Article:
Zweig, E. orcid.org/0000-0002-3535-7259 (2009) Number-neutral bare plurals and the multiplicity implicature. Linguistics and Philosophy. pp. 353-407. ISSN 0165-0157

https://doi.org/10.1007/s10988-009-9064-3

Published paper

Zweig E (2009)
Number-neutral bare plurals and the multiplicity implicature
LINGUISTICS AND PHILOSOPHY
32 (4) Pages: 353-407

http://dx.doi.org/10.1007/s10988-009-9064-3

Linguistics and Philosophy manuscript No.
(will be inserted by the editor)

Number-Neutral Bare plurals and the Multiplicity Implicature

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Received: date / Accepted: date

Abstract Bare plurals (*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 paper 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, relying on the scalar relationship between the bare plural and its singular alternative, and calculated in a sub-sentential domain; namely, before existential closure of the event variable. Finally, implications of this analysis will be discussed for the analysis of the quantified noun phrases that interact with bare plurals, such as indefinite numeral DPs (*three boys*), and singular universals (*every boy*).

1 Introduction

It is well known that bare plurals in English have two interpretations: one in which they denote kinds, and one in which they function similarly to indefinites[1]. While much of the work on bare plurals in English has focused on the former, the latter shows some unexpected properties as well. Specifically, while in many contexts bare plurals act like indefinites that denote more than one of the relevant entities – a reading so common that many consider 'more than one' to be the basic semantic contribution of the plural

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[1] There may be other readings as well, such as the quasi-universal reading argued for by Condoravdi (1992), but like the kind reading, these fall beyond the scope of discussion in this paper.

– there are other cases in which they seem to lack such a meaning. These cases are the focus of this paper, and examining them will be the basis of a theory of bare plural meaning that accounts for the full variety of it meaning in existential contexts. It will be shown that the 'more than one' meaning is not part of the denotation of the bare plural, but is rather arrived at by scalar implicature, and a method for calculating this implicature will be proposed.

It is easy to find examples of bare plurals that appear to be interchangeable with quantified plural DPs. For example, both (1a) and (1b) can be paraphrased as (1c); and (2a) and (2b) can be paraphrased as (2c) equally well:

(1) 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.

(2) 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 were barking outside my window last night.

Based on examples such as (1) and (2), it is quite plausible to conclude that existential bare plurals assert the existence of more than one entity. For example, *a dog* might denote something like (3), while both *dogs* and *some dogs* denote (4):

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

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

It turns out, however, that this simple picture becomes considerably more complicated once additional data is considered. As was first observed by Chomsky (1975), a bare plural noun phrase that falls in the scope of another plural does not behave like other plural indefinites. To illustrate this, note that the following inference, featuring a non-bare plural, is valid:

(5) a. All the linguistics majors dated several chemistry majors.
    b. John is a linguistics major.
    c. ∴ John dated several chemistry majors.

Given the premises in (5a) and (5b), it is proper to deduce (5c). But if we substitute a bare plural for *several chemistry majors*, we suddenly get a different picture:

(6) a. All the linguistics majors dated chemistry majors.
    b. John is a linguistics major.
    c. ∴ John dated a chemistry major.

From (6a) and (6b), we cannot deduce (5c). Instead, a valid deduction is (6c). Note that the predicate *date* is distributive; but nonetheless, while the requirement that more than one chemistry major was dated is associated with each linguistics major in (5), it does not distribute in the same way in (6). Instead, in this context, it seems that the bare plural behaves more like the singular indefinite in (7):

(7) 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 (6), that display this behavior[2].

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

(8) Ten students live in New York boroughs.

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

It is most natural to assign (8) a dependent plural reading, where each student has only a single dwelling place. For example, if five students live in Manhattan and five live in Brooklyn, (8) would be judged as true. Replacing the object with a singular DP (9) 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) (8) would not be judged true, unlike (9)[3]

Throughout this paper, I will use the term **multiplicity** to refer to a 'more than one' meaning component. 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**.

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

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[2] 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 (6), but not in (i) below, de Mey implies that the bare plural itself is somehow ambiguous:

(i) 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 (6) 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.

[3] 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 (i), it is not valid to deduce (iia), but it is valid to deduce (iib):

(i) John always wears suits.

(ii) 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 (i). (i) requires that John wear different suits, but not that he wear more than one at a time. Thus, this too is a dependent plural reading. While an analysis of these cases along the lines proposed below for non-adverbial dependent readings should certainly be possible, showing that would require a discussion of adverbial quantification beyond the scope of this paper and thus adverbial dependent readings will not be discussed further.

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 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 introduce both approaches, and discuss the strengths and weaknesses of both. Ultimately, I will show that it is the latter approach that is to be preferred.

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, this seems 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:

(10) 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.*'

(11) 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:

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

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

(12) 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). (13) can be understood in several ways, one of them being the cumulative reading. 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 (12) and the cumulative reading of (13) both sentences would be judged true in exactly the same conditions. Taking into account the fact that *at least two tables* in (13) is basically an explicit spellout of the denotation of *tables* under the view that the latter encodes multiplicity, it is not surprising that many researchers are tempted to take dependent plural readings as just one more example of cumulativity. This explanation has been the basis of the line of inquiry taken by many researchers.

Indeed, this approach is treated as straightforward enough that most of the researchers who take it are not primarily interested in dependent plurality. Rather, they are interested in using dependent plurals to make a case about cumulativity; either arguing in favor of cumulative quantification as a semantic primitive independent from collectivity (Beck 2000), or against it (Roberts 1990). An approach along similar lines is given by de Mey (1981), who does not mention cumulative readings *per se* but does assume that dependent plurals are cases where both plural arguments involved are interpreted collectively.

A different variation on this approach can be found in Bosveld-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[4]. However, both seem to treat dependent readings of *des* plurals as representative of dependent readings in general. They discuss examples such as the following:

(14) Les Français portent des cravates jaunes.
The French wear indef_{pl} yellow ties.
'The French wear yellow ties.'

Bosveld-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 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. This analysis was questioned by Spector (2003). He shows that French has dependent readings in non-habitual contexts, and that these are not necessary interpreted as a bijection. (15) neither entails that no boy read more than one book, nor than no book was read by more than one boy:

(15) 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 Bosveld-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 The Two-Part Meaning Hypothesis

As you may recall, the definition of dependent plurality given in section 1 involved two properties. The first is that bare plurals, when falling in the scope of another plural, can

[4] But see Roodenburg (2004) and 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.

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, and view multiplicity as distinct from the truth conditional contribution of plurals. Rather, plurals are denotationally number-neutral[5], but 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 3 below, I will provide several different types of evidence for this approach. I will then show that this data leads to the conclusion that the multiplicity condition is, in fact, a scalar implicature. Before doing so, however, it is worthwhile to consider similar approaches that have been argued for in the literature.

2.2.1 Number-Neutral Theories of Dependent Plurality

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 new. It has been present since the earliest work on the phenomenon, and while not as popular as the multiplicity + cumulativity-based theories, it has shown up 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[6].

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 is that there is a syntactic rule in English that allows VPs to undergo morphological pluralization. This rule has no semantic correlate. When this rule is applied, all nouns in the VPs appear morphologically plural but are interpreted as singular. For example, (16) below actually has a structure like (17). The plurality feature on the VP exists only as an agreement reflex with the subject, and has no semantic effect:

(16) Unicycles have wheels.

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

Chomsky uses this example to argue that the pluralization rule is an example of semantics-free syntax, and thus an argument against a compositional syntax/semantics interface. But note that the reason this example works is because of its generic nature, as world knowledge independently rules out a single wheel overall. Had Chomsky considered episodic sentences such as (6a) or (8) above, it would have been apparent that the bare plural and singular arguments allow for different readings[7].

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[5] Or at least, they are ambiguous between a 'more than one' reading and a number neutral one. See section 2.2.4 below for discussion of this point.

[6] But see section 2.2.2 below for discussion of work that argues for number-neutrality of bare plurals based on phenomena other than dependent plurality.

[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.

A variant of this view is presented by Roberts (1990), based on principles from 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 proposed 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, and singular 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 (16) as (18):

(18) 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. Among other objections, she points out that both her rule and Chomsky's do not take the semantics of the dependent plural itself into account, and can apply to any singular. So (19) would be interpreted as (20):

(19) The men married wives who are similar.

(20) 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 (20) is nonsensical. Indeed, there is no such set as {y:y married a wife who is similar}; this can be seen by the oddity of (21):

(21) * 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 the aforementioned Bosveld-de Smet (1998) and de Swart (2006), Spector focuses on dependent readings of French *des* plurals. These, he argues, are synonymous with singulars; but they are also subject to a licensing condition, akin to the licensing requirement of negative polarity items, such that they are only acceptable if they appear in the scope of a second, non-*des*, plural. Unfortunately for his argument, he himself notes that it is perfectly possible to have sentences in French that feature a *des* plural outside of such a context:

(22) Je veux acheter des chemises qui sont en vente ici.
I want buy $_{pl}$ shirts which are on sale here
'There are several shirts on sale here 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 can 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

[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.

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.

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, recall that the main motivation for the view 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:

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

(24) 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:

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

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

The sentence in (26) is a straightforward negation of (24); if the envoy met exactly one senior official in his visit, (24) is false and (26) is true. But while (23) is inappropriate in that state of affairs, (25) 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:

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

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

The bare plural sentence (27) suggests that the UN envoy does not expect to meet any senior officials, while (28) indicates that he expects to meet at most one. Here too, the multiplicity condition does not seem to have made its way into the antecedent of the conditional.

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

(29) Did you see bears during your hike?

(30) 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 (29) with (30a). A natural answer is instead (30b). 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:

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

(32) a. No, I saw one.
b. # Yes, I saw one.

