh}(E)\ \&\ {}^{*}\textsc{ag}(E)(y)\ \&\ {}^{*}\textsc{at}(E)(X)]]$
'Every student laughed at exactly two professors'

Since scalar comparison has already happened in this path, we have our first possible LF for the entire sentence.

But remember that there is another path. In that branch of the semantic derivation, we apply *every student* to the unenriched meaning in (252):

(256) $\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 2 \ \& \ {}^*\textsc{prof}(X) \ \& \ {}^*\textsc{laugh}(E) \ \&$
$^*\textsc{ag}(E)(y) \ \& \ {}^*\textsc{at}(E)(X)]$

Here, scalar alternatives were not yet calculated. Thus, it is time to calculate the alternatives set to (256):

(257) $[\![\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 2 \ \& \ {}^*\textsc{prof}(X) \ \& \ {}^*\textsc{laugh}(E) \ \&$
$^*\textsc{ag}(E)(y) \ \& \ {}^*\textsc{at}(E)(X)]]]\!]^{ALT} =$
$\{\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 3 \ \& \ {}^*\textsc{prof}(X) \ldots]],$
$\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 2 \ \& \ {}^*\textsc{prof}(X) \ldots]],$
$\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 1 \ \& \ {}^*\textsc{prof}(X) \ldots]]\}$

The alternative involving $|X| \geq 3$ means that every student laughed at three professors. This is a stronger claim than the statement that every student laughed at two or more professors, which is stronger than the one involving $|X| \geq 1$. Thus, here too, we can derive an enriched meaning by canceling the stronger alternative:

(258) $\forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 2 \ \& \ {}^*\textsc{prof}(X) \ \& \ {}^*\textsc{laugh}(E) \ \&$
$^*\textsc{ag}(E)(y) \ \& \ {}^*\textsc{at}(E)(X)]] \ \&$
$\neg \forall y[\textsc{student}(y) \rightarrow \exists E \exists X[|X| \geq 3 \ \& \ {}^*\textsc{prof}(X) \ \& \ {}^*\textsc{laugh}(E) \ \&$
$^*\textsc{ag}(E)(y) \ \& \ {}^*\textsc{at}(E)(X)]]$
'Every student laughed at two or more professors, and it is not the case that all the students laughed at more than two professors'

We now have now derived two different enriched meanings, based on whether the scalar alternatives were calculated before, or after, *every student* was applied:

(255) *'Every student laughed at exactly two professors'*

(258) *'Every student laughed at two or more professors, and it is not the case that all the students laughed at more than two professors'*

In order to decide which enriched meaning the sentence actually has, Chierchia offers the following principle:

(259) In enriching a meaning, accord preference to the strongest option (if there is nothing in the context/common ground that prevents doing so).

Since (258) only rules out a case where all the students laugh at more than two professors, while (255) rules out all the cases where any students laugh at more than two professors, the latter is the stronger of the two enriched meanings, and thus it wins out as the overall sentence meaning.

It may seem that this theory is somewhat redundant. After all, (255) was already calculated as the result of the first path taken. Why should we bother to calculate a second enriched meaning only to discard it? The reason is that this ensures proper interaction with downwards entailing environments. Take the following sentence:

(260) No student laughed at two professors.

At the first scopal point, (260) is identical in its LF to (251). Thus, its enriched LF is (254), and after *no students* is applied, we get the following meaning:

(261) $\neg\exists y[\textsc{student}(y)\ \&\ \exists E\exists X[|X|\geq 2\ \&\ \neg(|X|\geq 3)\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh}(E)\ \&\ {}^{*}\textsc{ag}(E)(y)\ \&\ {}^{*}\textsc{at}(E)(X)]]$

'No student laughed at exactly two the professors

But this is an unwelcome enrichment; it is actually weaker than the intended meaning of the sentence, as (261) is true if some, or even all, of the students laughed at three or more professors, while normally (260) is taken to be false in that circumstance.

However, the path that postpones the implicature calculation gives a different result. First, we apply *no students*, and then generate the alternatives to the resulting LF. We now have the following alternative set:

(262) $[\![\neg\exists y[\textsc{student}(y) \rightarrow \exists E\exists X[|X|\geq 2\ \&\ {}^*\textsc{prof}(X)\ \&\ {}^*\textsc{laugh}(E)\ \&$
$^*\textsc{ag}(E)(y)\ \&\ {}^*\textsc{at}(E)(X)]]]\!]^{ALT} =$
$\{\neg\exists y[\textsc{student}(y) \rightarrow \exists E\exists X[|X|\geq 3\ \&\ {}^*\textsc{prof}(X)\ldots]],$
$\neg\exists y[\textsc{student}(y) \rightarrow \exists E\exists X[|X|\geq 2\ \&\ {}^*\textsc{prof}(X)\ldots]],$
$\neg\exists y[\textsc{student}(y) \rightarrow \exists E\exists X[|X|\geq 1\ \&\ {}^*\textsc{prof}(X)\ldots]]\}$

Because the scalar element is in the scope of negation, the strongest alternative is the one involving $|X| \geq 1$ (no students laughing at two or more professors may be true even if no students laughing at any professors is false, but not vice versa). We thus get the following enrichment:

(263) $\neg\exists y[\textsc{student}(y)\ \&\ \exists E\exists X[|X|\geq 2\ \&\ {}^*\textsc{prof}(X)\ \&\ {}^*\textsc{laugh}(E)\ \&$
$^*\textsc{ag}(E)(y)\ \&\ {}^*\textsc{at}(E)(X)]]\ \&$
$\neg\neg\exists y[\textsc{student}(y)\ \&\ \exists E\exists X[|X|\geq 1\ \&\ {}^*\textsc{prof}(X)\ \&\ {}^*\textsc{laugh}(E)\ \&$
$^*\textsc{ag}(E)(y)\ \&\ {}^*\textsc{at}(E)(X)]]$
'No student laughed at two professors, but it is not the case that no student laughed at any professors' =
'No student laughed at two or more professors, but some students laughed at a professor'

Again, Chierchia has us compare the two enriched meanings; this time, the one derived from postponing the implicature calculation is strongest, and thus (258) ends up being the overall sentence meaning.

To summarize, Chierchia's system is built upon two stages of comparison. The first stage involves comparing scalar items. At each scopal point, the derivation splits. In one branch, the alternative set is calculated immediately, and the rest of the sentence is then applied to the resulting enriched meaning[2]. In the other path, the scalar comparison is postponed to the next possible point. Once all possible enriched

[2]Note that in this path, the calculation will not split again. Thus, this system predicts that there will be exactly as many alternative comparisons as there are scopal points.

meanings are calculated, the second stage of comparison applies, and the strongest wins out as the overall utterance meaning.

6.2 Deriving the Multiplicity Condition

6.2.1 The basic case

As discussed above, scalar implicatures enhance the meaning of a sentence by negating a stronger alternative – either an alternative to the entire sentence, or an alternative to a meaning that arose as part of the recursive composition process to the sentence.

In chapter 2, I have argued that the basic semantics for the bare plural are number-neutral, so that a sentence such as (264a) has an assertion like (264b), which is compatible with at least one dog barking:

(264) a. Dogs are barking.

b. $\exists E \exists X[{}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)]$

If the multiplicity condition associated with bare plurals is indeed a scalar implicature, than it is necessary to show how exactly the negation of an alternative is used to enrich the meaning of (264b) such that the end result is the exclusion of a single dog barking from the meaning. To begin, we need to find a suitable alternative to *dogs*. The obvious candidate, in this case, is the singular sentence in (265):

(265) a. A dog is barking.

b. $\exists E \exists x[{}^{*}\textsc{dog}(x)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(x)]$

It should be clear that (265b) entails (264b); since the domain of plural variables such as X is a superset of the domain of atomic variables such as x, if (265b) is true, then (264b) is true. Nonetheless, (265b) is not a stronger reading than (264b). Because of the inherently cumulative nature of $^{*}\textsc{ag}(E)(X)$[3], (264b) entails (266):

(266) $\exists E \exists X[^{*}\textsc{dog}(X)\ \&\ ^{*}\textsc{bark}(E)\ \&\ \forall x \leq X[\exists e \leq E[\textsc{ag}(e)(x)]]]$

To see why this is a problem, take a situation in which two dogs, Fido and Benji, are barking. There is an event E such that $^{*}\textsc{ag}(E)(fido \sqcup benji)$; thus, (264b) is true. But, that entails (266), which in turn entails that there is an event e_1 such that $^{*}\textsc{ag}(e_1)(fido)$ and an event e_2 such that $^{*}\textsc{ag}(e_2)(benji)$. Either of these events makes (265b) true.

In other words, not only does (265b) entail (264b), but (264b) also entails (265b). Despite the difference in the type of variables involved, the two readings are actually equivalent.

Thus, if we compare alternatives at the sentence level, there is no stronger reading to negate. The "enriched" meaning at this level is exactly the same as the unenriched meaning; i.e., (264b).

However, while Chierchia's (2004, 2006) system allows for implicature calculations at scope points and at the root sentence, we are free to consider other implicature calculation points. One such point is once the event type has been calculated, but before event closure has applied[4]:

(267) $\lambda E \exists X[^{*}\textsc{dog}(X)\ \&\ ^{*}\textsc{bark}(E)\ \&\ ^{*}\textsc{ag}(E)(X)]$

(268) $\lambda E \exists x[^{*}\textsc{dog}(x)\ \&\ ^{*}\textsc{bark}(E)\ \&\ ^{*}\textsc{ag}(E)(x)]$

Here, the situation is different. Both (267) and (268) denote sets of events (both atomic and non-atomic). Taking our scenario above, we can see that E, e_1 and e_2 are members of the set in (267), but only e_1 and e_2 are members of the set in (268).

