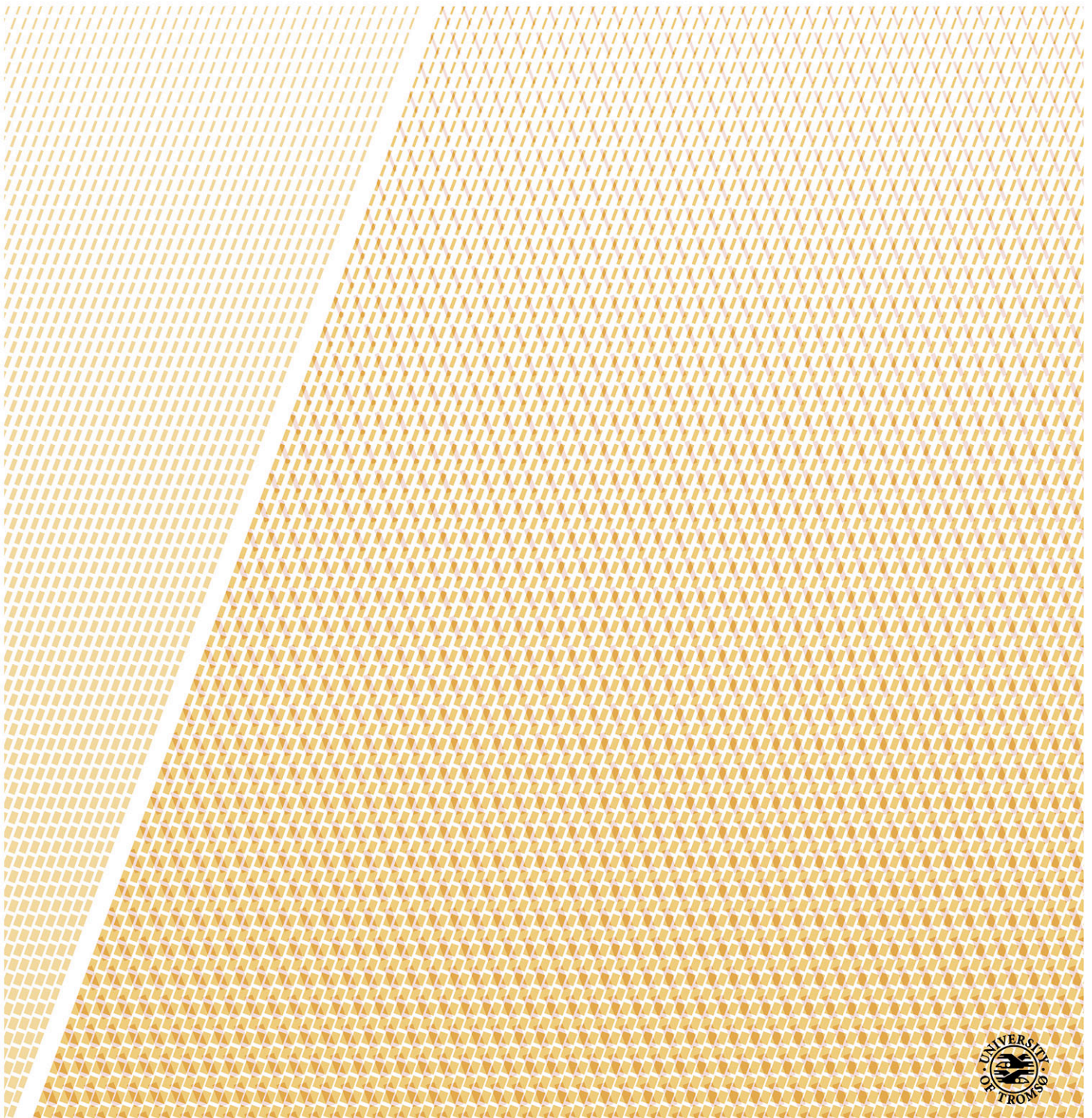


Dependent Plurals and the Semantics of Distributivity

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Introduction

The main focus of this thesis is the concept of *multiplicity*, and its representation in the semantics of natural language. Human languages generally possess a variety of means to convey the notion of a multitude of objects being involved in a particular situation. Consider, for instance, the examples in (1):

- (1) a. The girls watched three movies.
- b. Each girl watched a movie.
- c. All the girls watched movies.

All these sentences can be used in English to describe a situation involving three girls and three movies, with a one-to-one correspondence between the girls and the movies they watched. Both the grammatical form of the subject and that of the object varies across the examples in (1). In (1a) the subject is a definite plural DP, while the object is an indefinite DP involving a numeral. The subject in (1b), on the other hand, consists of the determiner *each* combined with a singular noun, while the object is a singular indefinite. In (1c) the subject is a combination of *all* with a definite plural, whereas the object is a bare plural. There are other possibilities. For instance, we could replace the subject in any of the examples in (1) with the indefinite DP *three girls*, and the resulting sentence would still be true with respect to the situation described above. Similarly, the subject in (1b) can be replaced with e.g. *each of the girls* or *every girl*, with no significant change in the truth conditions.

However, not all combinations of the various types of subjects and objects pro-

duce sentences which can be truthfully uttered in the above context, e.g.:

- (2) a. Each girl watched three movies.
 b. Each girl watched movies.
 c. All the girls watched three movies.

All these examples imply that each of the three girls watched *more than one* movie, and thus cannot be true with respect to a situation involving a one-to-one correspondence between girls and movies.

Let us now consider by what means the notion of multiplicity of individuals and objects is conveyed in these types of examples. There appear to be three relevant classes of linguistic items: grammatical number marking on the noun phrases (singular vs plural), numerals, and quantificational items such as *each* and *all*. The task is to determine the semantic representation of these items in a way that adequately captures the semantic effects of their interaction, as e.g. in sentences like (1), as well as the minimally different examples in (2).