In the same scenario, if I were asked (31), I would most probably answer with (32a). 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 occurs in certain modal environments. For example:

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

Given (33), 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 conclude that bare plurals do not contain a multiplicity condition in their denotation. 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 (23) 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 4.2. However, neither paper considers data from dependent plurals; Sauerland et al. focus entirely on sentences with only one plural NP, and make no mention of the phenomenon. Spector makes a brief mention of dependent plurals in a footnote, in which he suggests that the behavior of bare plurals in dependent readings and in downwards entailing environments are independent phenomena. The methods used to calculate the multiplicity implicature in Sauerland et al. (2005) and Spector (2007) differ both from each other and from my own proposal. Detailed discussion of their proposals appear in sections 5.1 and 5.2 below.

Also advocating a number-neutral account of bare plurals is Farkas (2006)[9]. She argues along lines very similar to Sauerland et al. (2005), but differs in that she takes

[9] 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.

the number neutral interpretation to be anomalous, even in the environments which allow it. She discusses the following contrasts:

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

(35) 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 (34b) compared to (34a), and of (35b) versus (35a), leads Farkas to argue that *wives* and *brooms* are not interpreted as number neutral in the degraded sentences. Number neutrality, she argues, can only exist if pragmatic considerations bias towards it.

While I agree with Farkas's observation that the plural is sometimes degraded in contexts where the singular is fine, and that this seems to be correlated with pragmatic factors, I disagree with her conclusion. The oddity of (34b) and (35b) is not an indication that the plurals in them mean *more than one*. Compare:

(36) Do you have fewer than four children?

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

In a monogamous society, (37) is also odd, even though (36) is fine. But nobody would argue that *fewer than four* means 'two or three'. Similarly, if a friend asks you to help him clean, you would not ask him:

(38) Do you have at least one broom?

The oddity of (38) is comparable to (34b), but it is obviously not because in (38) *at least one broom* means 'more than one broom'. In other words, (37) and (38) show that similar pragmatic effects occur even when the argument explicitly ranges over the singular, and thus, these contrasts are not evidence against a universal number neutrality of bare plurals[10].

2.2.3 Is a Uniform Analysis Justified?

By bringing together the literature on dependent plurality with the literature on other number neutral behavior of bare plurals, I have been making the assumption that they are directly comparable. This assumes, however, that the bare plurals involved in both are the same. This assumption becomes problematic if there is independent motivation for arguing that dependent plurals are somehow special. One such potential problem can be found in Partee (1985).

Partee discusses a counter-example to Carlson's (1977) claim that bare plurals that are embedded under an attitude verb can only get opaque readings. Specifically, she argues that in dependent plural contexts, bare plurals seem to receive transparent readings. She presents the following three-way contrast:

(39) Miles wants to meet a policeman.

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.

[10] A related phenomenon is discussed in Spector (2007), who dubs it **the modal presupposition** of the plural. It is discussed below, in section 4.2.

(40) Miles wants to meet policemen.

(41) All the boys wants to meet policemen.

Carlson had observed that while the singular (39) has both opaque and transparent readings, the bare plural in (40) cannot mean that there is a specific policeman that Miles wants to meet, only that he is interested in meeting some policeman or other. Partee adds (41). She notes that it has a reading where for each boy, there is a specific policeman that the boy wants to meet. This is a transparent reading. Partee concludes from this that there are two types of bare plural: the first being so-called "Carlsonian" bare plurals which take part in 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 (40) and (41) 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[11]:

(42) Hans wanted to put Belladonna berries in the fruit salad, since he confused them with cherries.

(42) is a perfectly sensible statement, 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 (42).

Thus, it is possible for a bare plural embedded under an attitude verb to have a transparent reading without also being a dependent plural. The other direction of the correlation does not hold either, as shown by the following sentence:

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

Policemen in (43) has a dependent reading, and the sentence can be true if I desire that each boy meet one or more policeman. If, then, dependent plurals allow transparent readings, it would follow that (43) should have a reading wherein I have a particular policeman in mind for each boy. But (43) cannot be used to mean that – just like (40) indicates that Jenny wants to meet some policemen but does not care which, (43) requires that I hold a desire that each boy meet some policeman or other.

Thus, it seems that while the contrast 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. Obviously, this is not an explanation; there is certainly need for further exploration of the relationship between bare plurals and attitude verbs, and a full account of Partee's observation shall remain a task for future research. For our

[11] This is actually a translation of Kratzer's original example, which was given in German. The argument holds in both languages.

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.

2.2.4 Ambiguity or True Number-Neutrality?

One question that has been left somewhat obscure in the discussion of number neutral theories so far 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 one' reading that most people's intuitions tend to associate with them. Given a sentence like (44), it may be that there are two ways of interpreting *apples* as illustrated in (45a) and (45b):

(44) Three men ate apples.

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

Under this view, (45a) is the traditional reading, where (44) means that each man ate more than one apple. (45b) is the dependent plural reading, which only requires that each man ate a single apple to be true.

Indeed, among the accounts that propose number neutrality as an explanation of dependent plurality, there is disagreement. Some, such as Chomsky (1975), Roberts (1990) and Spector (2003), assume that bare plurals are ambiguous. Others, such as Kamp and Reyle (1993), treat bare plurals as always being number neutral. But the matter is decided by the downwards entailing environments, which provide conclusive evidence against ambiguity. If bare plurals were ambiguous between a number-neutral and a 'more than one N' reading, then, when embedded under negation (46), the resulting sentence would be itself ambiguous between a 'not more than one N' (47b) and 'no N' reading (47a):

(46) John did not eat apples.

(47) a. $\# \ \neg\exists X[|\textsc{apples}(X) \ \& \ \textsc{ate}(John)(X) \ \& \ |X|>1]$
b. $\neg\exists x[\textsc{apple}(x) \ \& \ \textsc{ate}(John)(x)]$

But clearly, (47a) is not a reading of (46). The same holds for other downwards-entailing environments, as seen above. Thus, there seems to be solid evidence that if (46) is 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 (44) above, are ambiguous between a dependent plural reading and a non-dependent reading. This question will be discussed again in section 8.3, 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 scopal behavior of the other plural DP in the sentence.

2.3 Section Summary

In this section, I have outlined both major approaches to the semantics of 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. However, we also noted that 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 part of the data.

3 A Closer Look at the Data

In this section, I discuss novel data that reveals how, once we look beyond the basic cases discussed in previous literature, there is clear evidence for a number neutrality + implicature account and against the multiplicity + cumulativity account. In later sections, this data will also be crucial in explaining both the nature of the implicature, and how it arises.

First, in section 3.1, I will provide data that argues directly against cumulativity as the sole explanation of dependent plurality. Section 3.2 will show that nonetheless, there is a sense in which dependent plural readings are cumulative. Next, in section 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 3.4, I will discuss sentences which feature bare plural arguments yet lack dependent readings, and explain their significance. Finally, in section 3.5 I will discuss the behavior of bare plurals in sentences featuring more than one other DP.

3.1 Non-Cumulative Contexts

Section 2.1 discussed the common view that dependent plurality is simply a case of cumulative readings, of the type known with non-bare plural indefinites. In this section, I outline one major problem with this hypothesis: dependent plural readings have a 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 the following pairs, the first sentence lacks a cumulative reading but the second sentence allows for a dependent plural reading:

(48) a. Most students wrote several essays. $\not\Rightarrow$
'*Most students wrote at least one essay, and more than one essay were written overall.*'
b. Most students wrote essays. $\Rightarrow$
'*Most students wrote at least one essay, and more than one essay was written overall.*'

(49) a. All the students wrote several essays. $\not\Rightarrow$
'*All the students wrote at least one essay and more than one essay were written overall.*'
b. All the students wrote essays. $\Rightarrow$
'*All the students wrote at least one essay and more than one essay was written overall.*'

This data is a major problem for cumulativity based accounts. In order for a theory which insists that plurals denote 'more than one' to properly account for the data, they must also provide some explanation of what is different between a 'more than one' denoting bare plural and a DP such as *several papers*, such that the former can participate in cumulative readings where the latter cannot. To the best of my knowledge, no such account exists.

However, it is important to note that this discussion is not an argument 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 this data shows is that cumulativity is not, in and of itself, an *explanation* of dependent plurality.

3.2 Cumulative-Like Behavior

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

(50) a. Prince wrote a song called "America".
 b. Simon and Garfunkel wrote a song called "America".

However interesting (50a) is as a piece of music trivia, it is not of much interest from a semantic perspective. (50b), 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[12]. 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.

Now consider the following sentence:

(51) 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, (51) is untrue 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 (51).

Now compare:

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

(52) 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 (51) is now available[13].

[12] 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.

[13] The availability of the cumulative reading was first observed by Gillon (1987), 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.

This data poses a problem for some variations of the number-neutral theories. If bare plurals are interpreted as singulars, there should be no difference between the interpretations available to (51) and (52)[14].

On the other hand, this data is predicted by the multiplicity + cumulativity theorists described in section 2.1. Should it be taken as an argument in their favor?

I believe not. This is not an argument against all number-neutral hypotheses; rather, it is only a problem for the branch which treats dependent plurals as singulars. But that is a stronger claim than mere number-neutrality; below, I will propose a number-neutral theory that does not have this property.

3.3 Dependent Readings in Downwards Entailing Contexts

In section 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. Rather, each branch focuses on one type of data.

However, 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 instead seems to show up 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 unsurprising in light of the previous discussion. In such an environment, 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 sentence:

(53) Few linguistics majors dated chemistry majors.

(54) 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.

[14] A proponent of these theories might object to the argument based on this data on the putative grounds that this behavior is not driven by the interpretation of the bare plural, but by 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 (52) as a two way conjunction:

(i) [Simon & Garfunkel] and Prince wrote songs called "America".

(i) 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 (52), it should also be analyzable as a two-way conjunction in (51), allowing that sentence the very reading it lacks.