[3]See discussion in chapter 5, section 5.1.2.2.

[4]Indeed, the theory of implicature proposed in Landman (2000), which in many ways is a direct precursor to Chierchia's theory, crucially relies on implicatures being calculated at this point. Landman uses this to derive the 'exactly' implicature associated with numerical DPs, in sentences where these are involved in cumulative readings. As far as I can tell, my theory as laid out below is compatible with Landman's calculations.

Here, there is a scalar relationship ((268) is a subset of (267)) between the two sets. This allows us to derive the enriched meaning (269):

(269) $\lambda E \exists X[{}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)]\ \&$
$\neg\exists x[{}^{*}\textsc{dog}(x)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(x)] =$
$\lambda E \exists X[{}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)\ \&\ \neg\exists x[x = X]] =$
$\lambda E \exists X[|X|>1\ \&\ {}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)]$[5]

Applying existential closure, we now get the following enriched meaning, as desired:

(270) $\exists E \exists X[|X|>1\ \&\ {}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)]$

The final step is to compare the enriched meaning in (270) with the enriched meaning after existential closure applies. The fact that there is no actual enrichment at the later stage does not matter; (270) can still be compared to (264b). Since (270) is clearly a stronger reading than (264b), it wins, and the sentence thus gets the meaning "more than one dog barked".

6.2.2 A downwards entailing sentence

Following the same principles as before, it is simple to show that this system provides the correct meaning in downwards entailing contexts as well[6]. Consider (271):

(271) It is not the case that dogs are barking.

We follow the same procedure as above. The event type is the same as the event type for the positive case (264a), and thus the first calculation point provides the same enriched event type as (269) above:

(272) $\lambda E \exists X[|X|>1\ \&\ {}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(E)\ \&\ {}^{*}\textsc{ag}(E)(X)]$

[5] To see that this equivalence holds, note that $\exists X[|X|>1]$ is equivalent to $\exists X[\neg\exists x[x = X]]$.

[6] For readability purposes, from now on I will leave out intermediate steps from the calculations that do not add anything new compared to the derivations detailed above. Fully explicit versions of these calculations can be found in appendix B.

Existential closure and negation then applied, giving the first potential enriched sentence meaning:

(273) $\exists E \exists X[|X|>1 \ \& \ {}^{*}\textsc{dog}(X) \ \& \ {}^{*}\textsc{bark}(E) \ \& \ {}^{*}\textsc{ag}(E)(X)]$

The second potential calculation point is after the application of existential closure:

(274) $\neg\exists E \exists X[{}^{*}\textsc{dog}(X) \ \& \ {}^{*}\textsc{bark}(E) \ \& \ {}^{*}\textsc{ag}(E)(X)]$

As seen above, there are no stronger alternatives, giving nothing to negate. After sentential negation is applied, the second potential sentence meaning is (275):

(275) $\neg\exists E \exists X[{}^{*}\textsc{dog}(X) \ \& \ {}^{*}\textsc{bark}(E) \ \& \ {}^{*}\textsc{ag}(E)(X)]$

The third calculation point is the sentence root:

(276) $\neg\exists E \exists X[{}^{*}\textsc{dog}(X) \ \& \ {}^{*}\textsc{bark}(E) \ \& \ {}^{*}\textsc{ag}(E)(X)]$

Just like the positive case, there is no stronger alternative. Thus, the third potential sentence meaning is (276), which is identical to (275). (275)/(276) is compared to the potential meaning in (273). It is easy to see that (273) is weaker – it is true if no more than one dog is barking, while the other readings are only true if no dogs are barking at all. Thus, (275)/(276) wins out as the sentence reading, giving us a sentence with no multiplicity condition.

6.2.3 Sentences with another plural argument and dependent readings

Now that we have seen how the multiplicity implicature is calculated in simple with a single bare plural argument, as well as why it fails to arise in downwards entailing sentences, it is time to show how this account works for sentences that get dependent readings. In fact, the calculation is pretty straightforward. Let us take the following sentence:

(277) Five boys flew kites.

There are several options for the interpretation of the subject *five boys*. As seen in chapter 5, unlike the bare plural object which can only be interpreted distributively and *in-situ*, the numerical indefinite can be interpreted in three ways: *in-situ* distributively, *in-situ* collectively, and scopally. Let us look at them in turn:

6.2.3.1 *In-situ* distributive reading

First, we calculate the event type, which is given below:

(278) $\lambda E \exists X \exists Y[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; {}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(X) \;\&\; {}^*\textsc{th}(E)(Y)]$

This is weaker than the alternative where an atomic variable is used instead of Y, so this alternative is negated, existential closure is applied and the following enriched meaning is arrived at:

(279) $\exists E \exists X \exists Y[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; |Y|>1 \;\&\; {}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(X) \;\&\; {}^*\textsc{th}(E)(Y)]$

Like with the simple case discussed above in section 6.2.1, once existential closure is applied, all the alternatives are equal. Thus, the other enriched meaning candidate is as follows:

(280) $\lambda E \exists X \exists Y[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; {}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(X) \;\&\; {}^*\textsc{th}(E)(Y)]$

It should be clear that (279) is stronger than (280), and thus it wins as the final sentence meaning.

But note that (280) is exactly identical to the cumulative reading of (281):

(281) a. Five boys flew at least two kites.

b. $\exists E \exists X \exists Y[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; |Y|>1 \;\&\; {}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(X) \;\&\; {}^*\textsc{th}(E)(Y)]$

This is the standard dependent plural reading: more than one kite has to have been flown overall, but no boy needs to have flown more than one kite. It is perfectly compatible with a scenario where there were one boy who had his own kite, and four boys who all took turns flying a second kite.

One thing worth clarifying is the status of the alternative that (277) is compared to. Informally, we speak of implicature calculation as being derived by comparing a sentence to other sentences involving elements on the relevant scale; for example, (277) is thought to be compared with (282):

(282) Five boys flew a kite.

However, that view is only a rough approximation. What is actually compared is sentence readings, so that the bare plural sentence is compared to the reading of (282) where both *five boys* and *a kite* are interpreted *in situ*. Nothing in the implicature calculation involves the other readings of (282). In other words, the prediction of this theory is not that a dependent reading will arise only in cases where it is impossible to use (282). Rather, it predicts that the dependent reading will arise if it impossible to use (282) to mean that there was one kite and five boys that flew it. The consequence of this is that there are scenarios (such as when each boy flew an individual kite) where it is possible to use the singular sentence in its scopal reading, but not in the *in-situ* reading, and that is sufficient to allow (277) to get a dependent reading.

6.2.3.2 ***In-situ* collective reading**

The only thing that differs between this interpretation and the one where *five boys* is interpreted distributively is the presence of a $\uparrow$ operator on X when it is passed to the role predicate; this has no effect on the implicature calculation. Thus, the resulting sentence meaning is the following:

(283) $\lambda E \exists X \exists Y[|X|=5 \;\&\; {}^{*}\textsc{boy}(X) \;\&\; |Y|>1 \;\&\; {}^{*}\textsc{kite}(Y) \;\&\; {}^{*}\textsc{flew}(E) \;\&$
$\quad {}^{*}\textsc{ag}(E)(\uparrow X) \;\&\; {}^{*}\textsc{th}(E)(Y)]$

This is a reading in which the five boys, working as a group, flew two or more kites. This is not a dependent reading in the traditional sense, matching speaker intuitions; (277) cannot be used to describe a scenario where five boys collaborated to fly a single kite.

6.2.3.3 Scopal reading

The third interpretation available to (277) is the one where the subject uses a scopal mechanism to take wide-scope.

Again, the first step is calculating the event type. Because the subject scoped out, we actually have a function from events to predicates:

(284) $\lambda E \lambda x \exists Y[{}^{*}\textsc{kite}(Y) \;\&\; {}^{*}\textsc{flew}(E) \;\&\; {}^{*}\textsc{ag}(E)(x) \;\&\; {}^{*}\textsc{th}(E)(Y)]$

Here, as before, replacing the plural variable Y with an atomic variable results in a stronger alternative. This alternative is negated, and the rest of the sentence is calculated, giving the following enriched LF:

(285) $\exists X[|X|=5 \;\&\; {}^{*}\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists Y[|Y|>1 \;\&\; {}^{*}\textsc{kite}(Y) \;\&\; {}^{*}\textsc{flew}(E) \;\&$
$\quad {}^{*}\textsc{ag}(E)(x) \;\&\; {}^{*}\textsc{th}(E)(Y)]]$

The second implicature calculation point is after existential closure applies to events. Just like in all the other cases discussed, replacing the bare plural with an atomic alternative does not result in a stronger reading, so nothing is negated, resulting in the following enriched meaning:

(286) $\exists X[|X|{=}5\ \&\ {}^{*}\textsc{boy}(X)\ \&\ \forall x{\leq}X\exists E\exists Y[{}^{*}\textsc{kite}(Y)\ \&\ {}^{*}\textsc{flew}(E)\ \&$
$\quad {}^{*}\textsc{ag}(E)(x)\ \&\ {}^{*}\textsc{th}(E)(Y)]]$

There is a third implicature calculation point, after the subject is added; however, as it also occurs after the event existential closure, there are also no stronger alternatives to the bare plural and the result is identical to (285).