The most influential approach to the semantics of plurals, both those that involve numerals or quantity modifiers such as *several* and those that do not, has been to assume that they denote or quantify over *collections of individuals*, formally defined either as sets (as in e.g. Scha 1984, Gillon 1990, Lasersohn 1995, Schwarzschild 1996 etc.) or as sums (cf. Link 1983, 1998, Krifka 1990, 1998, Landman 1989, 2000, Zweig 2008, 2009 a.o.; see especially Hovda 2009 and Champollion 2010 for a detailed overview of the formal underpinnings of the sum-theoretic approach). Thus, following Link's (1983) analysis (see also Sharvy 1980), the definite plural *the girls* in (1a) denotes the maximal sum of girl-individuals $\sigma x. \text{GIRL}(x)$. Similarly, the indefinite plural *three girls* is taken to existentially quantify over sums consisting of three individual, or *atomic*, movies, i.e. the role of the numeral is to restrict the number of atomic parts in a sum (or elements in a set). Finally, bare plurals like *movies* in (1c) can be analysed as existentially quantifying over sums or sets of individuals, either including or excluding atomic individuals/singleton sets in the domain of quantification (cf. the discussion in

section 1.4.7.3 below). Generally, the role of the plural number feature on this approach is to include non-atomic sums/non-singleton sets into the denotation of a nominal predicate. Thus, in Landman's (2000) theory, the singular *movie* denotes the set MOVIE of atomic movies, whereas the plural *movies* denotes the set of sums *MOVIE which is the closure of MOVIE under the sum operation. For instance, if MOVIE contains three atomic elements $\{m_1, m_2, m_3\}$, then *MOVIE contains seven elements $\{m_1, m_2, m_3, m_1 \sqcup m_2, m_1 \sqcup m_3, m_2 \sqcup m_3, m_1 \sqcup m_2 \sqcup m_3\}$, where $x \sqcup y$ is the sum of x and y .¹

The next question is how to derive the correct semantics for sentences involving the interaction of multiple plurals, as in (1a). As we will discuss in the following chapters, this can be accomplished by generalising the *-operator to apply to two-place predicates.

Whereas in (1a) the semantics of multiplicity can be attributed to plural marking on the noun phrases and to the presence of a numeral, sentence (1b) lacks these grammatical elements. However, as we have seen, this sentence can also be used to describe a situation involving multiple individuals. In this case the connotation of multiplicity is standardly attributed to the semantics of the quantificational determiner *each*, which can be represented as follows using the standard first-order universal quantifier:

$$(3) \quad \lambda P. \lambda Q. \forall x. P(x) \rightarrow Q(x),$$

where P and Q are predicates (or sets) of individuals.

Thus, *each* applies its nuclear scope predicate Q *distributively* to every individual that satisfies its restrictor predicate P . The semantics of (1b) can then be represented as follows:

$$(4) \quad \forall x. \text{GIRL}(x) \rightarrow \exists y. y \in \text{MOVIE}(y) \wedge \text{WATCH}(x)(y)$$

In this case, the implication that multiple girls were involved derives from the fact that the predicate denoted by the singular restrictor noun applies to multiple

¹In this thesis I will use \oplus as the symbol for sums, instead of \sqcup .

atomic individuals. Moreover, since the existential quantifier occurs in the scope of the universal quantifier in (4), this interpretation is compatible with the girls having watched different movies, i.e. with a situation involving multiple movies.

Now, combining the semantics for *each* and *three movies*, we can derive the interpretation for (2a):

$$(5) \quad \forall x. \text{GIRL}(x) \rightarrow \exists y. * \text{MOVIE}(y) \wedge |y| = 3 \wedge \text{WATCH}(x)(y),$$

where $|y|$ returns the number of atomic individuals in a sum.

This interpretation captures the fact that sentence (2a) cannot be used to describe a situation where each girl watched a single movie. The infelicity of (2b) in this context can be accounted for in a similar way if bare plurals are taken to impose a non-atomicity condition, as in (6):²

$$(6) \quad \forall x. \text{GIRL}(x) \rightarrow \exists y. * \text{MOVIE}(y) \wedge |y| > 1 \wedge \text{WATCH}(x)(y)$$

Consider, now the semantics of *all*. Given the fact that the truth conditions of sentence (2c) are very similar to those of (2a), we may consider adopting a distributive analysis for *all* similar to that for *each*, e.g.:

$$(7) \quad \lambda x. \lambda Q. \forall y. |y| = 1 \wedge y \leq x \rightarrow Q(y),$$

where $y \leq x$ means that y is part of x .

Then, sentence (2c) will be interpreted as follows:

$$(8) \quad \forall y. |y| = 1 \wedge y \leq \sigma x. \text{GIRL}(x) \rightarrow \exists z. * \text{MOVIE}(z) \wedge |z| = 3 \wedge \text{WATCH}(y)(z)$$

On this interpretation sentence (2c) will be true if for each of the atomic individuals in the maximal sum of girls there is a sum of three movies that she watched.

This seems to conform to our intuitions.

²The non-atomicity condition is not necessarily part of the semantics of the plural itself (cf. e.g. Landman's (2000) semantics for plurals described above), but may be derived via a mechanism of pragmatic strengthening in competition with the alternative singular form. This issue will be discussed in detail in the following chapters.

Consider, however, sentence (1c), and specifically the contrast between (1c) and (2c). Recall, that above we attributed the fact that sentence (2c) cannot be truthfully uttered in a context where each girl watched a single movie to a non-atomicity condition associated with the bare plural. Then, sentence (1c) should be assigned the interpretation in (9), which is similarly incompatible with the above context:

$$(9) \quad \forall y. |y| = 1 \wedge y \leq \sigma x. \text{GIRL}(x) \rightarrow \exists z. * \text{MOVIE}(z) \wedge |z| > 1 \wedge \text{WATCH}(y)(z)$$

In fact, sentence (1c) can be used to describe a situation where each girl watched a single movie. There are other well known contrasts between *all* and *each*. For instance, DPs involving *all*, but not those involving *each*, can combine with collective predicates like *gather*, *meet*, *be similar* etc.:

- (10) a. All the girls gathered/met in the hall.
 b. *Each girls gathered/met in the hall.