(53) is quite readily paraphrased as (54a), with a singular substituted for the bare plural. The non-dependent reading in (54b) is flat out unavailable; (54b) would be true if many linguistics majors dated a chemistry major but only few date two, but there is no possibility for (53) to be true in that case. Nor is the paraphrase in (54c), which is modeled after dependent plural readings in upwards entailing environments, appropriate. (53) is true if only one chemistry major was ever dated by a linguistics major. The overall multiplicity requirement seen earlier in examples such as (6a) is missing.

The same holds true of all the other environments where a bare plural on its own exhibits number neutral behavior, as discussed in section 2.2.2:

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

(56) 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.

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

(58) 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.

(59) The students must consult relevant articles.

(60) a. The students must consult at least one relevant article each.
b. #The students must consult more than one relevant article each.
c. #The students must consult at least one relevant article each, and they must not all consult the same article.

(61) Do all your friends like cooking shows?

(62) a. #No, they all like the same one: 'The Frugal Gourmet'.
b. Yes, they all like the same one: 'The Frugal Gourmet'.

The sentences in (55), (57), and (59) are offered suggested readings in (56), (58), and (60) respectively. In all these examples, the only valid reading is the one that exhibits no multiplicity condition at all. The same point is shown for by the question (61) and its putative answers in (62). In other words, 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.

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:

(63) John denied that two carpenters built tables.

(64) 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 (63) to be true, John must have claimed that no tables at all were built by the carpenters. However, on the cumulative reading of (64), 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.

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', (65a) means (65b) and (66a) means (66b):

(65) a. I saw John eating apples.
b. I saw John eating more than one apple.

(66) 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 (by the boys).

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 (65a) should more accurately be paraphrased as (67), which just happens to be equivalent to (65b):

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

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 (65a), 'more than one overall' ends up synonymous to 'more than one for John' due to the lack of another plural element.

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]:

(68) a. All dentists have scary chairs.
b. Every dentist has scary chairs.

The sentence in (68a) has a straightforward dependent reading; it is perfectly true if each dentist owns a single scary chair. (68b), on the other hand, states that each dentist owns more than one scary chair. While de Mey (1981) only discusses universal quanti-

[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.).

fiers, it is not difficult to demonstrate this in other minimal pairs involving a contrast between singular and plural quantified subjects. Consider the following contrast:

(69) a. More than two dentists own Porsches.
b. More than one dentist owns Porsches.

Here, as in (68), the sentence with a plural subject (69a) states that more than two dentists are such that each owns one or more Porsches. (69b) requires that there are at least two dentists that own multiple Porsches each. Yet, there seems to be no obvious semantic or syntactic distinction between *more than one* and *more than two* except the number features of their nouns.

In other words, unlike plural subjects, quantified singular subjects do distribute over the 'more than one' condition.

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. (68b) 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, we saw in 3.1 that the same argument would predict no dependent reading for *all*. 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.

3.5 Ditransitives

Most previous research on dependent plurality, regardless of the overall approach taken, focuses on dependent plurality as a relationship between two DPs, and does not discuss bare plurals in sentences with more than two arguments[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.

First, take the case where a bare plural appears in a sentence with two quantified plural DPs:

(70) Two boys told three girls secrets.

As is standard with numerical indefinites, this sentence is ambiguous, offering two scopal orderings for *two boys* and *three girls*[17]. Since the readings for ditransitive

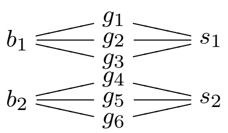
[16] Though there are a few studies that come close. Partee (1975) shows that ditransitive sentences can have dependent readings, which is a counter-example to Chomsky (1975) (see fn 7), but goes no further. de Mey (1981) suggests that sentences with more than two arguments can be used to test whether there is a syntactic constraint on dependent plurals, but does not attempt the actual investigation himself. Finally, Kamp and Reyle (1993) look at sentences where the dependent plural is embedded within a second DP, but do not discuss ditransitives.

[17] In what follows I assume, following the tradition of Carlson (1977), that the bare plural itself takes narrowest scope.

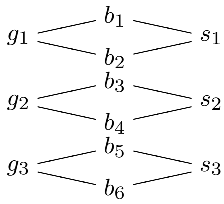
sentences are going to be quite complex, I will use diagrams to represent the various readings rather than English paraphrases, as below[18]:

(70) Two boys told three girls secrets.

(71) a.



b.



As the diagrams show, both scopal possibilities allow for a dependent reading of the bare plural. If *two boys* takes wide scope, as in (71a), we can see that *secrets* can get a dependent reading; in fact, each boy in (71a) only tells one secret, and each girl is only told one secret. The same is true when *three girls* takes wide scope (71b).

The availability of the dependent reading in ditransitives is not limited to the double object construction. Changing the recipient to a *to* PP does not affect the available readings:

(72) Two boys told secrets to three girls.

(72) also allows two scopal relationships between *three girls* and *two boys*, and it to can be true in either (71a) or (71b).

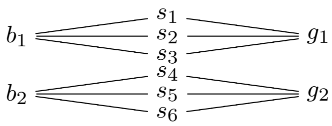
A slightly more complicated situation arises in ditransitives where the bare plural is the recipient rather than the theme:

(73) Two boys told girls three secrets.

(74) Two boys told three secrets to girls.

Both (73) and (74) allow a dependent reading in their surface scope:

(75)



Just like the parallel scenario in (71a), each boy in (75) 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:

(76) Two boys told me three secrets.

(77) Two boys told three secrets to me.

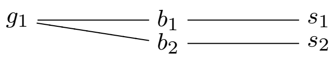
[18] None of the diagrams in this section are supposed to represent the *only* scenario in which the sentences they correspond to may be true. Instead, they represent a sufficient scenario for them to be true, one which can differentiate between the different possible readings available.

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

(78) Two boys told a girl secrets.

Just like in the case of the two plurals, *two boys* and *a girl* have two possible scopal orderings. Let us first consider the wide-scope reading of *a girl* in (78). The multiplicity condition, as we know it, states that there must be more than one secret overall. This is satisfied in the following scenario:

(79)

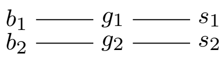


The reading depicted in (79) conforms with our expectations so far. It is a dependent reading in that there only has to be one secret per boy, but there has to be more than one secret overall. Since only one girl is involved, that means she must have told both secrets.

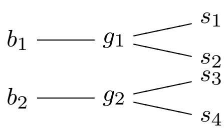
But what of the surface-scope reading of (78)? Based on what we have seen so far, it is a logical expectation that (78) would be true in the scenario depicted in (80a):

(78) Two boys told a girl secrets.

(80) a. #



b.



The situation in (80a) is equivalent to (71a): each boy tells one secret, each girl is told one secret, and more than one secret is told overall. The problem is that (78) is actually false in (80a). Rather, its surface scope reading requires a scenario like (80b). In other words, there have to be multiple secrets *per girl*; the dependent reading is unavailable. The same is true with a *to* PP recipient:

(81) Two boys told secrets to a girl.

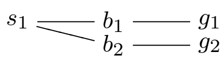
If *a girl* takes wider scope than the subject, (81) is true in (79), but if the subject takes wider scope, it too is false in (80a) and true in (80b).

A similar pattern holds if the theme is singular and the bare plural is the recipient:

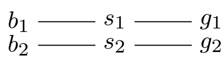
(82) Two boys told girls a secret.

(83) Two boys told a secret to girls.

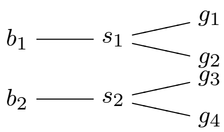
(84) a.



b. #



c.



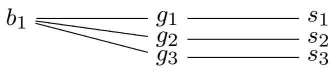
Both (82) and (83) can be true in (84a) and (84c), but not in (84b).

One final case that needs to be examined is what happens when the subject is singular:

(85) A boy told three girls secrets.

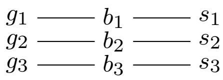
In (85), the reading where the singular DP takes wide scope is the surface scope, rather than the inverse scope as it was in (78). Just like in (79), *secrets* can act as a dependent plural:

(86)

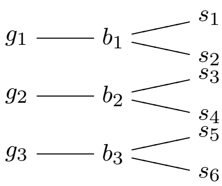


Similarly, the inverse scope reading of (85) acts just like the surface order reading of (78), being true in (87b) but not in (87a):

(87) a. #



b.



What all the examples discussed have in common is that the availability of a dependent reading is entirely contingent on whether the singular DP scopes between the bare plural and the subject, not on what their surface syntactic position is, nor on their semantic role.

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 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.

3.6 Section Summary

This section provided a range of data that proves problematic for previous accounts. In this section, 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 argued 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 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. The task of the remainder of this paper is to account for this data, as well as the data covered by previous approaches.

4 The Meaning of Bare Plurals

Having discussed earlier work and the problems it faces, it is time to lay out my own approach in detail. In this section, I will present the basic principles behind such a theory, setting the scene for its formalization.

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. Where some of the existing theories 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, the fact that a predicate holds of one thing does not preclude that it is also true of several other things. This explains 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. Explicit versions of this idea are developed by Sauerland et al. (2005) and Farkas (2006).

In formal terms, I will assume a mereological theory of plurality[19] Following a tradition well established in the semantic literature (see Link (1998), Hoeksema (1988), Landman (2000), among others) I will take singular NPs to denote atomic individuals, and plural NPs to denote sums of individuals. I will use the * operator, first introduced by Link, to denote closure of an (atomic) predicate under the sum operation. So, of BOY is the set of boys, *BOY is the set that includes all the sums of boys.