The final step is comparing (284) and (285) and picking the stronger of the two. Obviously, a sentence that states that five children each flew at least two kites is stronger than a sentence that states that five children each flew at least one. Thus, (284) is the final enriched meaning of the scopal interpretation of (277).

This is, of course, a non-dependent reading. What this section shows, then, is that sentences featuring a bare plural in the scope of another plural DP are indeed ambiguous between a dependent reading and a non-dependent reading, just as originally proposed by Chomsky (1975) and Partee (1975). However, the ambiguity does not arise from an ambiguity in the bare plural itself. On the contrary, the bare plural is interpreted in exactly the same manner under all the readings discussed above. What differs is the interpretation of the plural DP subject; if it is interpreted *in-situ* distributively, a dependent reading results, while if it is interpreted scopally or collectively, we get a non-dependent reading.

6.2.3.4 A note on choice function interpretations

So far, I have treated indefinite plurals such as *five boys* as generalized quantifiers, and have assumed they take wide scope by a quantifier raising mechanism. However, since Reinhart (1997), it has been known that indefinites have readings for which this is not a plausible analysis. Rather, Reinhart and others have argued that indefinites can be interpreted as unbound choice function variables, and can attain wide scope via existential closure over these variables.

A detailed discussion of choice function readings is beyond the scope of this thesis.

However, it is worth noting that the existence of such a reading for (277) is not incompatible with the calculation of the multiplicity implicature proposed in this chapter. Winter (1997) observed that choice function indefinites can receive both collective and distributive readings, based on whether these readings are made available by the predicate, just like any other DP. Thus, it follows that the entity selected by the choice function must be a sum (which can then be modified by the group operator), and that it is the argument of a role predicate. The unenriched LF of the choice function reading of (277), therefore, is the following:

(277) Five boys flew kites.

(287) $\exists f \exists E \exists Y[{}^{*}\textsc{kite}(Y)\ \&\ {}^{*}\textsc{flew}(E)\ \&$
$\quad {}^{*}\textsc{ag}(E)(f(\{X : |X|{=}5\ \&\ {}^{*}\textsc{boy}(X)\}))\ \&\ {}^{*}\textsc{th}(E)(Y)]$

In other words, there is a choice function that selects from the set of sums of five boys, such that the sum selected by this function is the agent of the kite-flying events.

It should be obvious that, at the level of the event type, before either existential closure applies, whether or not the subject is interpreted as a choice function makes no real difference with respect to the semantics of the bare plural object. It should be equally clear that even if the choice function closure is taken to add another potential implicature calculation point, it will not introduce new alternatives, as it occurs after the existential closure over events. Thus, the multiplicity condition is expected to arise with choice function interpretations just as it is with non-choice function *in-situ* readings.

This means that the choice function reading of *five boys*, which does not involve an explicit use of the scopal mechanism, is predicted to give rise to a dependent readings for *kites*. This indeed is confirmed by speaker intuitions[7].

[7] It is worth noting that, like Reinhart (1997), I am assuming that indefinites allow both choice function readings and standard scopal readings, as the choice function mechanism itself as implemented here does not allow creating scopal dependencies.

6.2.4 Ditransitives and intervention effects

In Chapter 2, section 2.3.5, I have shown that when a singular DP scopes between a plural DP and a bare plural, a dependent reading does not arise. More precisely, the generalization was that in a sentence such as (101), if *a girl* co-varies with *two boys*, there is no dependent reading between *secrets* and *two boys*. But if *a girl* does not co-vary, then a dependent reading between the two plurals is possible.

(101) Two boys told a girl secrets.

It should be clear by now why this is the case. Simply enough, in order for *a girl* to co-vary with *two boys*, it is necessary that *two boys* outscope *a girl*. Thus, *two boys* must achieve its distributivity via the scopal mechanism. This is regardless of whether *a girl* is interpreted *in-situ* or whether it itself has scoped out. We have seen in section 6.2.3.3 that if *two boys* has scoped out of the event type, then the multiplicity condition will be trapped under it, hence no dependent reading.

In other words, it is not the presence of the singular DP that blocks the dependent reading. Rather, it is the fact that *two boys* has scoped out that rules out this reading.

6.2.5 Bare plurals in the scope of *every*

A very similar reason can be found for why sentences with a singular quantified subject do not have dependent readings:

(288) Every boy flew kites.

We have seen in chapter 5, section 5.1.2.3 that singular quantifiers such as *every boy* cannot be interpreted *in-situ*, and must always scope out of the event type. As in the case of a plural subject, if it is interpreted scopally then the multiplicity condition ends up being distributed over. What differs between the quantified singular subject and the quantified plural subject is only that the latter can remain *in-situ*, allowing for a dependent reading, while the former does not have that possibility. Thus, (288) is not ambiguous.

What is more complicated is explaining the availability of dependent readings for sentences with an *every* DP as an object:

(289) Boys flew every kite.

If *every* DPs in object position had to be interpreted scopally in the same way as *every* subjects, the prediction would be that the dependent plural reading would be unavailable as well. However, while I cannot offer a complete account of the behavior of singular quantifiers in object position, there is some evidence that indicates that they are not interpreted the same way as in subject position.

One piece of evidence comes from passivization. Imagine a scenario where an international chess tournament is held between three teams from three countries: Estonia, Fiji, and the Peru. The tournament consists of a series of games, with no game played by two players from the same team. No draws or stalemates are allowed; the game is replayed until there is a winner. At the end of the day, it turns out that the Estonian team did very poorly: no Estonian won any games. It is true in this scenario to say:

(290) The Fijians and the Peruvians won every game.

However, if (290) is passivized, the resulting sentence is judged as false:

(291) Every game was won by the Fijians and the Peruvians.

Native speakers uniformly judge that (291), unlike (290), implies that each game was won by both teams, an impossibility. When asked for a passive sentence that means the same as (290), speakers give (292):

(292) All the games were won by the Fijians and the Peruvians.

The same is true in the dependent plural case. (289) has a dependent reading, but its passive counterpart does not:

(293) Every kite was flown by boys.

However, changing *every kite* to *all the kites* gives a passive that preserves the meaning:

(294) All the kites were flown by boys.

It seems, then, that *every* in object position is interpreted in the same manner as *all* in the subject position. A second piece of evidence for this comes from May (1985). May observed that while (295a), where the *every*-DP is a subject, allows a pair-list reading, (295b), wherein the *every* DP is an object, does not:

(295) a. Which book did every student read?

b. Which student read every book?

In this, the object in (295b) again shows the same behavior as an *all* DP, which will not allow a pair-list reading in any position:

(296) a. Which book did all the students read?

b. Which student read all the books?

Neither (296a) and (296b) can be interpreted as a pair-list question.

Thus, it seems that *every*-DPs in object position are interpreted in the same manner as *all*-DPs. The reasons for this must be left for future research; however, this data does indicate that it is not the bare plural that acts differently in these cases, but the *every*-DP.

Of course, the above discussion is insufficient. All it does is equate object position *every* to *all*. As of yet, I have not yet explained how *all*-DPs get dependent readings. That will be explained below.

6.2.6 *all* and *most*

So far, the account I have presented of bare plurals and their multiplicity implicature makes the enriched meaning of the sentences resemble that of cumulative readings. A dependent reading, I have argued, arises when the bare plural and the plural DPs it "depends" on are both interpreted *in-situ*, with no scopal relationship between them. However, I have already presented an obvious challenge to this generalization. In chapter 2, section 2.3.1, I have shown that sentences involving *all*-DPs and *most*-DPs allow dependent reading for bare plurals but do not allow cumulative readings for indefinites. How is this possible, in the framework I have presented so far?

The answer lies in the denotation of *all* and *most*. The availability of dependent readings means that they must be able to be interpreted *in-situ* within the event type. If they had to be interpreted scopally, then they would be predicted to act exactly like singular quantified DPs. Another reason to argue against *all* and *most* being interpreted scopally comes from contrasts like the following:

(297) a. * Every boy met.

b. All the boys met.

A meeting event cannot involve just one participant. Therefore, it is not surprising that (297a) is bad, as it basically means that for each boy, there was an event in which he met. If *all* were to be interpreted scopally, (297b) would be just as bad. However, it is true. And furthermore, it is not only true in the case that all the boys met in one big meeting. If the boys are Bill, John and Frank, then (297b) can be true in a situation where Bill and John met on Monday, John and Frank met on Tuesday, and Bill and Frank met on Wednesday. In other words, what (297b) means is that the sum of boys was the agent of a sum of meeting events. This can be expressed by the following denotation[8]:

[8]This denotation is only a rough approximation, since, as will become apparent below, it ignores questions such as why the acceptability of (297b) is highly degraded in a scenario where Bill met

(298) $[\![\textit{all the boys}]\!] = \lambda\phi_{\langle e,t\rangle}\exists X[|X|=|\textsc{boy}| \;\&\; {}^*\textsc{boy}(X) \;\&\; {}^*\phi(X)]$

Compare this to the (non-group) denotation of *two boys* given in chapter 5:

(212a) $[\![\textit{two boys}]\!] = \lambda\phi_{\langle e,t\rangle}\exists X[|X|=2 \;\&\; {}^*\textsc{boy}(X) \;\&\; \phi(X)]$

The difference between the two, other than the cardinality, is that *all* pluralizes the predicate to which it is attached.