Facts like these have lead some researchers, e.g. Hausser (1974), Bennett (1975), Scha (1984), to assume that *all* is ambiguous between a quantificational and non-quantificational interpretation. On the latter, the semantics of DPs like *all the girls* was taken to be similar to that of a simple definite plural, i.e. *the girls*. Note, however, that on this analysis we would expect sentence (2c) to be true in all the contexts where sentence (1a) is true, which is not the case, as we have seen.

We are thus confronted with a dilemma. On the one hand, DPs involving *all* appear to behave like non-quantificational DPs when they have bare plurals in their scope (e.g. compare 1c to *The girls watched movies*), but like distributive quantificational DPs when they co-occur with numerical indefinites (compare, again, 2c and 2a). Or if we look at it another way, bare plurals appear to have an interpretation similar to indefinites with numerals when they occur in the scope of DPs involving *each* (compare 2a and 2b), but are closer to singular indefinites when they occur in the scope of DPs involving *all* (compare 1c to *All the girls watched a movie*). In fact, as we will see, this problem extends well beyond the specific

contrasts described here, with whole classes of items patterning with *all* and *each*, and multiple types of DPs patterning with bare plurals.

It is clear that that a simple combination of the semantics of plurals and quantificational determiners outlined above is insufficient, and that sentences like (1c) lie at the heart of the problem. The relevant reading of sentences like (1c), i.e. the one that allows for a one-to-one correspondence between two collections of individuals, is what has been referred to as a *dependent plural* interpretation, a term introduced by de Mey (1981). And it is this type of interpretation that is going to be the focus of the investigation presented in this thesis, an investigation that will lead us to reconsider the semantics of numerals, grammatical number, and distributivity.

The structure of the thesis is as follows. Chapter 1 introduces the core data concerning dependent plurals, and puts forward a set of empirical generalisations which need to be accounted for by an adequate theory of this phenomenon. Chapter 2 discusses previous approaches to dependent plurals, and evaluates them with respect to the disedarata formulated in Chapter 1. Chapter 3 lays out the core ideas of the proposal, introducing the distinction between weak and strong distributivity and spelling out the semantics for grammatical number features, numerals and distributivity operators. Chapter 4 is concerned with the semantics of quantificational items. It focuses primarily on the distinction between two classes of quantificational determiners, while also addressing the semantics of pluractional adverbials and modals. Chapter 5 discusses further applications of the proposed theory, addressing a range of phenomena which seem particularly challenging for previous approaches. Chapter 6 contains some final remarks and concludes the thesis.

Chapter 1

Dependent Plurals: The Data

1.1 Introduction

The aim of this chapter is to provide an overview of the empirical properties of constructions involving dependent plurals. Parts of the chapter constitute a survey of what has been noted about dependent plurals in the existing literature, other parts contain my original observations. The chapter is divided into three sections.

Section 1 deals with three basic properties of dependent plurals: co-distributivity and multiplicity (noted already in de Mey 1981), and intervention effects (discovered by Zweig 2008, 2009).

The remaining sections provide a detailed discussion of the two primary elements in a dependent plural relation: the licensor (section 2) and the dependent (section 3).

This chapter will be for the most part concerned with constructions which involve a *local* (i.e. inter-clausal) relation between the licensor and the dependent plural. Non-local (cross-clausal) dependencies will be discussed in Chapter 5.

1.2 Dependent Plurals: A First Look

1.2.1 Co-distributivity

Bare plural noun phrases in the context of other plurals can have a reading which appears to be synonymous with that of singular indefinites, as illustrated by the following examples – (1) is from Zweig 2009; (2) is from Chomsky 1975:

- (1) a. All the linguistics majors dated chemistry majors.
 b. All the linguistics majors dated a chemistry major.
- (2) a. Unicycles have wheels.
 b. Unicycles have a wheel.

Both sentences (1a) and (1b) will be judged true if each linguistics major dated a single chemistry major. Crucially, sentence (1a) does not state that each linguistic major dated *more than one* chemistry major.

Similarly, in a neutral context, sentences (2a) and (2b) are synonymous, both stating that, generally, each unicycle has one wheel. Again, sentence (2a) does not state, contrary to fact, that each unicycle has *more than one* wheel.

Examples (1) and (2) can be contrasted with (3) and (4):

- (3) a. All the linguistics majors dated more than one chemistry major.
 b. Unicycles have more than one wheel.
- (4) a. Each linguistics major dated chemistry majors.
 b. Each unicycle has wheels.

Sentences (3a) and (3b) differ from (1a) and (2a) in that the bare plural direct objects have been replaced with noun phrases involving the numerical expression *more than one*. These examples are not synonymous with sentences involving singular objects, i.e. (1b) and (2b). In contrast to (1a), sentence (3a) must be judged false if there is at least one linguistics major who dated just one chemistry

major. Similarly, unlike (2a), sentence (3b) must be judged false in the neutral context, because it states that generally a unicycle has two or more wheels.

Examples (4a) and (4b) are similar to (1a) and (2a) in that they involve bare plural direct objects. But this time, the subjects have been replaced with noun phrases involving the quantifier *each*. Here again, like in the case of (3a) and (3b), synonymy with (1b) and (2b) disappears. In fact, (4a) and (4b) have interpretations which are very close to (3a) and (3b): (4a) will be judged true only if each linguistics major dated *more than one* chemistry major, and (4b) will be judged false in the neutral context because it asserts that each unicycle has *more than one* wheel.

I will refer to the kind of interpretation that obtains for plural objects in examples (3) and (4) as the *distributive interpretation*, because the multiplicity condition associated with the plural (*more than one*) is applied distributively to each individual in the set referenced by the subject.