So, if the boys are Adam, Bill and Charles, then the following denotations hold:

(88) $[\![boy]\!] = \{a, b, c\}$
$[\![two\ boys]\!] = \{a \sqcup b, b \sqcup c, a \sqcup c\}$

One issue of contention in the literature that treats plurals as sums is whether the denotation of plural nouns (as opposed to plural DPs) includes the atoms. Since I have shown, based on extensive evidence, that bare plurals are number neutral, I will take the view that bare plural denotations range over the whole mereology, including both the atoms and the non-atoms. In other words, the denotation of *boys* is as follows:

(89) $[\![boys]\!] = {}^*[\![boys]\!] = \{a, b, c, a \sqcup b, b \sqcup c, a \sqcup c, a \sqcup b \sqcup c\}$

[19] This choice is made for expository reasons; nothing I say below depends on the use of a mereological implementation of plural semantics. See Zweig (2008) for discussion on how to implement the multiplicity condition in a set-based theory of plurality (e.g. Schwarzschild (1992) among others), or a second-order logic theory (Schein (1993) among others).

(89) is number neutral in the sense that if *a* is a boy, then he falls within the denotation of *boys*. Note that this means that the denotation of *boy* is a subset of the denotation of *boys*. This will play a crucial role in calculating the multiplicity condition as seen below[20].

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 such a complex fashion: 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 observed 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 with the following 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*:

(90) Most men saw three movies $\Rightarrow_{impl}$
'*Most men saw exactly 3 movies.*'

(91) 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[21]:

(92)
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.

[20] Note that in this paper I will not be taking a position as to how bare plurals acquire their existential force. I am assuming that bare plurals denote predicates and that a type-shifting/existential closure rule is involved, along the lines of Chierchia (1998) and Krifka (2004). However, this plays no crucial role in what follows, and my arguments are compatible with other views.

[21] This is somewhat of an oversimplification; a more correct claim is that in these environments the scales are reversed Horn (1972, 2004). Section 8.2 shows how scale reversal leads to the disappearance of the multiplicity condition.

g. Did those men share some pizzas?
No, they shared all of the pizzas.
Yes, they shared all of the pizzas.

A second parallelism between bare plurals and classic scale implicatures is their behavior in non-monotone environments. This was first noted by Spector (2007). He notes an important aspect of the behavior of the following sentence:

(93) Exactly one student solved some difficult problems.

(93) 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 (94):

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

To see this, note that (94) can be paraphrased as (95):

(95) 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, (93) is best paraphrased as (96):

(96) There exists one student that solved some, but not all, of the difficult problems, and there were no other students that solved even one 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, (94)/(95) are true but (93)/(96) are false.

Spector notes that exactly the same pattern occurs with the multiplicity of bare plurals. (97) cannot be paraphrased as (98):

(97) Exactly one student solved difficult problems.

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

The reason here is the same as with the *some* sentence in (93). (98) is true if Bob solved one difficult problem and Mary solved two (and no one else solved any); but (97) is false in that circumstance. An appropriate paraphrase is (99):

(99) 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.

The behavior of bare plurals under quantifiers such as *every* also conforms with the behavior of scalar implicatures. As was first observed Gazdar (1979) scalar implicatures can be embedded under the scope of certain operators, universal quantifiers included[22]:

[22] see section 7 for more on embedded implicatures

(100) 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 (101), and the multiplicity condition in (102) are overridden in a context where it is natural to assume the speaker did not intend them:

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

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

One final set of evidence comes from an acquisition study reported in Sauerland et al. (2005). This study is based on several earlier 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"[23]. 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 (2001) and Gualmini et al. (2001) for a variety of different scalar items.

Based on this data, Sauerland and his co-authors devised a study which 14 children ranging in age from 3 to 6 were asked questions about their world knowledge. The questions formed three categories; the first consisted of questions like (103a), which would be rejected by adults because girls have exactly one nose. The second included questions such as (103b), which would be rejected because fish have no legs. And the final category featured questions such as (103c), that an adult would accept:

(103) a. Does a girl have noses?
b. Does a fish have legs?
c. Does a cat have feet?

The results, as reported by Sauerland et al. (2005), were very clear. For questions such as (103b) and (103c), the children's answers matched expected adult responses 97% of the time. On the other hand, children matched adult-like answers in the (103a) category in only 4% of the trials. 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 not in itself conclusive, (none of the studies supply 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[24].

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

[24] 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 question

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. However, doing so in a way that captures both simple sentences, and sentences with dependent readings, is not straightforward, as will be shown in the next section.

5 Multiplicity as a Scalar Notion: The Problem and Attempts at Solution

There are many different approaches to the calculation of scalar implicatures, and it is beyond the scope of this paper to fully survey them[25]. However, the basic notion that all share is that a sentence is compared against its scalar alternatives, and a calculation takes place as follows: if the weaker alternative is uttered, that must be because the stronger alternative cannot be uttered. Therefore, the utterance of the weaker alternative must mean that the speaker is in no position to utter the stronger alternative; thus, assuming the speaker knows the truth of the stronger alternative, it must be false. For example, take the sentence (104):

(104) Some of the boys arrived.

We can assume that this sentence belongs to the following alternative set[26]:

(105) $\langle$Some of the boys arrived$\rangle^{ALT}$ = {Some of the boys arrived, All of the boys arrived}

Since the weaker member of the alternative set has been uttered, we assume that the stronger one is false, and must be negated, resulting in the following enriched meaning:

(106) Some of the boys arrived, but not all of the boys arrived.

If the multiplicity condition is truly a scalar implicature, then, a similar process must be involved. And, at first blush, this may not look too complicated. We have seen, according to the number-neutral hypothesis of the meaning of bare plurals, a sentence such as (107) asserts something along the lines of (108), which is compatible with at least one dog barking:

(107) Dogs are barking.

(108) $\exists X[^{*}\textsc{dog}(X)\ \&\ ^{*}\textsc{bark}(X)]$

We also know what the outcome of the implicature process is; i.e., the sentence meaning that arises after the negation of a stronger alternative:

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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.

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

26 I will use the notation $\langle\phi\rangle^{ALT}$ to denote the set that contains all the scalar alternatives of ϕ. The use of this notation should not be taken as a commitment to any particular notion of alternative calculation.

(109) $\exists X[{}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(X)\ \&\ \neg|X|=1]$

We can use (109) to work our way backwards through the implicature calculation process. However, we have a minor problem as (109) is not formulated as the conjunction of a proposition with a negated stronger proposition; however, it is easy to see that it is equivalent to (110), which is (remember that lower cap variables denote atoms):

(110) $\exists X[{}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(X)]\ \&\ \neg\exists x[{}^{*}\textsc{dog}(x)\ \&\ {}^{*}\textsc{bark}(x)]$

Or, in English - it's true that one or more dogs barked, and it's not true that one dog barked. Thus, we can say that the enriched meaning of (107) is derived from the conjunction of its meaning, (108), with the negation of (111):

(111) $\exists x[{}^{*}\textsc{dog}(x)\ \&\ {}^{*}\textsc{bark}(x)]$

What remains is to see whether (111) is a plausible alternative to (108). And it appears that it is, as it is the meaning of the singular sentence in (112):

(112) A dog is barking.

It should be clear that (111) entails (108); since the domain of plural variables such as X is a superset of the domain of atomic variables such as x, if (111) is true, then (108) is true.

If we could leave things there, it would appear as if we have exactly the scalar relationship we are looking for. But things are not quite as simple as that. Indeed, (111) is not a stronger reading than (108). Because of the distributive nature of ${}^{*}\textsc{bark}(X)$, (108) entails (113):

(113) $\exists X[{}^{*}\textsc{dog}(X)\ \&\ \forall x \leq X[{}^{*}\textsc{bark}(x)]]$

To see why this is a problem, take a situation in which two dogs, Fido and Benji, are barking. It is true that ${}^{*}\textsc{bark}(fido \sqcup benji)$; thus, (108) is true. But, that entails (113), which in turn ensure that tails that ${}^{*}\textsc{bark}(fido)$ and ${}^{*}\textsc{bark}(benji)$ are both true. But each of these means that (111) is true.

In other words, not only does (111) entail (108), but (108) also entails (111). Despite the difference in the type of variables involved, the two readings are actually equivalent[27]. 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., (108).

It seems, then, that the straightforward comparison attempt does not work. Indeed, this has been observed before, in the literature that looks at the multiplicity condition in non-dependent context, and several attempts have been made to address this. Each of them works by questioning one of the assumptions of the derivation above.

First, it is possible that, despite my arguments above, the multiplicity condition is an implicature, but not a scalar implicature. This approach was taken by Sauerland et al. (2005). The second possibility is that the implicature is calculated by a scalar comparison, but that this comparison is not between (108) and (111), but rather than (108) has a different alternative to be compared to. This is the view of Spector (2007).

[27] This does not hold for collective predicates, but that makes little difference to the problem as the multiplicity condition is unaffected by whether the verb is interpreted as collective or distributive.

Finally, it's possible that, intuitions to the contrary aside, (108) does not actually entail (113). In the following three sections, I shall describe these approaches, and show that they all fail to account for the behavior of bare plural across different environments.

5.1 Sauerland et al. (2005)

Like this paper, the theory proposed in Sauerland et al. (2005) takes bare plurals to be number neutral. Where it differs, however, is that it proposes that singulars are also number neutral as far as their denotation goes. The difference between singulars and plurals is that singulars have an atomicity presupposition, which, moreover, must satisfied locally. This means that the contrast between the singular and the plural is not scalar. Rather, a pragmatic principle, first introduced in Heim (1991), called **maximize presupposition**, is responsible for the behavior of the plural.

Maximize presupposition says that when choosing between two different morphological forms, the one with stronger presuppositions must be chosen, as long as no presupposition violation will result. Given the assumption that the singular form presupposes atomicity, while the plural form has no presupposition, it follows that if the singular form can be used without presupposition failure, it must be used. This, in turn, means that whenever a (bare) plural was used, it is possible to infer that the singular's presupposition would be violated in that context. This inference is a conversational implicature, just not a scalar one. 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 the singular sentence (112), 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 (107), I am in violation of maximize presupposition. On the other hand, if two dogs were barking, uttering (112) would lead to presupposition failure, while (107) can be uttered safely. Thus, the use of (107) implies that, given the assumption that the speaker is being cooperative, he must believe that more than one dog barked.