In order to understand the implications of this, we must first note that for any predicate ϕ, ${}^*\phi$ is the closure of ϕ under the sum operation. Therefore, by the definition of the sum operator, we know that the following equivalence is true:

(299) $\forall X\forall\phi[{}^*\phi(X) \leftrightarrow \exists\psi[\forall x\in\psi[x\leq X \;\&\; \phi(x)] \;\&$
$\neg\exists x'\leq X[\phi(x') \;\&\; \neg[x' \in \psi]]]]$

What (299) says is that, for every plural entity X and predicate ϕ such that X is a member of a ${}^*\phi$, it is possible to find a set ψ of atoms such that all and only the members of ψ are parts of X and members of ϕ. For example, if we know that ${}^*\mathrm{DOG}(X)$, then we can find a set ψ of all the atomic parts of X that are dogs. ψ can be a singleton set, if ϕ happens to be true of X itself, or it can be made of sub-parts of X. A similar equivalence holds if instead of ϕ, we have a role relation Φ between entities and events:

(300) $\forall X\forall E\forall\Phi[{}^*\Phi(E)(X) \leftrightarrow \exists\psi[\forall x\in\psi\exists E'\leq E[x\leq X \;\&\; \Phi(E')(x)] \;\&$
$\neg\exists x'\leq X\exists E''\leq E[\Phi(E'')(x') \;\&\; \neg[x' \in \psi]]]]$

By the denotation of *all* and the normal rules of an *in-situ* reading as given in chapter 5, we can tell that (301) has the logical form in (302):

(301) All the boys flew two kites.

John and John met Frank but Bill and Frank did not meet. I believe, however, that the answer to these issues will not impact the conclusions with regard to dependent plurality versus cumulativity discussed below, though showing this remains a task for future research.

(302) $\exists E \exists X[|X|=|\textsc{boy}\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*(\lambda X' \lambda E' \exists Y[{}^*\textsc{flew}(E)\ \&\ |Y|=2\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{ag}(E')(X')\ \&\ {}^*\textsc{th}(E')(Y)])(X)(E)]$

Based on the equivalence in (300), and functional application, we know this is the same as:

(303) $\exists E \exists X[{}^*\textsc{flew}(E)\ \&\ |X|=|\textsc{boy}\ \&\ {}^*\textsc{boy}(X)\ \&\ \exists \psi[\forall x \in \psi \exists E' \leq E[x \leq X\ \&\ \exists Y[{}^*\textsc{flew}(E')\ \&\ |Y|=2\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{ag}(E')(x)\ \&\ {}^*\textsc{th}(E')(Y)]]\ \&\ \neg \exists x' \leq X \exists E'' \leq E \exists Y[{}^*\textsc{flew}(E')\ \&\ |Y|=2\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{ag}(E'')(x')\ \&\ {}^*\textsc{th}(E'')(Y)]\ \&\ \neg[x' \in \psi]]]$

Or, to use an English-like paraphrase, there is a plural event E and a plurality of boys X such that there is a set ψ, each of its members is an atom x which is part of X, and of which it is true that x flew two kites. Thus, the denotation of *all* introduces a distribution over the pairs of kites that prevents a cumulative reading for (301).

But now, let us see what happens with a bare plural object:

(304) All the boys flew kites.

(305) a. $\exists E \exists X[|X|=|\textsc{boy}\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*(\lambda X' \lambda E' \exists Y[{}^*\textsc{flew}(E)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{ag}(E')(X')\ \&\ {}^*\textsc{th}(E')(Y)])(X)(E)]$

b. $\exists E \exists X[{}^*\textsc{flew}(E)\ \&\ |X|=|\textsc{boy}\ \&\ {}^*\textsc{boy}(X)\ \&\ \exists \psi[\forall x \in \psi \exists E' \leq E[x \leq X\ \&\ \exists Y[{}^*\textsc{flew}(E')\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{ag}(E')(x)\ \&\ {}^*\textsc{th}(E')(Y)]]\ \&\ \neg \exists x' \leq X \exists E'' \leq E \exists Y[{}^*\textsc{flew}(E')\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{ag}(E'')(x')\ \&\ {}^*\textsc{th}(E'')(Y)]\ \&\ \neg[x' \in \psi]]]$

The sentence in (304) is interpreted as (305a), which in turn is equivalent to (305b). But note that by the definition of $\sqcup$ and *, the following holds:

(306) $\exists X \exists \psi_{\langle e,t\rangle}[\forall x \in \psi \exists E[x < X$ &

$\exists Y[{}^*\textsc{flew}(E)$ & ${}^*\textsc{kite}(Y)$ & ${}^*\textsc{ag}(E)(x)$ & ${}^*\textsc{th}(E)(Y)]]] \Rightarrow$

$\exists E' \exists Y'[{}^*\textsc{flew}(E')$ & ${}^*\textsc{kite}(Y')$ & ${}^*\textsc{ag}(E')(\sqcup\psi)$ & ${}^*\textsc{th}(E')(Y')]$

In other words, if we have a set of boys such that each boy was the agent of an event of flying one or more kites, then the sum of the members of that set is such that it is the agent of a sum of events of flying kites. And since the sum of the set of boys in question in (305b) is the sum of all the boys, (305b) is in fact equivalent to (307):

(307) $\exists E' \exists X \exists Y'[|X| = |\textsc{boy}$ & ${}^*\textsc{boy}(X)$ & ${}^*\textsc{kite}(Y')$ & ${}^*\textsc{flew}(E')$ &

${}^*\textsc{ag}(E')(X)$ & ${}^*\textsc{th}(E')(Y')]$

To put it differently, there is no difference between saying "there is a sum of boys, such that each of its atomic parts is the agent of an event of flying kites", and "there is a sum of boys that is the agent of a sum of events of flying kites". This stands in contrast to the case with a numerical object; "there is a sum of boys, such that each of its atomic parts is the agent of an event of flying two kites" is not equivalent to "there is a sum of boys that is the agent of a sum of events of flying two kites".

In other words, if there is no cardinality information in the predicate with which *all* combines with, then the distribution can be done away with, giving the same configuration as the *in-situ* reading of a numerical plural subject. On the other hand, with a numerical object, the last step is impossible, as the following entailment does not hold:

(308) $\exists X \exists \psi_{\langle e,t\rangle}[\forall X' \in \psi \exists E[X' < X$ &

$\exists Y[|Y| = 2$ & ${}^*\textsc{kite}(Y)$ & ${}^*\textsc{ag}(E)(X')$ & ${}^*\textsc{th}(E)(Y)]]] \not\Rightarrow$

$\exists E' \exists Y'[|Y| = 2$ & ${}^*\textsc{kite}(Y')$ & ${}^*\textsc{ag}(E')(\sqcup\psi)$ & ${}^*\textsc{th}(E')(Y')]$

What is crucial here is that the multiplicity condition is not yet present in the logical form of the sentence at the point in which *all* is combined with the predicate. Thus, it does not get in the way of the equivalence in (306). Here we see a real difference in the behavior between number neutral bare plurals and indefinite plurals that contain number information.

Most functions in a similar fashion to *all*, the only difference being in the cardinality condition:

(309) $[\![\textit{most boys}]\!] = \lambda\phi_{\langle e,t\rangle}\exists X[|X| > |\textsc{boy}|/2\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\phi(X)]$

6.2.7 Section Summary

In chapter 2, it was argued that the multiplicity condition associated with bare plurals shows the behavior pattern of a scalar implicature. What was missing is a means of calculating this implicature. This section provided the means, using a theory of implicature based on Chierchia (2004, 2006) and the formal system laid out in chapter 5 to show not only how this implicature is calculated, but also why it shows the range of behavior discussed in chapter 2. It was shown that before existential closure, a plural variable is weaker than a singular variable, leading to the scalar implicature. The multiplicity implicature will be interpreted scopelessly relative to any quantifier that is interpreted *in-situ* in the event type, but it will be trapped under any quantifier that scopes out. In this, it is similar to a cumulative reading. It was also shown that some quantifiers, such as *all*, impose a semi-scopal dependency inside the event type, preventing cumulative readings. However, because the bare plural is number neutral, this dependency can be factored out before the multiplicity implicature is calculated, allowing for dependent readings.

6.3 Other implicature-based theories of multiplicity

The observation that atomic variables are just a subset of the plural variables, and therefore can be compared on a scale, is not unique to this dissertation. Indeed, the idea that multiplicity may be derived from a scalar implicature has recurred, often as an aside, in semantic literature dealing with plurality throughout the years[9]. However, other than the current work, there have only been two serious attempts to develop an implicature based theory for the multiplicity of bare plurals.

As noted in the beginning of this chapter, it is far easier to notice that singulars appear to be stronger than number-neutral plurals than it is to derive an implicature based on this premise. We have seen that in an event-based theory, once existential closure is applied to the event variable then the singular and plural statements are in fact equal. I have solved this problem by calculating the implicature before event closure is applied. In an eventless theory, however, the problem is even more acute, as there is no such step. Thus, we are left with two equivalent logical forms:

(310) a. Dogs are barking.

b. $\exists X[{}^*\textsc{dog}(X)\ \&\ {}^*\textsc{bark}(X)]$

(311) a. A dog is barking.

b. $\exists x[{}^*\textsc{dog}(x)\ \&\ {}^*\textsc{bark}(x)]$

It is clear that (311b) entails (310b) since X ranges over the atoms. Similarly, the distributivity of the predicate means that for every X that are barking dogs, there has to be an atom x that is a barking dog; (310b) thus entails (311b). And with no event variable, there is nowhere to get a scalar relationship in the sentence.