Conversely, I will refer to the interpretation of (1a) and (2a) as the *co-distributive interpretation*, a term borrowed from Sauerland (1994). Furthermore, I will adopt the term *dependent plural* (cf. de Mey 1981), or simply *dependent*, to refer to the plural nouns phrase which in this construction can be replaced by a singular indefinite with little change in interpretation (save for the *Multiplicity Condition* discussed below). The other plural element, which cannot be replaced by a corresponding singular noun phrase without a change in meaning, and in the context of which the dependent plural receives a co-distributive interpretation, will be called the *licensor*. In (1a) and (2a), the direct objects are the dependents, while the subject DPs are the licensors. As examples (3) and (4) show, the availability of the co-distributive interpretation depends both on the form of the dependent and that of the licensor.

One further comment is in order. We have established that bare plurals allow for a co-distributive interpretation in the contexts of other plural DPs. This means that the multiplicity requirement normally associated with plurals is not applied

with respect to each member of the set referenced by the licenser DP. However, the question remains whether the opposite, ‘singularity’, requirement is applied distributively. I.e. at this point we don’t know whether the correct interpretation of (1a) should be as in (5a) or as in (5b):

- (5) a. ‘Each linguistics major dated *one* chemistry major.’
 b. ‘Each linguistics major dated *one or more* chemistry majors.’

If dependent plurals have the same underlying semantics as singular indefinites, the interpretation in (5a) should be correct. Kamp and Reyle (1993) show convincingly that this is in fact not the case. They discuss the following example:

- (6) Most students bought books that would keep them fully occupied during the next two weeks.

This example can be contrasted with that in (7):

- (7) Most students bought a book that would keep them fully occupied during the next two weeks.

If dependent plurals had the same interpretation as singular indefinites we would expect these sentences to be synonymous. And indeed, there are contexts where both of these sentences will be judged true, e.g. if there is a set comprising a majority of students, and each student in that set bought one book such that this single book would keep her fully occupied for two weeks. But crucially (6) on its dependent plural reading would be judged true in a wider range of contexts than (7). Kamp and Reyle (1993) describe the following scenario: There are five students, and only three of them – Alan, George, and Miriam – bought any books. Specifically, Alan bought one book, George bought three, and Miriam four. In each case the book or books that the student bought would keep the buyer fully occupied for two weeks. In this scenario, (7) would be false because it is not true that there is a majority of students such that each of these students bought a single book that would keep her occupied for two weeks. On the other hand (6) would be judged true in this situation.

Note, that it can't be the distributive reading of (6) that makes this sentence true in the above scenario: on the distributive reading (6) would be true only if a majority of students bought *more than one* book, which is not the case.

This example strongly indicates that dependent plurals are in fact *number-neutral* with respect to the members of the licenser-set, i.e. the semantics of (6) is closer to that of (8), than to (7):

- (8) Most students bought one or more books that would keep them fully occupied during the next two weeks.

Another important property that distinguishes dependent plurals from singular indefinites is discussed in the next section.

1.2.2 Multiplicity

The discussion in the previous section was centred around the parallelism that exists between the interpretation of dependent plurals and singular indefinites, exemplified in (1) and (2). This parallelism has already proved to be only partial, with dependent plurals having a number-neutral, rather than a singular interpretation. And it turns out that this is not all. Consider the following examples, due to Zweig (2008, 2009) (cf. also de Mey 1981, Spector 2003 a.o. for similar observations):

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

As Zweig (2008, 2009) points out, sentence (9a) can have a reading on which each student lives in just one New York borough, i.e. a co-distributive reading. A similar reading is readily available for sentence (9b), on the low-scope interpretation of the indefinite object DP.

The crucial difference between these examples is that (9b) would be true in a scenario where all the students live in the same New York borough (e.g., Manhattan), while sentence (9a) would be judged false under this scenario. For sentence

(9a) to be true, at least two of the students must live in different boroughs, i.e. more than one New York borough must be involved overall. Zweig (2008, 2009) calls this requirement associated with dependent plurals the *Multiplicity Condition*, a term that I adopt in this thesis.

The Multiplicity Condition

More than one of the things referred to by a dependent plural must be involved overall.

We will see below that providing an adequate account of the Multiplicity Condition is the primary obstacle faced by one of the two core approaches to the analysis of dependent plurals.

Concluding the two sections, we see that on the one hand dependent plural readings are *non-distributive*, in the sense that the ‘more than one’ condition normally associated with plurals is not applied distributively to each element in the plurality denoted (or quantified over) by the licenser. This makes them similar to singulars. On the other hand, unlike singulars, dependent plurals introduce an overarching ‘more than one’ requirement, the Multiplicity Condition, and this draws them closer to non-dependent plurals.

1.2.3 Intervention Effects

Another core property of constructions involving dependent plurals is the existence of what Zweig (2008, 2009) calls *intervention effects*. Zweig analyzes dependent plurals in constructions with ditransitive predicates. He observes that sentences such as (10a) and (10b) are ambiguous: either the Agent scopes over the Recipient or vice versa. But either way, the bare plural can be interpreted as dependent on the higher scoping DP:

- (10) a. Two boys told three girls secrets.
 b. Two boys told secrets to three girls.

On the surface scope reading, (10a) can be true in a scenario where boy *A* told three girls secret *X*, while boy *B* told (a potentially different set of) three girls secret *Y*. On the inverse scope reading, it can be true in a scenario where girl *A* is told secret *X* by two boys, girl *B* is told secret *Y* by two boys, and girl *C* is told secret *Z* by two boys. Similar readings obtain for the surface and inverse scope interpretations of (10b).

If the bare plural is the Recipient rather than the Theme, only the surface scope reading is available, presumably for independent reasons. But in this case, again, the bare plural can be interpreted as dependent on the higher scoping DP, i.e. the Agent:

- (11) a. Two boys told girls three secrets.
 b. Two boys told three secrets to girls.

Both of these sentences can be used to describe a scenario where boy *A* told three different secrets to girl *X*, while boy *B* told three different secrets to girl *Y*.

Examples (12a) and (12b) contrast with those in (10a) and (10b):

- (12) a. Two boys told a girl secrets.
 b. Two boys told secrets to a girl.