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 *per se* is not involved. However, they note that a sentence which says "there is no atom x such that $\phi(x)$" is inherently weaker than saying "there is no X such that $\phi(X)$", 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 discuss sentences with an *every* subject, such as (114) below[28]:

(114) Every boy invited friends to the party.

(115) Every boy invite a friend to the party.

[28] The actual examples in Sauerland et al. (2005) are more complicated, featuring a modal and a possessive, but neither affect their argument so they have been removed for simplicity.

Their argument is that in (115), the atomicity presupposition of *a friend* is distributed over by the subject, so that (115) presupposes that each boy had invited a single friend. They point out that in a situation where at least one boy invited more than one friend, (115) cannot be used and (114) must be used instead. This is indeed correct. But the situation is more complicated when sentences with dependent readings are considered:

(116) All the boys invited friends to the party.

(117) All the boys invited a friend to the party.

Sauerland et al. do not discuss what happens to the atomicity presupposition of *a friend* under *all*. But since (117) can only be used felicitously if each boy invited a single friend, then it appears that the presupposition is distributed over by the subject, just like in (115). But this creates the exact same expectation as before: that (116) could only if each boy invited more than one friend. However, as we know, (116) can be used even if each boy invited a single friend, as long as more than one friend was invited overall.

Thus, it appears that while the proposal in Sauerland et al. (2005) can derive the multiplicity condition in some cases, it cannot explain the behavior of dependent plurals. 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 is a sufficient explanation for the behavior of bare plurals.

5.2 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:

(118) 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:

(119)
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):

(120) 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:

(121) a. $\langle$Jack saw horses$\rangle^{ALT}$ = {Jack saw horses, Jack saw a horse}
b. $\langle$Jack saw a horse$\rangle^{ALT}$ = {Jack saw several horses, Jack saw horses, Jack saw a horse}
c. $\langle$Jack saw several horses$\rangle^{ALT}$ = {Jack saw several horses}

Implicatures are now calculated in the normal fashion. (119c) has only one alternative, so it has no implicature. (119a) has two alternatives; however, they both have the same basic meaning. Thus, there is no implicature as well. (119b), however, has a stronger alternative. This alternative is negated and an enriched meaning is derived. This stage is the first-level implicatures:

(122) a. I_1((119a)) = Jack saw *at least one horse.*
b. I_1((119b)) = Jack saw *exactly one horse.*
c. I_1((119c)) = 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. (119c) still has only one alternative, so its meaning does not change. (119b) has one alternative which is weaker (122a), and one which is no longer ordered relative to it (122c). Neither is stronger, so there is no enriched meaning. (119a), however, now has a stronger alternative in (122b). This is negated, creating the second-level implicatures:

(123) a. I_2((119a)) = Jack saw *at least one horse but not exactly one horse.*
b. I_2((119b)) = Jack saw *exactly one horse.*
c. I_2((119c)) = 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 (119a) and (119b).

In downwards entailing environments, the scales are reversed. In this case, neither (119a) nor (119b) 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:

(124) a. Three men saw horses.
b. Three men saw a horse.
c. Three men saw several horses.

Which can be paraphrased as:

(125) a. Three men saw *at least one horse.*
b. Three men saw *at least one horse.*
c. Three men saw *at least two horses.*

And have the following alternatives:

(126) a. ⟨Three men saw horses⟩^{ALT} = {Three men saw horses, Three men saw a horse}
b. ⟨Three men saw a horse⟩^{ALT} = {Three men saw several horses, Three men saw horses, Three men saw a horse}
c. ⟨Three men saw several horses⟩^{ALT} = {Three men saw several horses}

The first round of implicature calculation gives:

(127) a. I_1((124a)) = Three men saw *at least one horse.*
b. I_1((124b)) = Three men saw *exactly one horse.*
c. I_1((124c)) = Three men saw *at least two horses.*

And, the second round:

(128) a. I_2((124a)) = Three men saw *at least one horse but not exactly one horse.*
b. I_2((124b)) = Three men saw *exactly one horse.*
c. I_2((124c)) = Three men saw *at least two horses.*

And no further rounds make a difference. But (128a) 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 {Three men saw horses, Three men saw a horse}, the alternative set of (124a) would have been {Three men saw horses, There was a horse that three 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.

5.3 Eliminating lexical distributivity[29]

One final approach is worth considering. Recall that the problem with calculating the multiplicity implicature as a straightforward scalar implicature was that it appears that with a distributive predicate, it's not only true that (112) entails (107), but that (107) also entails (112):

(107) Dogs are barking.

(112) A dog is barking.

However, it may be that the entailment from (107) to (112) is not a real problem. After all, it depends on world knowledge; we know that it is impossible for multiple dogs to bark without it being the case that single dogs bark, and we encode this with the * operator on the predicate. Perhaps, however, this is a false step - perhaps out semantic

[29] I wish to thank an anonymous reviewer for suggesting this approach to me.

system does not capture distributivity information based on world knowledge. In such a system, we can give the sentences paraphrases as follows:

(129) Either exactly one dog is barking, or exactly two dogs is barking, or exactly three dogs is barking...

(130) Exactly one dog is barking.

Note that none of the disjuncts in (129) entail each other, and certainly (129) does not entail (130), but the (130) still entails (129). Thus, scalar calculation can proceed without a hitch.

This idea, of course, has implications far beyond the semantics of bare plurals. Indeed, much of the work of researchers such as Link and Landman would have to be reevaluated, as it relies heavily on distributivity entailments. However, for our purposes, it is sufficient to ask whether this will properly account for the multiplicity behavior. The answer, unfortunately, is no. While it derives the correct implicature in positive contexts, it predicts the wrong meaning in negative contexts.

As is well known, negative contexts invert scales. Thus, while (131) entails that not all the cookies were eaten, (132) entails that some were:

(131) I ate some of the cookies. $\Rightarrow_{impl}$ I ate some but not all of the cookies.

(132) I didn't eat all of the cookies. $\Rightarrow_{impl}$ I didn't eat all of the cookies, but it's not true I didn't eat some.

This is because *not some* is stronger than *not all*. However, note that negating (129) gives a result that is strictly stronger than the negation of (130):

(133) It's false that either exactly one dog is barking, or exactly to dogs is barking, or exactly three dogs is barking... $\Longleftrightarrow$
It's false that any amount of dogs is barking.

(134) It's false that exactly one dog is barking.

As a direct result, we now predict that instead of the multiplicity implicature canceling under negation, it will be reversed:

(135) It's not true that a dog is barking $\Rightarrow_{impl}$ It's not true that exactly one dog is barking, but some amount of dogs is barking.

Or, to put it differently, this view predicts that *It's not true that a dog is barking* and *Dogs are barking* are synonymous, which is obviously incorrect[30].

5.4 Summary

In this section, I have shown why attempting to calculate the multiplicity implicature by comparing the sentence as a whole with a singular alternative fails. I have also discussed several proposed solutions to this problem, and have shown that, while they

[30] It is also not at all clear to me that this view can account for dependent readings; however, this relies on specific assumptions about plurality and cumulativity that may not be shared by researchers exploring this view. I therefore leave open the possibility that a theory of plurality that is built without an equivalent to the * operator may properly account for the behavior of bare plurals in the scope of other plurals.

work for simple, positive sentences, no single account works for both negative sentences and dependent plural readings.

The fact that several proposals fall short, however, is not in itself a reason to abandon the implicature account of multiplicity. Rather, it suggests that we perhaps need to look elsewhere for the solution. Identifying the right alternative is not sufficient. Rather, we need to also identify the comparison domain. Below, I will argue that this domain is provided by a Neo-Davidsonian event semantics. In the next section, I will explain why events are closely tied to plurality.

6 Cumulativity and Events

Before I will discuss the use of events in calculating the multiplicity condition, it is worthwhile to take a step back and see why events have become a major part of the research into plurality. The main reason for this has been cumulative readings. We have already discussed cumulative readings, and have seen that they share some properties with dependent plural readings, even though neither can be reduced to the other. Of specific importance to us is the fact that cumulative readings provide a problem to the traditional, view of scope. To see the basic problem, let us look at a simple sentence, such as sentence (136):

(136) Five elephants sat on a thousand mice.

It is easy to see that (136) has a cumulative reading in which five elephants were involved in sitting, and one thousand mice were sat on, in total. In the standard view, in order for arguments of SAT to be saturated by the two DPs *five elephants* and *a thousand mice*, the predicate must fall in the scope of both. And since scope is taken to be both linear and transitive, the only way for that to happen is if one outscopes the other, as schematically represented below:

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

However, neither (137a) nor (137b) properly represent the cumulative reading; in (137a), a total of five thousand mice was sat on, while (137b) has a total of five thousand elephants doing the sitting.

One of the most important developments in the literature on plurality was the observation by Schein (1993) that using a neo-Davidsonian event semantics allows for a solution to this problem. In a neo-Davidsonian event theory, arguments are not introduced directly as arguments of the main predicate but rather are introduced via role predicates, which are conjoined to each other. In other words, it is possible for an argument of a predicate to fall under the scope of a quantifier without the predicate itself (or the predicate's other arguments) falling under the quantifier's scope. This allows for a semantics where the DPs are also scopally independent of each other:

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

Unlike (137a) and (137b), (138) captures the cumulative reading of (136) in a straightforward manner[31].

[31] Note that this is an oversimplification; while events are one method of achieving a scopeless reading for (136), there are quite a few other methods which can achieve similar results for

We have already seen that dependent plural readings resemble cumulative readings in many ways, one of which is the lack of scopal dependency between the bare plural and the other plural arguments. This suggests that they, too, are best accounted for in terms of events. Below, I will show that the use of events is indeed crucial for the calculation of the multiplicity implicature.