Thus, there are two options available for anyone who wants to derive a multiplicity

[9]One recent example of a work that raises the possibility without developing it is Pafel (2006).

implicature in an eventless system. The first is to derive this implicature by a non-scalar calculation. This approach was taken by Sauerland et al. (2005). The second is to argue that the implicature is calculated by a scalar comparison, but that this comparison is not between (310b) and (311b), but rather than (310b) has a different alternative to be compared to. This is the view of Spector (2007). In the following two sections, I shall describe the two approaches, and show that while both can properly account for sentences with a single bare plural, they fail to account for dependent plurality.

6.3.1 Sauerland, Anderssen, and Yatsushiro (2005)

Like my own theory, the theory proposed in Sauerland et al. (2005) takes bare plurals to be number neutral. In contrast to me, however, they argue that the atomicity of singulars is not part of their denotation, but rather a presupposition which must be satisfied locally. This presupposition plays an important role in their calculation. The contrast between the singular and the plural, according to Sauerland et al., is not a scalar one. Rather, the singular and the plural compete based on a pragmatic principle called **maximize presupposition**, which was first introduced in Heim (1991). This principle says that when choosing between two different morphological forms, the one with stronger presuppositions must be chosen, as long as that will not lead to a presupposition violation. Given their argument that the singular presupposes atomicity, while the plural has no presupposition, the principle of maximize presupposition entails that if the singular form can be used without presupposition failure, it must be used. This, in turn, means that if the plural was used, it is possible to infer that the singular could not have been used in that context. This inference is a conversational implicature, but not a scalar one.

In other words, for Sauerland et al. (2005), the multiplicity implicature is not based on any of the original Gricean maxims[10], but rather on a different principle, that of maximize presupposition. Unlike traditional scalar implicatures, the resulting implicature is not based on the idea that the negated alternative is false. Rather, it assumes that the negated alternative lacks truth value, as using it would result in a presupposition failure.

Thus, in the case of (311), it is presupposed that the subject refers to an atomic dog (and not to a sum). If a single dog is barking, this presupposition is satisfied. Thus, if I say (310), I am in violation of maximize presupposition. On the other hand, if two dogs were barking, uttering (311) would lead to presupposition failure, while (310) can be uttered safely. Thus, the use of (310) implies that, given the assumption that the the speaker is being cooperative, he must believe that more than one dog barked.

(310) Dogs are barking.

(311) A dog is barking.

Sauerland et al. also propose an explanation of why this implicature does not arise in downwards entailing sentences. Since this is not a scalar implicature, scale reversal *pre se* is not involved. However, they note that a sentence which says "there is no atom x such that ϕ(x)" is inherently weaker than saying "there is no X such that ϕ(X)", when X is number neutral. Choosing the sentence with the presupposition, thus, leads to a weaker utterance. They posit that maximize presupposition only applies when it strengthens the utterance, not when it weakens it. Thus, if a negated plural is uttered, it cannot be inferred that this was because the presupposition fails, and there is no implicature.

Sauerland et al. limit their attention to sentences with just a bare plural, and do not discuss sentences where there is any other plural involved. However, they do

[10] At least not as originally formulated. The principle that presuppositions must be maximized may be taken to be a form of the maxims of quantity or manner.

discuss sentences with an *every* subject, such as (312) below, which they contrast with (313):

(312) Every boy should invite his sisters to the party.

(313) Every boy should invite his sister to the party.

Their argument is that in (313), the atomicity presupposition of *his sister* is distributed over by the subject, so that (313) presupposes that every boy has a single sister. They point out that in a situation where at least one boy has more than one sister, (313) cannot be used and (312) must be used instead. This is indeed correct. However, their theory states that this is because (313) must be used whenever it can be; i.e. when each boy has exactly one sister. Unfortunately, according to my informants both (312) and (313) are acceptable if that is the case. That means that the explanation for why (312) can be used in a scenario where most boys have one sister cannot be derived from an inference over maximize presupposition.

The data is further complicated by the fact that (312) contains the modal *should*, which, I have argued in chapter 2, creates an environment in which plurals do not denote 'more than one'. Indeed, comparing (312) with (314) shows that the latter displays the pattern familiar to use with *every* sentences:

(314) Every boy invited his sisters to the party.

Unlike (312), (314) can only be used if each boy has at least two sisters. But Sauerland et al. cannot predict that either; for them, there is no difference between (314) and (312), and thus they predict that (314) would be usable as long as any boy has more than one sister, even if all the other boys have only one each.

A similar problem occurs once sentences which get dependent readings are considered. Take the following two sentences:

(315) All my friends own nice cars.

(316) All my friends own a nice car.

Sauerland et al. do not discuss what happens to the atomicity presupposition of *a nice car* under *all*. But since (316) can only be used if each of my friends owns a single car, then it appears that the presupposition is distributed over by the subject, just like in (313). But that creates the exact same expectation as before: that (315) could only be used if I have at least one friend who owns more than one nice car. However, as we know, (315) can be used even if no such friend exists, as long as more than one car is owned overall. Thus, assuming that the presupposition is distributed over by *all* gives the wrong result.

A different possibility is that (316) involves some process of presupposition accommodation, and that it does not presuppose that each of my friends owns a single car, but rather asserts it[11]. If this is the case, maximize presupposition does not hold; (315) can thus be used without any implicatures. But we have also seen this to be the wrong result. Dependent plurals are not completely number neutral, but rather have an overall multiplicity condition, which this suggestion leaves unexplained.

Overall, then, it appears that while the proposal in Sauerland et al. (2005) can derive the multiplicty condition of bare plurals that are not in the scope of another plural or *every*, it cannot explain the behavior of dependent plurals, and it provides truth conditions which are too weak for bare plurals in the scope of *every*. Furthermore, the account of why multiplicity is not implied in downwards entailing environments invokes scalar reasoning which is otherwise absent from their proposal. Thus, though they may be correct that singular NPs presuppose atomicity rather than assert it, it does not seem that such a presupposition offers a better explanation of the behavior of bare plurals compared to the scalar analysis proposed above.

[11]Sauerland et al. (2005) do not discuss accommodation in this context, but they do argue that presuppositions associated with NPs inside indefinite DPs are accommodated, thus showing that the process exists in their system.

6.3.2 Spector (2007)

Unlike Sauerland et al. (2005), Spector (2007) does take the multiplicity implicature to be a scalar implicature. However, Spector offers a very different method of deriving this implicature than my own.

Spector notes that traditional scalar reasoning cannot account for the multiplicity implicature, as sentences involving singulars are not stronger than sentences involving number-neutral bare plurals. He offers an ingenious solution to this problem, based on the observation that the singular is not only the alternative to the bare plural, but it is also involved in another scale: the singular *one boy* is weaker than *two boys*. This leads to a familiar scalar implicature:

(317) John met one boy $\Rightarrow_{impl}$ John met one boy and he didn't meet two or more = John met exactly one boy.

Spector's proposal is that both these scales play a role in the calculation of the multiplicity condition. According to his theory, the alternative to the bare plural is not the singular, but the pragmatically enriched version of the singular derived after calculating its other implicature. He calls this a higher-order implicature.

Spector offers a formal account of higher order implicatures that works through this proposal. However, the basic idea is simple to demonstrate without getting into the details. Take the following triplet:

(318) a. Jack saw horses.

b. Jack saw a horse.

c. Jack saw several horses.

They can be paraphrased as follows (given that the bare plural is number-neutral):

(319) a. Jack saw *at least one horse*.

b. Jack saw *at least one horse*.

c. Jack saw *at least two horses*.

Spector gives the following scalar alternatives:

(320) a. ALT(Jack saw horses) = {Jack saw horses, Jack saw a horse}

b. ALT(Jack saw a horse) = {Jack saw several horses, Jack saw horses, Jack saw a horse}

c. ALT(Jack saw several horses) = {Jack saw several horses}

Implicatures are now calculated in the normal fashion. (318c) has only one alternative, so it has no implicature. (318a) has two alternatives; however, they both have the same basic meaning. Thus, there is no implicature as well. (318b), however, has a stronger alternative. This alternative is negated and an enriched meaning is derived. This stage is the first-level implicatures:

(321) a. I_1((318a)) = Jack saw *at least one horse*.

b. I_1((318b)) = Jack saw *exactly one horse*.

c. I_1((318c)) = Jack saw *at least two horses*.

We now compare the sentences again. This time, each alternative is taken to mean not its basic meaning, but rather its enriched meaning. (318c) still has only one alternative, so its meaning does not change. (318b) has one alternative which is weaker (321a), and one which is no longer ordered relative to it (321c). Neither is stronger, so there is no enriched meaning. (318a), however, now has a stronger alternative in (321b). This is negated, creating the second-level implicatures:

(322) a. I_2((318a)) = Jack saw *at least one horse but not exactly one horse*.

b. I_2((318b)) = Jack saw *exactly one horse*.

c. I_2((318c)) = Jack saw *at least two horses*.