Like (10a) and (10b), these sentences allow for both surface and inverse scope interpretations, with either the Agent scoping over the Recipient or vice versa. But unlike (10a) and (10b), on the surface scope reading the bare plural cannot be interpreted as dependent on the higher Agent DP. I.e. these sentences cannot be judged true in a scenario where boy *A* told one girl secret *X* and boy *B* told a different girl secret *Y*. In this case, only a distributive interpretation is allowed for the bare plural, i.e. boy *A* told one girl *more than one* secret, and boy *B* told one girl *more than one* secret.

On the other hand, on the inverse scope reading with the Recipient DP taking wide scope, the bare plural can be interpreted as dependent on the Agent DP. In

this case (12a) and (12b) are true if boy *A* told one girl secret *X* and boy *B* told *the same* girl secret *Y*.

A similar effect is observed in sentences such as (13a) and (13b), which contrast with (11a) and (11b):

- (13) a. Two boys told girls a secret.
 b. Two boys told a secret to girls.

In contrast to (11a) and (11b), both surface scope and inverse scope readings are available here. But again, as in examples (12a) and (12b), on the surface scope reading the bare plural cannot be interpreted as dependent on the Agent DP. These sentences cannot be used to describe a scenario where boy *A* told girl *X* one secret and boy *B* told girl *Y* a different secret. Again, only a distributive interpretation arises: boy *A* told *more than one* girl a secret, and boy *B* told *more than one* girl a secret.

On the wide scope reading of the singular indefinite, the dependence between the bare plural and the Agent DP is allowed in these examples.

Next, sentence (14) involves a singular indefinite in the subject position:

- (14) A boy told three girls secrets.

On the surface scope readings, under which the singular DP takes wide scope, the bare plural Theme can be dependent on the the Recipient DP. In this case the sentence would be true e.g. if a boy told girl *A* secret *X*, girl *B* – secret *Y*, and girl *C* – secret *Z*.

On the other hand, if the plural Recipient takes scope over the singular Agent, the dependent plural reading disappears. Under this inverse scope reading, (14) would be true if girl *A* told one boy more than one secret, girl *B* told one boy more than one secret, and girl *C* told one boy more than one secret. This is the distributive interpretation. But the co-distributive interpretation is absent, i.e. (14) would be judged false if at least one of the girls told only one secret.

Based on this set of data Zweig (2008, 2009) derives what I will call the *Intervention Generalisation* for ditransitive constructions:

(15) *Intervention Generalisation*

A singular DP blocks the dependence between a potential licensor and a dependent plural just in case it co-varies with the licensor.

I would like to underscore two important contrasts implicit in this formulation. The first is discussed by Zweig (2008, 2009), and has to do with the opposition between DPs that co-vary with the licensor and those that do not. The discussion of examples (12), (13) and (14) has shown that singular indefinites do not block dependent plural readings if they do not co-vary with the licensor (i.e. scope above it). Similarly, if the singular DP is a scope-less element, e.g. a definite or a personal pronoun, it does not block plural dependencies:

- (16) a. Two boys told me secrets.
b. Two boys told secrets to me.

Both of these sentences allow the bare plural Recipient to be dependent on the plural Agent, i.e. they would be judged true if each boy told the speaker just one secret.

The second important contrast, which is not explicitly discussed by Zweig (2008, 2009) but is implicit in the judgements he reports for the examples, is between singular and plural DPs. Recall, that according to the judgements reported by Zweig, the examples in (10) have a reading on which they will be considered true if each of the two boys talked to a different set of three girls, and each boy told one (or, possibly, more than one) secret. On this reading, the reference of the DP *three girls* co-varies with the subject *two boys*. Nevertheless, it does not block a dependency between the subject and the bare plural *secrets* (i.e. each boy may have told a single secret). In contrast, singular DPs in analogous configurations in (12) do block dependent plural readings when they co-vary with the licensor, as discussed above.

A methodological note is in order. Some speakers who I consulted find the availability of dependent plural readings in examples like (12) and (13) hard to judge. This is probably partly due to the fact the a distributive reading between two indefinite DPs is harder to obtain than a cumulative reading (cf. Gil 1982*b*, Dotlačil 2010), and to the mere multiplicity of possible readings that such sentences allow.

However, judgements become clearer when we look at sentences where the intervener is an encompassing DP, which includes the dependent as a sub-constituent. Consider the following examples:

- (17) a. All the children received letters written by their fathers.
 b. #All the children received a letter written by their fathers.
 c. All the children received two letters written by their fathers.

Sentence (17a) involves a complex bare plural noun phrase which contains a possessive plural as a sub-constituent. Both of these plurals can be interpreted as dependent on the quantificational subject, i.e. these sentences will be judged true if each child received one or more letters written by his or her farther. In (17b) the encompassing plural noun phrase has been replaced by the corresponding singular indefinite. In this case the possessive plural within the singular DP cannot be interpreted as dependent on the subject. This sentence has a reading on which each child received a letter written by all the children's fathers together, or it can have a pragmatically odd reading on which each child has more than one father, and received a letter written by them. But this sentence does not have a reading on which each child received a different letter written by his or her (unique) father.

Now compare (17b) to (17c), where the encompassing noun phrase is a plural containing the numeral *two*. According to most of by informants, sentence (17c) has a reading on which each child received a different pair of letters. On this reading the referent of the numerical DP varies with the subject . But in contrast to (17b), this does not block a dependency between the subject and the plural possessive

contained within the larger plural. In other words, this sentence has a reading on which each child received a set of letters from his or her (unique) father.

Consider another example of a similar sort. Suppose, two men are separately looking for their wives, who had gone missing. Someone referring to this situation utters the following sentences:

- (18) a. To begin with, they both talked to friends who knew their wives well.
 b. To begin with, they both talked to a / one friend who knew their wives well.
 c. To begin with, they both talked to a few / two or three / several friends who knew their wives well.

In (18a) both the complex noun phrase *friends who knew their wives well*, and the possessive DP *their wives* contained within that complex NP, can be interpreted as dependent on the subject DP *they*. E.g. on this interpretation, (18a) will be judged true if each man talked to one friend who knew his wife well, and the men talked to different friends.