In what follows I will be adopting an event theory based to a large extent on the implementation by Landman (2000). In Landman's system, we can distinguish between two types of arguments: those interpreted scopally, and those interpreted non-scopally. The basic denotation of the verb and its arguments is a predicate over events. Let us take a simple sentence:

(139) Two dogs ran.

Based on the denotations of the lexical items, we can derive a denotation, such as (140), for (139)[32]:

(140) $\lambda e[\exists X[{}^*\textsc{dog}(X) \,\&\, |X|=2 \,\&\, {}^*\textsc{ag}(e)(X)] \,\&\, {}^*\textsc{run}(e)]$

Of course, this is not a final sentence meaning. In order to get to the desired meaning of the sentence, Landman uses a type-shifting rule of existential closure over events. So, from (140) we can reach (141):

(141) $\exists e[\exists X[{}^*\textsc{dog}(X) \,\&\, |X|=2 \,\&\, {}^*\textsc{ag}(e)(X)] \,\&\, {}^*\textsc{run}(e)]$

As mentioned above, there is a second option available to quantified DPs, in that they can take wide scope. If they do so, the DP denotation will not be applied to the sentence until after existential closure of the event occurs. Scopal readings, under Landman, are always distributive. A scopal reading for (139) is as follows:

(142) $\exists X[{}^*\textsc{dog}(X) \,\&\, |X|=2 \,\&\, \forall x\in X[\exists e[{}^*\textsc{run}(e) \,\&\, {}^*\textsc{ag}(e)(x)]]$

Note that in a sentence with just one quantificational operator, there is no clear difference between a scopal and non-scopal distributive reading. When more than one

this type of sentence. These include branching quantification (Sher 1990), and methods of splitting the quantifier from its restriction, such as the ** operator (Beck 2000) and similar type shifters, or the addition of a layer of degree quantification (Ferreira 2007).
To see the full importance of Schein's (1993) observation, it is necessary to examine sentences with more than two quantifiers:

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

This sentence has many possible readings. The one of interest here is the one where *three ATMs* and *two members* are unscoped with regard to each other, but *Exactly two passwords* is distributed over by *two new members* but not by *three ATMs* (so that, overall, three ATMs, two members, and four passwords were involved). This reading can be accounted for in a neo-Davidsonian event theory:

(ii) $\exists e[{}^*\textsc{give}(e) \,\&\, \exists X[{}^*ATM(X) \,\&\, |X|=3 \,\&\, {}^*\textsc{ag}(e)(X)] \,\&\, \exists Y[{}^*\textsc{member}(Y) \,\&\, |Y|=2 \,\&\, {}^*\textsc{to}(e)(Y) \,\&\, \forall y\in Y[\exists Z[{}^*\textsc{password}(z) \,\&\, |Z|=2 \,\&\, \exists e\in e'[{}^*\textsc{th}(e')(Z)]]$

The other solutions mentioned above, on the other hand, cannot account for this sentence (though see Bayer (1996) and McKay (2006) for a contrary viewpoint).

[32] Note that the details of this denotation are not crucial; following Landman and Schein, I treat events as mereologies akin to entity mereologies, but this plays no role in the calculation below. The crucial details are the neo-Davidsonian argument relations, and the fact that the sentence meaning, at one stage, is a predicate over events.

plural DP is involved, however, the two differ significantly. If both DPs are interpreted non-scopally, then they are joined by a conjunction, and no scopal dependency exists between them, and a cumulative reading is achieved. If one (or both) is interpreted scopally, then a scopal dependency will be created.

In summary, then, the event system adopted has two main properties:

1. The semantic derivation of a sentence includes a stage of meaning wherein the existing structure denotes a predicate over events.
2. Quantified plural DPs can be interpreted either scopally or non-scopally; both allow for distributive readings, but differ in whether a scopal dependency is achieved. Crucially, scopal readings are calculated at a point later than the stage of composition where event closure occurs.

6.1 Do events solve the scalar calculation problem?

Before we proceed, it is worth noting that the mere addition of events to our semantics does not solve the problem of scalar entailments. If we were to just add event variables to (108) and (111) we will get the following:

(143) $\exists e \exists X[{}^{*}\textsc{dog}(X)\ \&\ {}^{*}\textsc{bark}(e)\ \&\ {}^{*}\textsc{ag}(e)(X)]$

(144) $\exists e \exists x[{}^{*}\textsc{dog}(x)\ \&\ {}^{*}\textsc{bark}(e)\ \&\ {}^{*}\textsc{ag}(e)(x)]$

The number neutrality of X means that (144) entails (143), and the event quantifier makes no difference there. The question is - does it make a difference to the other direction entailment? Under normal assumptions about event, the answer is no. Events are taken to be ordered in mereological structures, just like individuals[33]. To see why this is necessary, consider (145) and (146):

(145) At least three dogs barked.

(146) A dog barked.

The fact that (145) entails (146) follows naturally in an event-less system, but in a Neo-Davidsonian system, these two sentences translate as merely positing the existence of two different events. For the entailment relation to follow, it must be assumed that the existence of an event of (at least) three dogs barking entails the existence of an event of a dog barking. Similar reasoning can be generalized to all plural-entity containing events. But that means that the existence of an event as described in (143) must also entail the existence of an event as in (144)[34].

Thus, events on their own are not sufficient to calculate the multiplicity condition. In the next section, we will see that we also need a more refined method of calculating implicatures in order to take advantage of the Neo-Davidsonian semantics.

[33] In fact, even theories of plurality that reject the use mereological sums of individuals tend to retain them for events; one such example is Schein (1993).

[34] As has been discussed in section 5.3, this relies on the assumption that predicate distributivity needs to be captured in our logical forms. It is perhaps possible to write an event-based semantics that does away with this assumption, but as far as I can tell, such an analysis will raise the same issues as the event-less, distributivity-free system discussed in that section.

7 Local Implicature Calculation

In the original work of Grice (1975), and in the work of those who have expanded upon it (such as Horn (1972)), implicature calculation is taken to be a process that applies to full sentence meanings. That is, first the meaning of the entire sentence is calculated according to semantic principles. Then, a pragmatic calculation takes place, giving rise to any implicatures.

As expressed above, this is an entirely global phenomenon; the sentence is considered as a whole. However, as has already been mentioned above, sometimes implicatures appear to embed under operators such as universal quantifiers. We have already seen one such example:

(100) Every boy ate some of the cookies.

If the global procedure above were to be followed, then we would be comparing (100) to the following set of alternatives:

(147) $\langle$Every boy ate some of the cookies$\rangle^{ALT}$ =
{Every boy ate some of the cookies,
Every boy ate all of the cookies}

Then, the stronger alternative would be negated and the result would be:

(148) Every boy ate some of the cookies, and it is not the case that every boy ate all of the cookies.

But (148) is not the correct enriched meaning for (100). Instead, to achieve the correct meaning, it seems that we need to compare alternatives not of the entire sentence, but of the semantic entity that *every boy* combines with. Specifically, assuming a standard semantics, there has to be a point where *every boy* combines with the (derived) predicate *eat some of the cookies*. In order to get the correct meaning of (100), it would appear that we need to compare the scalar alternatives of the predicate:

(149) $\langle$eat some of the cookies$\rangle^{ALT}$ =
{eat some of the cookies,
eat all of the cookies}

And negate the stronger predicate, resulting in an enriched predicate:

(150) eat some of the cookies but do not eat all of the cookies.

Which can then be combined with the quantifier to result in the final meaning for the sentence:

(151) Every boy ate some of the cookies, but did not eat all of the cookies.

Which is, indeed, the meaning speakers assign to (100)

This, then, is local implicature calculation - alternatives are compared on parts of the sentence during the derivation, rather than only on complete sentence meanings.

While the above example may seem simple, local implicature calculation has major implications towards the view of the semantics/pragmatics relationship. Gricean reasoning is based on the notion of speaker behavior - specifically, the cooperativity principle. While scalar implicatures are taken to usually operate at an automatic level below explicit consciousness, the normal assumption is that, if asked, a linguistically untrained speaker could still explain the reasoning behind the inferences she has just made. This is far harder to imagine in these cases, and it is not at all clear that notions such as derived predicates are available to speakers at any level other than the purely grammatical. This has led researchers into two opposing directions - some argue that the calculation of scalar implicatures is not really a pragmatic phenomenon at all, but rather a purely grammatical one, and that what looks like Gricean reasoning is really just a *post-hoc* recasting of a purely semantic process. Perhaps the most detailed arguments currently available for this view can be found in Chierchia et al. (to appear). One the other hand, some researchers reject this view and argue that so-called local implicatures are still derivable from global calculations; these include Russell (2006), Guerts (2009), and many others.

This controversy, to a large extent, lies beyond the scope of this paper, and I will not deal with it directly. Rather, I will make the following assumption - whatever process accounts for "local" implicatures in sentences like (100) is the same process that accounts for the multiplicity implicature of bare plurals. Whether this is a pragmatic process or a grammatical one, is not one that I can address here.

Nonetheless, it is necessary for me to adapt a specific framework in order to demonstrate how multiplicity implicatures are derived. This framework will be inspired almost entirely by Chierchia (2004, 2006), though somewhat simplified. This framework, much like my mock calculation of (100)'s implicatures above, lies halfway between the grammatical and pragmatic view - namely, it treats scalar implicatures as being derived locally but does so using the same scalar principles that the pragmatic view takes to apply at the global level. In the following section, I will give a detailed description of the workings of this system.