There is no pre-specified limit on the number of iterations, so, theoretically , the calculation can be repeated yet again. However, none of the sentences have any alternatives that are stronger. Thus, all further iterations will not change the meaning, and we can take these as the final outcomes. Thus, we have arrived at the correct implicatures for both (318a) and (318b).

In downwards entailing environments, the scales are reversed. In this case, neither (318a) nor (318b) have any stronger alternatives in the first iteration, so neither meaning is enriched, and no further iterations will change this.

However, like Sauerland et al. (2005), Spector offers no direct account of sentences with dependent plural meaning. And here, too, these pose a problem. Let us look at the following set of sentences:

(323) a. All the men saw horses.
b. All the men saw a horse.
c. All the men saw several horses.

Which can be paraphrased as:

(324) a. All the men saw *at least one horse*.
b. All the men saw *at least one horse*.
c. All the men saw *at least two horses*.

And have the following alternatives:

(325) a. ALT(All the men saw horses) = {All the men saw horses, All the men saw a horse}
b. ALT(All the men saw a horse) = {All the men saw several horses, All the men saw horses, All the men saw a horse}
c. ALT(All the men saw several horses) = {All the men saw several horses}

The first round of implicature calculation gives:

(326) a. I_1((323a)) = All the men saw *at least one horse.*

b. I_1((323b)) = All the men saw *exactly one horse.*

c. I_1((323c)) = All the men saw *at least two horses.*

And, the second round:

(327) a. I_2((323a)) = All the men saw *at least one horse but not exactly one horse.*

b. I_2((323b)) = All the men saw *exactly one horse.*

c. I_2((323c)) = All the men saw *at least two horses.*

And no further rounds make a difference. But (327a) is too strong an implicature; it means that each man saw more than one horse. Thus, like Sauerland et al. (2005), Spector's analysis provides no account of dependent plurals. That said, it is not impossible to arrive at a multiplicity condition using Spector's system, as long as the alternatives are carefully chosen. If, for example, instead of {All the men saw horses, All the men saw a horse}, the alternative set of (323a) would have been {All the men saw horses, There was a horse that all the men saw}, then the correct implicature would be arrived at. It may be that a principled system may be found that will give all sentences involving bare plurals the correct set of alternatives to derive dependent readings under Spector's theory. As far as I know, however, no such system exists.

6.4 Chapter Summary

In this chapter, I have shown how the formal framework described in chapter 5 allows for the calculation of the multiplicity implicature. While the fact that plural variables range over a domain that is a superset of the domain of singular variables, and therefore can be considered to be weaker, is well known, using this scalar relationship to derive an implicature is complicated. Because of the distributive nature of the * operator, matrix sentences that include a number neutral plural variable are in fact logically equivalent to their alternative using a singular variable.

What I have shown is that by calculating the implicature before event closure is applied, this problem is circumvented. I have further shown that this step is a natural one in a recursive implicature calculation system such as the one suggested by Chierchia (2004, 2006). By adding this step, it becomes possible to account for the data presented in chapter 2.

Finally, I have described two alternative proposals that derive multiplicity implicatures, and have shown that while both do well in accounting for bare plurals in the scope of a singular DP, they cannot explain dependent plural readings, nor is there a simple extension of either that will do the job. Thus, my account allows for an explanation of a greater range of data.

CHAPTER 7

CONCLUSIONS AND FURTHER QUESTIONS

7.1 Conclusions

In the preceding chapters, I have presented an account of bare plurals, focusing of their existential readings, especially in the context of dependent readings. Based on the behavior of plurals in these, and other, environments, I have argued for a few main conclusions. The first is that while bare plurals may be ambiguous between a kind reading and existential reading, the existential reading itself should be treated uniformly across sentences, whether or not it is interpreted as a dependent plural.

The second conclusion is that the meaning contributed directly by bare plurals does not contain a multiplicity condition. Rather, this condition is added by the pragmatics. I have shown that this not only explains the basic phenomenon of dependent plurality, but also how bare plurals behave in downwards entailing environments. Furthermore, I have also shown that the number neutrality of bare plurals explains why they can receive dependent readings even with some quantifiers that do not allow cumulative readings with indefinites such as *all* and *many*.

Third, I have shown that the multiplicity implicature is a scalar implicature, but that to generate it, we need a recursive system of implicature calculation. The behavior of the implicature provides clear evidence that it is calculated at the point of sentence interpretation before event closure has applied.

In a compositional theory of semantics, it is part of the goal to deduce the meaning of sentence elements from the meaning of the sentence as a whole. Therefore, a better understanding of bare plurals is not only valuable on its own right, but it also allows for a better understanding of the DPs they interact with. Some such conclusions were also achieved in this thesis. The difference in availability of dependent plurality provides important insight to understanding the meaning difference between *every* and *all*. Similarly, new insights into the behavior of *every* in subject versus object position were achieved.

Thus, I have shown that dependent plurality is crucial in understanding the meaning of bare plurals, and through them, the meaning of other DPs as well. It is certainly possible to account for many subsets of the data discussed in this dissertation in a theory that argues that bare plurals denote 'more than one'. But when taken together, it is shown that, despite the tendency to associate plurals and multiplicity, this theory falls short of explaining the data. And by doing so, it becomes possible to re-evaluate other sentences involving bare plurals and shed light on puzzles beyond dependent plurality.

7.2 Further Questions

While the exploration of dependent plurality in this dissertation provide a unified semantics for bare plurals in English, it is only one step in the more general goal of establishing a compositional semantics for plurality in general. Several additional directions for this research are listed below.

7.2.1 Cross-linguistic variation

In this dissertation, I have focused almost exclusively on English. To some degree, this was a matter of convenience; English, after all, is the language this thesis is written in, and therefore by necessity available to anyone reading it. But it is also true that the behavior of English bare plurals is mirrored in many other languages across the world, even if they differ in other aspects of the syntax and semantics of plurals. In addition to English, dependent plural readings can be found in languages such as French (as mentioned in chapter 2), Spanish, Dutch, German, Modern Hebrew, Serbian[1], Slovenian[2], Telugu[3], and Turkish[4]. However, it is not a universal phenomenon. Some languages, such as Hungarian[5], Finnish[6] and Brazilian Portuguese[7], do not allow dependent readings, or only allow them in very limited environments. Understanding this variation is crucial to for a fully universal account of plurality. In particular, it is important to investigate whether either the languages that allow dependent plurality, or the languages that do not, form a class with respect to any other feature. It is not at all evident whether this is the case.

A separate, though closely related question is the way different languages utilize dependent plural readings in idioms and other lexicalized expressions. de Mey (1981), for example, has famously observed the following distinction between English and Dutch:

(328) a. The sailors lost their #life/lives.

b. De zeelieden verloren hun leven/#levens.
The sailors lost their life/#lives.

In English, the plural *lives* must be used; using the singular *life* forces a collective

[1] Boban Arsenijevic (p.c.).
[2] Franc Marušič (p.c.).
[3] Rahul Balusu (p.c.).
[4] Serkan Şener (p.c.).
[5] Anna Szabolcsi (p.c.).
[6] Liina Pylkkänen (p.c.).
[7] Müller (2001)

reading for the subject. The inverse is true in Dutch; using the singular allows for the pragmatically natural distributive reading, but using the plural *levens* forces a reading where each sailor had more than one life to lose[8]. Traditionally, this has been taken to be a difference in the interpretation of the bare plural between the two languages. However, the difference in acceptability of the singular indicates that this is more likely to be a difference in the interpretation of the subject. It is worth mentioning that English itself has idiomatic constructions that prefer the singular. Take the following example, where Spain, Italy and Uruguay are competing teams:

(329) Spain, Italy and Uruguay lost their chance to win the 1958 title.

Here, *lose their chance* in English behaves like *verloren hun leven* in Dutch. If *chance* were replaced by a plural *chances*, the implication would be that each team had more than one opportunity to win.

Nonetheless, these data deserve further investigation, and the theory of dependent plurality I argue for in this dissertation is helps make such investigation possible. Whether or not the variation in idiom interpretation is due to a variation in the interpretation of the bare plurals or of the subjects is a question that can only be answered once the interaction between the two is made explicit.

7.2.2 Other cross-linguistic parallels (Balusu 2005)

In addition to the behavior of bare plurals (or their equivalents) in other languages, some languages feature constructions that exhibit semantic conditions similar to that of the multiplicity implicature. One such language is the Dravidian language Telugu, which was investigated by Balusu (2005). In Telugu, it is possible to reduplicate numerals, allowing for both (330) and (331):

[8] Suzanne Dikker (p.c.). de Mey (1981) states that this does not have the intended meaning, but does not mention the reading it does have.

(330) renDu kootu-lu egiriniyyi.
two monkey-Pl jumped.
'Two monkeys jumped.'

(331) renDu renDu kootu-lu egiriniyyi.
two two monkey-Pl jumped.
'Two monkeys jumped in each time interval.' **or**

'Two monkeys jumped in each location.'

Just like its English translation, (330) asserts that there was an event of two monkeys jumping. According to Balusu (2005), however, (331) is different. It asserts that there were multiple pairs of monkeys that jumped - either at different times, or in different places. The sentence cannot be satisfied if a single pair of monkeys jumped repeatedly. Similarly to a dependent plural reading, an overall multiplicity condition seems to be involved; but instead of multiple individuals, there are multiple sets of as many monkeys as the numeral dictates.