In (18b) the bare plural *friends who knew their wives well* has been replaced with a singular indefinite DP *a friend who knew their wives well* (or *one friend who knew their wives well*). We are interested in the reading on which the referent of that DP co-varies with the subject, i.e. each man talked to a different friend. On this reading *their wives* cannot be interpreted as dependent on the subject, i.e. this sentence will not be judged true if each man talked to a (different) friend who knew his wife well, but did not know the other man's wife well. It will only be judged true if each man talked to a friend who knew the wives of both the men well. Thus, the singular indefinite DP in (18b) acts as an intervener, blocking a dependency between the subject and a plural DP in the relative clause.

Finally, consider sentence (18c). In this case the complex DP is a plural indefinite. According to most of my informants, the plural indefinite in this case, in contrast to the singular indefinite in (18b), does not block the dependency between

the subject and the plural DP *their wives* within the relative clause, even if it co-varies with the subject. I.e. this sentence will be judged true if each man talked to a different set of friends who knew his wife well, but did not know the other man's wife well.¹

The same asymmetry between singular and plural interveners exists when dependent plurals are licensed by adverbials. Consider the following example:

(19) I sometimes give one of my students special assignments.

In this example a singular indefinite *one of my students* intervenes between the quantificational adverb *sometimes* and the bare plural *special assignments*. If the indefinite has wide scope with respect to the adverb, i.e. if each relevant occasion involves the same student, the bare plural can be interpreted as dependent on the adverb. Thus, this sentence will be judged true if there is a specific student such that the speaker gives her one, or possibly more, special assignments on each relevant occasion. Crucially, in this case the speaker does not claim to give more than one special assignment on each occasion. On the other hand, if the indefinite is interpreted as having low scope with respect to the adverb, i.e. if the identity of the student co-varies with the relevant occasions quantified over by the adverb, the bare plural cannot be interpreted as a dependent licensed by the adverb. In this case the bare plural must pick out a strictly plural set of special assignments for each relevant occasion, i.e. this sentence will be judged true only if for each relevant occasion there is a student such that the speaker gives her *more than one* special assignment.

Now compare the example in (19) to that in (20):

(20) I sometimes give two or three students joint assignments. ✓ *Dep. Pl.*

Here, the singular indefinite *one of my students* has been replaced with a plural indefinite *two or three students*. As in the previous example, if the indefinite

¹Some speakers I consulted reject the dependent plural interpretation in examples like (17c) and (18c). Thus, for these speakers both singular and numerical plural DPs act as interveners with respect to dependent plural licensing. I return to the issue of speaker variation in this domain in Chapter 5, cf. section 5.2.2.

takes wide scope with respect to the adverb, the bare plural can be interpreted as dependent on the licensor. But in this case, crucially, a dependent plural interpretation is available even if the intervening indefinite is interpreted as co-varying with the situations quantified over by the adverb. Thus, according to most of my informants, this sentence will be judged true if on each relevant occasion there is a possibly different set of two or three students such that the speaker gives them one joint assignment.

To conclude, whereas singular DPs interpreted as co-varying with respect to the licensor induce intervention effects, plural DPs interpreted in a similar way do not.

A successful theory of dependent plurals must account for both aspects of the *Intervention Generalisation*: the contrast between DPs that co-vary with the licensor and those that do not, and among those that do co-vary with the licensor – between singulars and plurals.

1.3 Licensors

The aim of the next two sections (1.3 and 1.4) is to broaden the empirical and analytical base of the investigation by providing a more detailed analysis of the properties of dependent plurals.

I start by taking the bare plural to be the prototypical dependent, and establishing the class of nominal elements that can serve as licensors for this type of dependents, i.e. the elements that can be interpreted co-distributively with bare plurals. I propose a generalisation governing membership of DPs in this class. Once the class of licensors has been established for the bare plural, I examine what other types of nominal phrases can serve as dependents in the context of these licensors. I show that dependents fall into two categories: those that can be dependent on quantificational licensors, and those that can't. I show, that the former class is not restricted to bare plural NPs (as in Kamp and Reyle 1993), but is open to a wide class of nominal expressions. Again, I put forward a generalisation which de-

termines whether a certain type of nominal phrase can serve as a dependent plural under quantificational licensors.

1.3.1 Nominal Licensors: The Licensing Generalisation

Dependent plural readings of bare plural noun phrases can be licensed by a wide range of nominal licensors. As the following examples illustrate, dependent plural readings can be licensed by plural definite and demonstrative DPs, numerical DPs and plural indefinites with cardinal modifiers such as *several*, *a few*, *some* etc., as well as by bare plurals and conjoined DPs:

- (21) a. (The / these) linguistics majors are dating chemistry majors.
 b. Five / several linguistics major are dating chemistry majors.
 c. Mary, Jane, and Bob are dating chemistry majors.

These examples will be judged true relative to a situation in which each of the linguistics majors referred to by the subject dated one or more chemistry majors, as long as they dated more than one chemistry major overall.

Dependent plural readings can also be licensed by a subset of quantification DPs. The following contrast was discussed in section 1.2.1:

- (22) a. All of the linguistics majors are dating chemistry majors.
 b. Each linguistics major is dating chemistry majors.

Recall that sentence (22a) can have a dependent plural interpretation under which each of the linguists is dating one or more chemistry majors. On the other hand, sentence (22b) lacks this interpretation. It will only be judged true if each linguistics major is dating two or more chemistry majors.

Clearly, this contrast is related to the form of the subject in these sentences, and specifically to the difference between noun phrases involving *all* and those involving *each*. Discussing similar data from Dutch, de Mey (1981) relates this contrast to the number feature associated with the quantified DP - plural quantified DPs license dependent plurals, while singular quantified DPs do not.

Zweig (2008, 2009) shows that this generalisation is not restricted to universal quantifiers, citing the following contrast:

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

In (23a), which involves a plural subject, the bare plural *Porsches* can have a dependent interpretation. In this case the sentence will be true if there is a set consisting of three or more dentists, such that each dentist in that set owns one or more Porsches. The multiplicity requirement is not applied to each member of the set.