7.1 Chierchia's (2006) system of implicature calculation

As alluded to above, Chierchia's (2006) implicature calculation system 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 globally, they are calculated at various points in the semantic derivation. What makes this system especially useful to current purposes is that it makes the points of local computation explicit. 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 semantic element (usually, a predicate of some sort) that will be combined with the scopal operator 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 three-point scale such as the following numerals:

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

For instance, take (153a). It can be represented, somewhat informally, by the LF in (153b):

(153) a. Two men laughed.
b. $\exists X[|X| \geq 2 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)]$

Using the scale in (152), it is possible to calculate the following alternative set for (153b):

(154) $\langle \exists X[|X| \geq 2 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)]\rangle^{ALT} =$
$\{\exists X[|X| \geq 3 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)],$
$\exists X[|X| \geq 2 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)],$
$\exists X[|X| \geq 1 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)]\}$

By uttering the sentence (153a), the speaker signals that she thinks all the alternatives in (154) stronger than (153b) are false. There is one such alternative, the one which states $|X| \geq 3$. Thus, its negation is added, by conjunction, to (153b), giving the following enriched meaning:

(155) $\exists X[|X| \geq 2 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)] \;\&$
$\neg\exists X[|X| \geq 3 \;\&\; {}^*\textsc{man}(X) \;\&\; {}^*\textsc{laugh}(X)]$

Of course, (153a) is a relatively simple case. It only contains 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 (156):

(156) Every student laughed at two professors.

This sentence is of a similar for to example (100) described in the previous section. In Chierchia's system, much like in the informal discussion above, the alternatives are compared before each scopal element, as well as at the root sentential 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, the element under comparison is the predicate represented in (157):

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

At this point, the calculation path splits. The first path involves calculating the alternative set at this point, which is as follows:

(158) $\langle \lambda y \exists X[|X| \geq 2 \;\&\; {}^*\textsc{prof}(X) \;\&\; {}^*\textsc{laugh at}(y)(X)]\rangle^{ALT} =$
$\{\lambda y \exists X[|X| \geq 3 \;\&\; {}^*\textsc{prof}(X) \ldots],$
$\lambda y \exists X[|X| \geq 2 \;\&\; {}^*\textsc{prof}(X) \ldots],$
$\lambda y \exists X[|X| \geq 1 \;\&\; {}^*\textsc{prof}(X) \ldots]\}$

As we are dealing with predicates rather than sentence meanings, the scalar relation is set containment rather that entailment. 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 uttered predicate, and it is ruled out, giving the enriched predicate in (159):

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

Now it is time to apply *every student* to the enriched predicate, giving the LF in (160):

(160) $\forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 2 \;\&\; \neg(|X| \geq 3) \;\&\; {}^{*}\textsc{prof}(X) \;\&\; {}^{*}\textsc{laugh at}(y)(X)]]$
'*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 (157):

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

Here, scalar alternatives were not yet calculated. Thus, it is time to calculate the alternatives set to (161):

(162) $\langle \forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 2 \;\&\; {}^{*}\textsc{prof}(X) \;\&\; {}^{*}\textsc{laugh at}(y)(X)]] \rangle^{ALT} =$
$\{\forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 3 \;\&\; {}^{*}\textsc{prof}(X) \ldots]],$
$\forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 2 \;\&\; {}^{*}\textsc{prof}(X) \ldots]],$
$\forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 1 \;\&\; {}^{*}\textsc{prof}(X) \ldots]]\}$

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:

(163) $\forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 2 \;\&\; {}^{*}\textsc{prof}(X) \;\&\; {}^{*}\textsc{laugh at}(y)(X)]] \;\&$
$\neg \forall y[\textsc{student}(y) \rightarrow \exists X[|X| \geq 3 \;\&\; {}^{*}\textsc{prof}(X) \;\&\; {}^{*}\textsc{laugh at}(y)(X)]]$
'*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:

(160) Every student laughed at exactly two professors.

(163) 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 determine which of the two enriched meanings is the correct one, Chierchia offers the following principle:

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

Since (163) only rules out a case where all the students laugh at more than two professors, while (160) 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, (160) 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:

(165) No student laughed at two professors.

At the first scopal point, (165) is identical in its LF to (156). Thus, its enriched LF is (159), and after *no students* is applied, we get the following meaning:

(166) $\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 2\ \&\ \neg(|X|\geq 3)\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh at}(y)(X)]]$
'*No student laughed at exactly two professors*'

But this is an unwelcome enrichment; it is actually weaker than the intended meaning of the sentence, as (166) is true if some, or even all, of the students laughed at three or more professors, while normally (165) 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:

(167) $\langle\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 2\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh at}(y)(X)]]\rangle^{ALT} =$
$\{\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 3\ \&\ {}^{*}\textsc{prof}(X)\ldots]],$
$\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 2\ \&\ {}^{*}\textsc{prof}(X)\ldots]],$
$\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 1\ \&\ {}^{*}\textsc{prof}(X)\ldots]]\}$

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:

(168) $\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 2\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh at}(y)(X)]]\ \&$
$\neg\neg\exists y[\textsc{student}(y)\ \&\ \exists X[|X|\geq 1\ \&\ {}^{*}\textsc{prof}(X)\ \&\ {}^{*}\textsc{laugh at}(y)(X)]]$
'*No student laughed at two professors, but it is not the case that no student laughed at any professors*'

Which can be paraphrased as:

(169) 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 (163) ends up being the overall sentence meaning.

To summarize, Chierchia's system is has the following properties, both of which will be crucial for our purposes:

1. Instead of only allowing comparison of propositions, predicates at specific points in the semantic calculation are also compared with their scalar alternatives.
2. The scalar calculation happens multiple times, but it is not recursive. Rather, the outcome of the process is itself an alternative set - a set of possible enriched meanings, one for each potential comparison point. Of these, the strongest is chosen.

In section 8 below, we will see how this system allows the calculation of the multiplicity implicature.

8 The Calculation of the Multiplicity Implicature

In the previous two sections, we have seen the motivation for using an event semantics for plurality, and for adopting a local theory of implicature calculation. In this section, I will show how, together with a number-neutral theory of bare plurals, they can be used to calculate the multiplicity implicature.

The basic insight is this: local implicature calculation applies not just to sentence denotations, but also to (some) sentence elements, which have predicate denotations. A Neo-Davidsonian event system suggests that before event closure is applied, a sentence denotes a predicate over events. I will argue that this predicate can also serve as a calculation point for implicatures. This, indeed, is not a new idea; 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 that is associated with numerical DPs, in sentences where these are involved in cumulative readings. While detailing Landman's arguments will take us too far afield, it is worth noting that if we allow implicatures to be calculated over any type of predicate, there seems to be no barrier to doing so with event predicates.

In the following sections, I will show how this basic idea allows us to calculate the multiplicity implicature and avoid the problems described in section 5.

8.1 Simple Sentences

As just described, the neo-Davidsonian framework we adopted above offers us a new point in the derivation of a sentence's meaning where, potentially, implicatures may be calculated: the point after the all the arguments have been incorporated into a predicate over events, but before event closure has applied. Again, we take as our example sentence the following:

(107) Dogs are barking.

We can calculate that, before event closure, the sentence denotes the following predicate:

(170) $\lambda e \exists X[{}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$

Which can be compared to the following predicate, involving a agent:

(171) $\lambda e \exists x[{}^*\textsc{dog}(x) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(x)]$

Are (170) and (171) in a scalar relationship? Let us imagine that there are two events, e_1 and e_2, such that e_1 is an event of Fido barking, and e_2 is an event of Benji barking. Let us say that e_3 is the sum of these two events; i.e. $e_3 = e_1 \sqcup e_2$. In this scenario, e_3, e_1 and e_2 are members of the set in (170), but only e_1 and e_2 are members of the set in (171). In other words, there is a scalar relationship ((171) is a subset of (170)) between the two sets. Canceling the stronger alternative, then, allows us to derive the enriched meaning (172):

(172) $\lambda e \exists X[{}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)] \;\&$
$\neg \exists x[{}^*\textsc{dog}(x) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(x)] \Longleftrightarrow$

$$\lambda e \exists X[{}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X) \;\&\; \neg\exists x[x = X]] \Longleftrightarrow$$
$$\lambda e \exists X[|X|>1 \;\&\; {}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$$ [35]

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

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

The final step is to compare the enriched meaning in (173) with the enriched meaning after existential closure applies (as discussed in section 6.1). The fact that there is no actual enrichment at the later stage does not matter; (173) can still be compared to (108). Since (173) is clearly a stronger reading than (108), it wins, and the sentence thus gets the meaning "more than one dog barked".

8.2 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[36]. Consider (174):

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

We follow the same procedure as above, assuming (as is necessary for the correct reading) that negation takes wider scope than the event quantifier. Therefore, before event closure applies, we have the same predicate over events as in positive case (107), and thus the first calculation point provides the same enriched predicate as (172) above:

(175) $\lambda e \exists X[|X|>1 \;\&\; {}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$

Existential closure and negation then apply, giving the first potential enriched sentence meaning:

(176) $\neg\exists e \exists X[|X|>1 \;\&\; {}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$

The second potential calculation point is after the application of existential closure:

(177) $\exists e \exists X[{}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$

As discussed above, once event closure applies replacing the plural variable with a singular alternative does not give a stronger reading, so there is no meaning enrichment. Thus, after sentential negation is applied, the second potential sentence meaning is (178):

(178) $\neg\exists e \exists X[{}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$

The third calculation point is the sentence root:

(179) $\neg\exists e \exists X[{}^*\textsc{dog}(X) \;\&\; {}^*\textsc{bark}(e) \;\&\; {}^*\textsc{ag}(e)(X)]$

Just like the positive case, there is no stronger alternative. Thus, the third potential sentence meaning is (179), which is identical to (178). (178)/(179) is compared to the

[35] To see that this equivalence holds, note that $\exists X[|X|>1]$ is equivalent to $\exists X[\neg\exists x[x = X]]$.

[36] For readability purposes, from now on I will leave out intermediate steps from the calculations that do not add anything new to the derivations detailed above.

potential meaning in (176). It is easy to see that (176) 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, (178)/(179) wins out as the sentence reading, giving us a sentence with no multiplicity condition.