Also somewhat similar to dependent plurals is the interaction of a reduplicated numeral with another DP. If the sentence has a single subject, the multiplicity condition over pairs of monkeys can be satisfied spatio-temporally, just like in (330):

(332) Raamu renDu renDu kootu-lu-ni cuuseeDu.
Ram two two monkey-Pl-Acc saw.
'Ram saw two monkeys in every place/in every time'

However, if the subject is plural, there is another reading, in which there is a pair of monkeys for each individual denoted by the subject:

(333) Prati pillavaadu renDu renDu kootu-lu-ni cuuseeDu.
Every boy two two monkey-Pl-Acc saw.
'Every boy saw two monkeys in every place/in every time/each'

There is no reading for (332) equivalent to the 'each' reading of (333), since, Ram being singular, that would entail only one pair of monkeys being referred to. This would defy the multiplicity condition.

The above observations by Balusu make the multiplicity condition of reduplicated numerals appear very similar to the bare plural condition. Indeed, his own explanation makes explicit reference to a 'more than one' condition that applies to the denotation of the NumP, rather than to the NP. It is not immediately obvious what this means in terms of the semantic theory I propose in earlier chapters, as the framework used in this work does not have a straightforward way to define multiplicity of n-tuples of monkeys[9]. Nonetheless, the similarity is striking.

There is a further parallel between bare plurals and reduplicated numerals, in that both of them lose their multiplicity conditions in modal and question contexts[10]:

(334) Raamu renDu renDu kootu-lu-ni cuuseeDaa?
Ram two two monkey-Pl-Acc saw-Q?
'Did Ram see two monkeys (in each location/time)?'

(335) Raamu renDu renDu kootu-lu-ni cuuDaali.
Ram two two monkey-Pl-Acc must-see.
'Ram must see two monkeys (in each location/time)?'

(334) can be answered affirmatively if Ram only saw two monkeys and Ram can answer the demands of (335) by only seeing a single pair of monkeys.

On the other hand, unlike bare plurals, reduplicated numerals do carry a multiplicity condition under negation:

(336) Raamu renDu renDu kootu-lu-ni cuuDaleedu.
Ram two two monkey-Pl-Acc not-see.
'Ram didn't see two monkeys in every place/in every time'

(337) PadiKantee Takkuva pillavaalu renDu renDu kootu-lu-ni cuuseeru.
Ten less-than boys two two monkey-Pl-Acc saw.
'Less than ten boys saw two monkeys in every place/in every time/each'

[9]Using the $\uparrow$ operator does not seem to be the correct answer, as jumping is an action performed by individual monkeys in the pairs, not by groups. However, further research needs to be done before this option can be eliminated altogether.

[10]The following data comes from Rahul Balusu, (p.c.).

(336) is true if Ram saw exactly two monkeys, and (337) is false if exactly one boy saw exactly two monkeys, as predicted if the multiplicity condition holds.

This data, then, poses an interesting set of puzzles. Both reduplicated numerals and bare plurals seem to be associated with a 'more than one' condition. But it is not clear whether the Telugu data can, or should, be accounted for using an implicature based account. How these two phenomena relate, then, is a question for further research. It is worth noting that in addition to the reduplicated numerals, Telugu also has bare plurals that seem to pattern very similarly to those of English; it is thus not only necessary to find a proposal that lets a language offer either behavior, but also one that allows them to co-exist.

7.2.3 The relationship between bare and other plurals

One obvious question that is raised by this dissertation is whether bare plurals are unique in being number neutral, or whether this is true of all plural NPs, even if they form a part of a larger DP that is not itself number neutral. It seems to be a standard assumption that there is some sense in which there exists a syntactic plural NP which is shared among both bare plurals and non-bare plural DPs, though this has been called into question (see Krifka (2004) for a dissenting opinion). If this is the case, then the multiplicity associated with DPs such as *three men* must come from the determiner. This seems reasonable for determiners such as *three* or *many*, but becomes more problematic with determiners such as *some*, and even more problematic when definite plurals such as *the men* are considered. The conclusion in this thesis that bare plurals are always number neutral allows an avenue into investigating the existence of a shared plural NP.

7.2.4 Non-sentential predication structures

While in this thesis I focused on sentences involving bare plurals, dependent plural phenomena exist in other predication structures. One such structure are NPs modified by prepositional phrases. Kamp and Reyle (1993) observed that *I own cars with automatic transmissions* does not imply that any car has more than one automatic transmission, while *I own a car with automatic transmissions* does. Similarly, possessive constructions allow dependent readings: *I met John and Mary's children* does not imply that either John or Mary have more than one child. These constructions are important not only for the semantics of plurals. Assuming my analysis of the multiplicity condition is correct, the availability of dependent readings here becomes a diagnostic for the place of various sub-DP components relative to the event structure of the sentence. The fact that *I met all the professors' students* allows me to meet one student per professor but *I met every professor's students* requires me to have met at least two students per professor indicates that just like with sentential arguments, the scopal properties of possessors are influenced differently by different quantifiers. Dependent plural readings provide a valuable tool for investigation of these questions.

APPENDIX A

LANDMAN'S (2000) DERIVATIONS

This appendix contains step-by-step calculations of the two readings of sentence (210) from chapter 5, section 5.1.2.2, based on the theory of Landman (2000):

(210) Two boys walked.

(A1) **Distributive:** (= (213a))

$$
\begin{array}{lll}
 & [\![\textit{two boys walked}]\!] & \\
= & [\![\textit{walked}]\!]([\![\textit{two boys}]\!]_1) & \\
= & \lambda X \lambda E[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)]([\![\textit{two boys}]\!]_1) & \\
\Rightarrow & \lambda\psi\lambda E[\psi(\lambda X[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)])]([\![\textit{two boys}]\!]_1) & \textbf{LIFT} \\
= & \lambda\psi\lambda E[\psi(\lambda X[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)])](\lambda\phi\exists X[|X|=2 \ \& & \\
 & {}^*\textsc{boy}(X) \ \& \ \phi(X)]) & \\
= & \lambda E[\lambda\phi\exists X[|X|=2 \ \& \ {}^*\textsc{boy}(X) \ \& \ \phi(X)](\lambda X[{}^*\textsc{walk}(E) \ \& & \\
 & {}^*\textsc{ag}(E)(X)])] & \\
= & \lambda E\exists X[|X|=2 \ \& \ {}^*\textsc{boy}(X) \ \& \ {}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)] & \\
\Rightarrow & \exists E\exists X[|X|=2 \ \& \ {}^*\textsc{boy}(X) \ \& \ {}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)] & \textbf{EC}
\end{array}
$$

(A2) **Collective:** (= (214a))

$$\llbracket \textit{two boys walked} \rrbracket$$

$$= \llbracket \textit{walked} \rrbracket(\llbracket \textit{two boys} \rrbracket_2)$$

$$= \lambda X \lambda E[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)](\llbracket \textit{two boys} \rrbracket_2)$$

$$\Rightarrow \lambda \psi \lambda E[\psi(\lambda X[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)])](\llbracket \textit{two boys} \rrbracket_2) \qquad \textbf{LIFT}$$

$$= \lambda \psi \lambda E[\psi(\lambda X[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)])](\lambda \phi \exists X[|X|{=}2 \ \& \ {}^*\textsc{boy}(X) \ \& \ \phi(\uparrow X)])$$

$$= \lambda E[\lambda \phi \exists X[|X|{=}2 \ \& \ {}^*\textsc{boy}(X) \ \& \ \phi(\uparrow X)](\lambda X[{}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(X)])]$$

$$= \lambda E \exists X[|X|{=}2 \ \& \ {}^*\textsc{boy}(X) \ \& \ {}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(\uparrow X)]$$

$$\Rightarrow \exists E \exists X[|X|{=}2 \ \& \ {}^*\textsc{boy}(X) \ \& \ {}^*\textsc{walk}(E) \ \& \ {}^*\textsc{ag}(E)(\uparrow X)] \qquad \textbf{EC}$$

APPENDIX B

DETAILED IMPLICATURE CALCULATIONS

This appendix contains fully spelled-out computations for the multiplicity conditions associated with examples in chapter 6. Rather than present a long series of calculations which are nearly identical, I will present different possible types of calculations, each of which is represented by several examples. The order of calculations is the order in which they are first encountered in chapter 6.

B.1 Bare plural in the scope of a negation

This section contains the full calculation of the enriched meaning of (271) from section 6.2.2. It shows why it does not feature a multiplicity implicature:

(271) It is not the case that dogs are barking.