On the other hand, (23b) only has a distributive interpretation. It will be true only if there is a set consisting of two or more dentists, and each dentist in that set owns at least two Porsches, i.e. in this case the multiplicity requirement is applied distributively to each member of the set. Zweig (2008, 2009) attributes this to the fact that (23b) has a singular subject. As he points out, there is no clear semantic or syntactic distinction between *more than two dentists* and *more than one dentist*, except for the “number features of their nouns”.

It seems clear that the ability to license dependent plural readings is tied to the number specification of the licensor. But what does it mean exactly, to say that the licensor is ‘singular’ or ‘plural’?

A straightforward interpretation is that a licensor is singular if it triggers singular agreement in the verb, and conversely, it is plural if it triggers plural agreement. This leads to the following generalisation:

- (24) *Licensing Generalisation (to be revised)*
 DPs that trigger singular agreement on the verb cannot license dependent plurals.

The contrasts in (22) and (23) conform to this generalisation. In (22a) and (23a) the subject agrees with the verb in the plural, and a dependent plural interpretation is available. In contrast, (22b) and (23b) have subjects which agree with

the verb in the singular, and a dependent plural interpretation is ruled out.

Similarly, DPs involving the quantifiers *most* and *both* trigger plural agreement on the verb, and are able to license dependent plurals:

- (25) a. Most dentists own Porsches.
 b. Both dentist owns Porsches.

Sentence (25a) will be judged true in a context where there is a majority of dentists who own one or more Porsches each. Similarly, (25b) will be true in a context where there are two dentists, and each of them owns one or more Porsches.

Conversely, DPs with the quantifier *every* are similar to those involving *each* in that they trigger singular agreement and fail to license dependent plurals:

- (26) Every dentists owns Porcsches.

This sentence will only be judged true if each of the dentists owns more than one Porsche.

These examples seem to support the *Licensing Generalisation* as formulated in (24). But there are also counter-examples to this generalisation.

One class of counter-examples involves the noun phrases *everyone* and *everybody* in English. These DPs trigger singular agreement on the verb when they occur in the subject position, but they are nevertheless able to license dependent plurals:

- (27) a. Everybody has cell phones these days.
 b. "Everyone has guns down there, it's like the wild West," Byrnes said.

Both of these examples have a dependent plural interpretation. Example (27a) will be judged true if every individual in a contextually specified set owns one or more cell phones. Similarly, Byrnes' claim in (27b), taken from the *Corpus of Contemporary American English* (COCA, cf. Davies 2008), is most naturally interpreted as stating that each individual in the relevant location has one or more guns, rather than asserting that each individual has at least two guns.

But note that in both (27a) and (27b) the subject triggers singular agreement on the verb. Thus, these examples pose a problem for the *Licensing Generalisation* as formulated in (24).

Note, that plural agreement with these quantifiers is much more marginal. E.g. the search for the collocation “everyone are” in the COCA performed on 21.04.2014 returned 10 results, only one of which was actually a case of plural verb agreement triggered by *everyone* not conjoined with any other DP, the other 9 were spurious. On the other hand, searching for “everyone is” returned 4578 examples, and in the first 100 of those none were spurious. Similarly, “everybody are” returned 5 examples, only one of which was actually a case of plural agreement triggered by *everybody*. On the other hand, “everybody is” returned 2533 results, where in the first 100 none were spurious.

Another class of counter-examples to the *Licensing Generalisation* as formulated in (24) involves DPs with ‘noun-like’ quantifiers in languages like Russian. These include e.g. *část* ‘part’, *polovina* ‘half’, and *bol’šinstvo* ‘majority, most’. Consider DPs with the quantifier *bol’šinstvo*:

- (28) Bol’šinstvo iz nix kupil-o / kupil-i novyje knigi.
 most of them bought-3.SG.NEUT / bought-3.PL new books
 ‘Most of them bought new books’.

Morphologically, *bol’šinstvo* is a singular neuter noun, bearing the ending *-o* characteristic of singular neuter nouns in the nominative case. DPs headed by *bol’šinstvo* in the subject position can trigger either singular neuter or plural agreement on the verb. But irrespective of the agreement pattern chosen, they can license dependent plurals. Thus, in (28) the verb can take either the neuter singular form *kupilo* or the plural form *kupili*, but either way the sentence has a dependent plural reading under which most of the individuals in the set referred to by the pronoun bought one or more new books.

A similar pattern is observed with DPs headed by *část* ‘part’ and *polovina* ‘half’, except that these quantifiers are morphologically singular feminine nouns, and can thus trigger singular feminine agreement on the verb. The following example is

from the Russian National Corpus (*ruscorpora.ru*):

- (29) Polovina vospitannikov dymil-a sigaretami.
 half pupils.GEN smoked-3.SG.FEM cigarettes
 ‘Half of the pupils were smoking cigarettes’.

This sentence is most naturally understood as describing a situation in which there was a set consisting of one half of the pupils, and each student in that set was smoking one cigarette, i.e. the bare plural DP *sigaretami* ‘cigarettes’ can be interpreted as a dependent plural. Crucially, the licenser DP *polovina vospitannikov* ‘half of the pupils’ triggers singular feminine agreement on the verb in this example.

We can conclude from these data that singular agreement does not block the availability of dependent plural readings, contra the *Licensing Generalisation* in (24).

In light of these counter-examples, I would like to propose that what is relevant for licensing dependent plurals is not the number feature that shows up on the verb which agrees with the DP in question. Rather, what is relevant is the number feature carried by the complement NP within the DP:

- (30) *Licensing Generalisation (revised)*
 DPs that involve complement NPs in the singular do not license
 dependent plurals.

Let us see whether this generalisation makes better predications than the previous version.