It is important to note that the fact that once existential closure is applied, replacing the plural variable with a singular alternative no longer creates a scalar relationship – the cause of the problem in section 5 – here explains the behavior of the multiplicity condition under negation. Instead of the reverse implicature emerging, no implicature emerges.

8.3 Sentences with Dependent Readings

Now that we have seen how the multiplicity implicature is calculated in sentences 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:

(180) Five boys flew kites.

There are several options for the interpretation of the subject *five boys*. As discussed above, the numerical indefinite can be interpreted *in-situ*, or scopally. Let us look at these two options in turn:

8.3.1 In-situ *reading*

First, we calculate the event predicate, which is given below:

(181) $\lambda e \exists X \exists Y[|X|=5 \ \& \ {}^*\textsc{boy}(X) \ \& \ {}^*\textsc{kite}(Y) \ \& \ {}^*\textsc{flew}(e) \ \& \ {}^*\textsc{ag}(e)(X) \ \& \ {}^*\textsc{th}(e)(Y)]$

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:

(182) $\exists e \exists X \exists Y[|X|=5 \ \& \ {}^*\textsc{boy}(X) \ \& \ |Y|>1 \ \& \ {}^*\textsc{kite}(Y) \ \& \ {}^*\textsc{flew}(e) \ \& \ {}^*\textsc{ag}(e)(X) \ \& \ {}^*\textsc{th}(e)(Y)]$

Like with the simple case discussed above, once existential closure is applied, all the alternatives are equal. Thus, the other enriched meaning candidate is as follows:

(183) $\lambda e \exists X \exists Y[|X|=5 \ \& \ {}^*\textsc{boy}(X) \ \& \ {}^*\textsc{kite}(Y) \ \& \ {}^*\textsc{flew}(e) \ \& \ {}^*\textsc{ag}(e)(X) \ \& \ {}^*\textsc{th}(e)(Y)]$

It should be clear that (182) is stronger than (183), and thus it wins as the final sentence meaning.

But note that (183) is exactly identical to the cumulative reading of (184):

(184) 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 (180) 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, (180) is thought to be compared with (185):

(185) Five boys flew a kite.

However, that view is only a rough approximation. What is actually compared is event descriptions, so that the bare plural sentence is compared to the reading of (185) where both *five boys* and *a kite* are interpreted *in situ*. Nothing in the implicature calculation involves the other readings of (185). 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 (185). Rather, it predicts that the dependent reading will arise if it impossible to use (185) 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 (180) to get a dependent reading.

8.3.2 Scopal Reading

Another possible interpretation available to (180) is the one where the subject uses a scopal mechanism to take wide-scope.

Again, the first step is calculating the event predicate. Because the subject scoped out, we actually have a function from events to predicates:

(186) $\lambda e \lambda x \exists Y[^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(e) \ \& \ ^*\textsc{ag}(e)(x) \ \& \ ^*\textsc{th}(e)(Y)]$

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:

(187) $\exists X[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ \forall x \leq X \exists e \exists Y[|Y|>1 \ \& \ ^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(e) \ \& \ ^*\textsc{ag}(e)(x) \ \& \ ^*\textsc{th}(e)(Y)]]$

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:

(188) $\exists X[|X|=5 \ \& \ ^*\textsc{boy}(X) \ \& \ \forall x \leq X \exists e \exists Y[^*\textsc{kite}(Y) \ \& \ ^*\textsc{flew}(e) \ \& \ ^*\textsc{ag}(e)(x) \ \& \ ^*\textsc{th}(e)(Y)]]$

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 (187).

The final step is comparing (186) and (187) 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, (186) is the final enriched meaning of the scopal interpretation of (180). 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.

8.4 Ditransitives and Intervention Effects

In section 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 (78), 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.

(78) 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*. A scopal relationship between the two is possible only if *two boys* also scopes over the event closure. As shown above, if *two boys* has scoped out, 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.

8.5 Bare Plurals in the Scope of *Every*

A very similar reasoning explains why sentences with a singular quantified subject do not have dependent readings:

(189) Every boy flew kites.

It has been independently motivated in the literature on plurals and events (Schein 1993, Landman 2000) that singular quantifiers such as *every boy* cannot be interpreted *in-situ*, and must always scope above the event predicate. If this is true, then the behavior of (189) follows in a straightforward manner; as seen in 8.3.2 for plural subjects, an element that scopes over event quantification will "trap" the multiplicity condition below. The only difference between *every* sentence and plural-DP sentences is that the former do not have the option of an *in-situ* reading, thus lacking the dependent reading altogether[37].

[37] This data applies only to *every* in subject position. In object position, there is a further complication. Compare the following two sentences:

8.6 Summary

This section explained both how the multiplicity implicature is calculated, but also why it shows the range of behavior discussed in section 3. It was shown that before existential closure, the event predicate with a plural variable is weaker than its counterpart with a singular variable, allowing for a scalar implicature to be calculated. Furthermore, I have shown that the multiplicity implicature will be interpreted scopelessly relative to any quantifier that is interpreted *in-situ*, but it will be trapped under any quantifier that scopes out. This explains its behavior in a variety of environments.[38]

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

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

As expected, (i) does not allow for a dependent reading; each left handed player had won multiple games. But (ii) does allow such a reading, where not all left-handed players won more than one game. If *every* DPs in object position had to be interpreted scopally in the same way as *every* subjects, this should be impossible. 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 Peru. 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 (iii); however, its passive counterpart (iv) is false:

(iii) The Fijians and the Peruvians won every game.

(iv) Every game was won by the Fijians and the Peruvians.

Native speakers uniformly judge that (iv), unlike (iii), implies that each game was won by both teams, an impossibility. When asked for a passive sentence that means the same as (iii), speakers give (v):

(v) All the games were won by the Fijians and the Peruvians.

A second piece of evidence comes from May (1985). May observed that while (via), where the *every*-DP is a subject, allows a pair-list reading, (vib), wherein the *every* DP is an object, does not:

(vi) a. Which book did every student read?
  b. Which student read every book?

In this, the object in (vib) again shows the same behavior as an *all* DP, which will not allow a pair-list reading in any position:

(vii) a. Which book did all the students read?
  b. Which student read all the books?

Neither (viia) nor (viib) 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 (see footnote 38 below). 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.

[38] The observant reader will not that the theory as presented in this section does not account for the dependent readings of *all* and *most*, as it provides no way to distinguish between the availability of cumulative readings and that of dependent readings. In order to do so, it would be necessary to argue that the distributivity associated with *all* and *most* is fundamentally different from that of other quantifiers. Proposals of this nature have been independently argued for in Dowty (1986) and Brisson (2003). Unfortunately, it is not clear that either of these approaches would explain this particular contrast, and combining either (or both) of

It is worth noting that while I couched my analysis in terms of a specific theory of local implicatures (Chierchia 2006), this is not essential. I am not arguing that dependent plurals form an argument in favor of Chierchia's view, even though they certainly are compatible with it. Rather, I believe it is the case that whatever accounts for Gazdar's (1979) original observation that some implicatures appear to be scoped over by certain operators, also accounts for dependent plural readings. If it turns out that the local implicature view is wrong, and that the embedded implicatures are derived by some other mechanism, I would expect that that mechanism will also be usable to explain the behavior of the multiplicity implicature of bare plurals.

9 A note on Cross-linguistic Variation

So far in this paper, I have focused almost exclusively on English. However, it is worth mentioning two issues that arise when further languages are considered. The first issue goes back to de Mey (1981), who has famously observed the following distinction between English and Dutch:

(190) 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 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[39]. 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:

(191) 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.

More problematic for the number-neutral view advocated in this paper, perhaps, is the fact that while the behavior of English bare plurals is mirrored in many other languages across the world[40], it is not a universal phenomenon. Some languages, such as Brazilian Portuguese[41], as well as Hungarian and Finnish, do not allow dependent readings, or only allow them in very limited environments. However, in at least some

them to the framework adopted in this article is far from a trivial task, and therefore is a topic for further research.

[39] Suzanne Dikker (p.c.). de Mey (1981) states that the example does not have the intended meaning, but does not mention the reading it does have.

[40] In addition to other Germanic languages like German and Dutch, Romance languages like French and Spanish, and Slavic languages like Serbian, dependent plurals are attested in non-European languages, such as Modern Hebrew, the Dravidian language Telugu, and Turkish, as well as many others.

[41] Müller (2001)

of those languages, bare plurals under negation and in questions behave the same as in English.

These data deserve further investigation, and the theory of dependent plurality I argue for in this paper does not provide an explanation. However, it can provide a useful comparison point for further research towards a true cross-linguistic understanding of plurality can be developed.

10 Conclusion

In the preceding sections, I have presented an account of bare plurals, focusing on 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.

Third, I have shown that the multiplicity implicature is a scalar implicature. However, this implicature cannot be simply generated by comparing whole sentence meanings. I compared several views that seek to solve this issue, and have concluded that the best way to generate it uses a recursive system of implicature calculation. The behavior of the implicature under such a system indicates that it is calculated at the point of sentence interpretation before event closure has applied.

Thus, I have shown that dependent plurality is crucial in understanding the meaning of bare plurals. It is certainly possible to account for many subsets of the data discussed in this paper 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 all the data. On the other hand, a number neutral theory allows us to re-evaluate other sentences involving bare plurals and may shed light on puzzles beyond dependent plurality.

Acknowledgements This paper is based on sections of my thesis, and has benefitted from a considerable amount of input as it evolved into its current form. All acknowledgements that appear there are carried over to the current version. In particular, I would like to thank Anna Szabolcsi, Mark Baltin, Chris Barker, Kit Fine, Lisa Levinson, Liina Pylkkänen, Barry Schein, Benjamin Spector, Hedde Zeijlstra, the audiences of NELS 36, ConSOLE 14, and IATL 26, three anonymous *Linguistics and Philosophy* reviewers, and editor Polly Jacobson, for highly useful commentary and criticism on both early and recent stages of the research.

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