Calculation

- Event type:

(B1) $\lambda E \exists X[{}^{*}\textsc{dog}(X) \ \& \ {}^{*}\textsc{bark}(E) \ \& \ {}^{*}\textsc{ag}(E)(X)]$

- Alternative set:

(B2) $[\![\lambda E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]]\!]^{ALT} =$
$\{\lambda E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)],$
$\lambda E \exists x[{}^*\textsc{dog}(x) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(x)]\}$

- Negating the stronger meaning, gives enriched event type:

(B3) $\lambda E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)] \,\&$
$\neg\exists x[{}^*\textsc{dog}(x) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(x)] =$
$\lambda E \exists X[|X|\!>\!1 \,\&\, {}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]$

- Existential closure and negation then applied, giving the first potential enriched sentence meaning:

(B4) $\neg\exists E \exists X[|X|\!>\!1 \,\&\, {}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]$

- The second potential calculation point is after the application of existential closure:

(B5) $\exists E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]$

- Again, calculate potential enrichment:

(B6) $[\![\exists E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]]\!]^{ALT} =$
$\{\exists E \exists x[{}^*\textsc{dog}(x) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(x)],$
$\exists E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]\}$

- There is no stronger alternative, so nothing to negate. Applying sentence negation gives the second possible enriched sentence meaning:

(B7) $\neg\exists E \exists X[{}^*\textsc{dog}(X) \,\&\, {}^*\textsc{bark}(E) \,\&\, {}^*\textsc{ag}(E)(X)]$

- The third calculation point is the sentence root:

(B8) $\neg\exists E \exists X[{}^*\textsc{dog}(X)\ \&\ {}^*\textsc{bark}(E)\ \&\ {}^*\textsc{ag}(E)(X)]$

- The alternative set is as follows:

(B9) $[\![\neg\exists E \exists X[{}^*\textsc{dog}(X)\ \&\ {}^*\textsc{bark}(E)\ \&\ {}^*\textsc{ag}(E)(X)]]\!]^{ALT} =$
$\{\neg\exists E \exists x[{}^*\textsc{dog}(x)\ \&\ {}^*\textsc{bark}(E)\ \&\ {}^*\textsc{ag}(E)(x)],$
$\neg\exists E \exists X[{}^*\textsc{dog}(X)\ \&\ {}^*\textsc{bark}(E)\ \&\ {}^*\textsc{ag}(E)(X)]\}$

- Here too, there is no alternative stronger than the utterance, so the third possible enriched meaning is the same as the second one:

(B10) $\neg\exists E \exists X[{}^*\textsc{dog}(X)\ \&\ {}^*\textsc{bark}(E)\ \&\ {}^*\textsc{ag}(E)(X)]$

- (B4) is weaker than the unenriched meaning in (B7)/(B10). Thus, (B7)/(B10) is the overall sentence meaning.

Outcome A bare plural in the scope of negation does not give rise to any multiplicity implicature.

B.2 Bare plural sharing a scope with other plurals

In this section, I provide the details of the calculation involved in the cases where a bare plural shares its scope with another plural in the sentence. This is the case in both the *in-situ* collective and distributive readings of (277)[1] (section 6.2.3), as well as the *all* sentence (304) (section 6.2.6). A very similar calculation is used for the

[1]The only difference between the two reading lies in the role predicate, where the distributive reading has ${}^*\textsc{ag}(E)(X)$ while the collective reading has ${}^*\textsc{ag}(E)(\uparrow X)$. This has no effect on the calculation of the implicature associated with $\exists Y$.

reading of (101) (section 6.2.4) where the plural subject remains *in-situ* in the event type, and does not distribute over the singular object.

(277) Five boys flew kites.

(304) All the boys flew kites.

(101) Two boys told a girl secrets.

I will use the distributive reading of (277) as the base for the calculation.

Calculation

- The event type is as follows:

(B11) $\lambda E \exists X \exists Y[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ ^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(E) \ \& \ ^*\textsc{ag}(E)(X) \ \& \ ^*\textsc{th}(E)(Y)]$

- Alternative set:

(B12) $[\![\lambda E \exists X \exists Y[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ ^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(E) \ \& \ ^*\textsc{ag}(E)(X) \ \& \ ^*\textsc{th}(E)(Y)]]\!]^{ALT} =$
$\{\lambda E \exists X \exists Y[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ ^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(E) \ \& \ ^*\textsc{ag}(E)(X) \ \& \ ^*\textsc{th}(E)(Y)],$
$\lambda E \exists X \exists y[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ ^*\textsc{kite}(y) \ \& \ ^*\textsc{flew}(E) \ \& \ ^*\textsc{ag}(E)(X) \ \& \ ^*\textsc{th}(E)(y)]\}$

- Negating the stronger meaning, gives enriched event type:

(B13) $\lambda E \exists X \exists Y[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ ^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(E) \ \& \ ^*\textsc{ag}(E)(X) \ \& \ ^*\textsc{th}(E)(Y)] \ \& \ \neg\lambda E \exists X \exists y[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ ^*\textsc{kite}(y) \ \& \ ^*\textsc{flew}(E) \ \& \ ^*\textsc{ag}(E)(X) \ \& \ ^*\textsc{th}(E)(y)] =$

$\lambda E \exists X \exists Y[|X|=5\ \&\ |Y|>1\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)]$

- Existential closure is then applied, giving the first potential enriched sentence meaning:

(B14) $\exists E \exists X \exists Y[|X|=5\ \&\ |Y|>1\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)]$

- The second potential calculation point is after the application of existential closure, i.e. the sentence root:

(B15) $\exists E \exists X \exists Y[|X|=5\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)]$

- The alternative set is as follows:

(B16) $[\![\exists E \exists X \exists Y[|X|=5\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)]]\!]^{ALT} =$
$\{\exists E \exists X \exists Y[|X|=5\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)],$
$\exists E \exists X \exists y[|X|=5\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(y)]\}$

- Both alternatives are identical, so the second possible final reading does not contain any implicature:

(B17) $\exists E \exists X \exists Y[|X|=5\ \&\ {}^*\textsc{boy}(X)\ \&\ {}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&$
${}^*\textsc{ag}(E)(X)\ \&\ {}^*\textsc{th}(E)(Y)]$

- (B14) is stronger than (B17), and therefore wins as the enriched meaning of the sentence.

Outcome A multiplicity implicature arises. Since there is no distributive scope in the sentence, it is an overall multiplicity condition. In other words, this is the dependent reading.

B.3 Bare plural in the distributive scope of a quantifier

In this section, I provide the details of the calculation involved in the cases where a bare plural falls under the scope of a quantifier. This is the case in both the scopal reading of (277) (section 6.2.3), and the *every* sentence (288) (section 6.2.5). A variant of this calculation is the so-called "intervention" case of ditransitives (section 6.2.4), where a singular quantifier takes intermediate scope between the bare plural and the scoping plural. However, as explained in chapter 6, the singular does not actually play any direct role in the nature of the multiplicity condition; rather, it is the fact that this configuration can only occur with a scopal reading for the quantifier that explains why the dependent reading is blocked. Thus, the calculation for these cases is essentially the same as the one outlined below.

(277) Five boys flew kites.

(288) Every boy flew kites.

I will use the scopal reading of (277) as the base for the calculation.

Calculation

- The event type is as follows:

(B18) $\lambda E \lambda x \exists Y[{}^{*}\textsc{kite}(Y)\ \&\ {}^{*}\textsc{flew}(E)\ \&\ {}^{*}\textsc{ag}(E)(x)\ \&\ {}^{*}\textsc{th}(E)(Y)]$

- Alternative set:

(B19) $[\![\lambda E\lambda x\exists Y[{}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&$
$^*\textsc{th}(E)(Y)]]\!]^{ALT} =$
$\{\lambda E\lambda x\exists Y[{}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(Y)],$
$\lambda E\lambda x\exists y[{}^*\textsc{kite}(y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(y)]\}$

- Negating the stronger meaning, gives enriched event type:

(B20) $\lambda E\lambda x\exists Y[{}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(Y)]\ \&$
$\neg\exists y[{}^*\textsc{kite}(y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(y)] =$
$\lambda E\lambda x\exists Y[{}^*\textsc{kite}(Y)\ \&\ |Y|>1\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&$
$^*\textsc{th}(E)(Y)]$

- Existential closure of the event is applied, as well as the denotation of *five boys*, to give the first potential enriched sentence meaning:

(B21) $\exists X[|X|=5\ \&\ {}^*\textsc{boy}(X)\ \&\ \forall x\leq X\exists E\exists Y[{}^*\textsc{kite}(Y)\ \&\ |Y|>1\ \&$
$^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(Y)]]$

- The second potential calculation point is after the application of existential closure:

(B22) $\lambda x\exists E\exists Y[{}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(Y)]$

- Alternative set:

(B23) $[\![\lambda x\exists E\exists Y[{}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&$
$^*\textsc{th}(E)(Y)]]\!]^{ALT} =$
$\{\lambda x\exists E\exists Y[{}^*\textsc{kite}(Y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(Y)],$
$\lambda x\exists E\exists y[{}^*\textsc{kite}(y)\ \&\ {}^*\textsc{flew}(E)\ \&\ {}^*\textsc{ag}(E)(x)\ \&\ {}^*\textsc{th}(E)(y)]\}$

- Both alternatives are identical, so the second possible final reading is derived by simply applying *five boys*:

(B24) $\exists X[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists Y[{}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(Y)]]$

- The third implicature calculation point is at the root sentence. The alternative set:

(B25) $[\![\exists X[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists Y[{}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(Y)]]]\!]^{ALT} =$
$\{\exists X[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists Y[{}^*\textsc{kite}(Y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(Y)]],$
$\exists X[|X|=5 \;\&\; {}^*\textsc{boy}(X) \;\&\; \forall x \leq X \exists E \exists y[{}^*\textsc{kite}(y) \;\&\; {}^*\textsc{flew}(E) \;\&\; {}^*\textsc{ag}(E)(x) \;\&\; {}^*\textsc{th}(E)(y)]]\}$

- Here too there is no difference between the two alternatives. The third possible enriched meaning is therefore identical to (B24).

- (B21) is a stronger reading than (B24), and therefore wins as the enriched meaning of the sentence.

Outcome A multiplicity implicature arises, but it is distributed over by the DP that scopes out of the event type. Thus, not a dependent reading.

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