First of all, the quantifiers *all*, *most* and *both*, which can license dependent plurals, all combine with plural NP or PP restrictors, and cannot combine with NPs in the singular:

- (31) a. All / most / both (of the) girls
 b. *All / most / both girl

Conversely, the quantifiers *each* and *every*, which cannot serve as licensers for dependent plurals, combine with singular, but not plural, NPs:

- (32) a. Each / every girl
 b. *Each / every girls

Thus, the behaviour of DPs involving *all*, *most* and *both* on the one hand, and *each* and *every* on the other is compatible with the revised version of the Licensing Generalisation in (30). Let us now turn to the DPs which proved problematic for the previous version based on agreement, and see if the new formulation fares better.

Recall that the DPs *everyone* and *everybody* are similar to other DPs involving the quantifier *every* in that they trigger singular agreement on the verb, but contrast with them in that they are able to license dependent plurals. Morphologically and historically, *everyone* and *everybody* involve the combination of the quantificational determiner *every* with a singular noun phrase, *one* and *body*. However, synchronically the nominal root does not function as an independent NP (it cannot be modified, can remain unstressed, etc.), and thus arguably does not itself carry a number feature. Instead, in both of these cases, the singular number feature which shows up in verbal agreement can be associated with the whole morphologically complex quantifier. This in turn means that *everyone* and *everybody*, even though they retain singular agreement with the verb, do not violate the Licensing Generalisation in its revised form, given in (30).

Consider now the Russian quantifiers *čast'* 'part', *polovina* 'half', and *bol'sinstvo* 'majority, most', which as we saw can trigger singular agreement on the verb, but are nevertheless able to license dependent plurals. All of these QDs take genitive plural NPs as restrictors. Thus, these quantifiers in Russian, which were problematic for the agreement-based formulation of the Licensing Generalisation in (24), no longer pose a problem for the Licensing Generalisation re-formulated in terms of number features on complement NPs in (30).

I conclude, that the version of the Licensing Generalisation which invokes the number feature of the complement NP is empirically superior to the version stated in terms of agreement.

1.3.2 Adverbial Licensors

Apart from the class of nominal licensors discussed above, dependent plurals can be licensed by various types of pluractional (quantificational, frequentitative, iterative) adverbials, which introduce a multiplicity of events/situations:²

(33) John often wears loud neckties. (Roberts 1990, attributed to B. Partee)

(34) John always introduces his girlfriends to his mother. ³

Sentence (33) is an example of a dependent plural licensed by the frequentative adverb *often*. On the most salient reading, this sentence states that there is a set of frequently occurring events which involve John wearing a loud necktie. Crucially, this sentence does not state that John necessarily wears more than one necktie on each occasion, i.e. it allows for a co-distributive relation between the set of events and the set of ties which is the hallmark of dependent plural readings.

Similarly, in (34) the quantificational adverb *always* serves as the licensors, while the dependent is the possessive DP *his girlfriends* (see section 1.4.4 on possessive dependents). On the most natural reading, this sentence states that on each relevant occasion John introduces his one current girlfriend to his mother. Importantly, it isn't necessary for John to be in a relationship with more than one woman on every (or any) relevant occasion for this sentence to be judged true. This indicates that we are again dealing with a dependent plural reading.

I will return to a more detailed discussion of non-nominal licensors and dependent readings in the context of event multiplicity in section 4.6.

²I am using the terms *event*, *situation*, and *occasion* quite informally here, not committing myself to any particular view on the ontological nature of the entities quantified over by the adverbs in question. See section 4.6 for an account of adverbial licensors in terms of a formalised notion of events.

³de Mey (1981) cites a similar example from Dutch:

(i) Hij neemt altijd zijn vriendinnetjes mee naar zulke feestjest
'He always takes his girlfriends to such parties.'

1.3.3 Non-Licensors: Attitude Predicates and Modals

We have seen that dependent plurals are licensed by a variety of plural and quantificational expressions - both in the domain of individuals, and in the domain of events/situations. However, as noted by Ivlieva (2013), there is one class of quantificational expressions which notably never license dependent plurals – those involving quantification over possible worlds. These include modals and propositional attitude predicates. Consider the following examples:

- (34) a. John wants to wear loud neckties to the party.
 b. John must have worn loud neckties to the party.

Assuming a version of the classic Hintikka analysis of propositional attitudes, the verb *want* introduces quantification over possible worlds:

$$(35) \quad \llbracket \text{want} \rrbracket^w = \lambda P_{(st)} \lambda x \forall w' [R^{\text{want}}(x)(w)(w') \rightarrow P(w')],$$

where $R_{(e(s(st)))}^{\text{want}}$ is an accessibility relation such that $R^{\text{want}}(x)(w)$ is true of all the worlds which are compatible with x 's wishes in w .

Sentence (34a) involves a bare plural noun phrase *loud neckties* in the complement of *want*. If quantification over possible worlds could license dependent plurals, we would expect (34a) to have the following reading: For every possible world w' such that w' is compatible with John's wishes in the actual world, John wears *one or more* neckties to the party in w' . In addition to that, the Multiplicity Condition would require that at least two neckties be involved overall. This interpretation would be compatible with a situation in which John wants to wear just one necktie to the party, as long as across the accessible possible worlds there are at least two alternative neckties he could wear, e.g. John could be choosing between two neckties, intending to wear one. Clearly, (34a) does not have this reading. Instead, it only has a more pragmatically unusual interpretation on which in every accessible world John wears several neckties to the party.

Similarly, if we follow the common assumption that the interpretation of modals involves quantification over possible worlds (cf. Kratzer 1991*b* and the references

therein), we may assume the following simplified denotation for the epistemic *must*:

$$(36) \quad \llbracket \textit{must} \rrbracket^w = \lambda P_{(st)} \forall w' [R^{epist}(w)(w') \rightarrow P(w')],$$

where $R_{(s(st))}^{epist}$ is an accessibility relation such that $R^{epist}(w)$ is true of all the worlds which are compatible with everything that is known in w .

Again, if bare plurals could be interpreted as dependent on modals, we would expect (34b) to have a reading which can be paraphrased as follows: For every possible world w' such that w' is compatible with all that is known in the actual world, John wears *one or more* neckties to the party in w' . The Multiplicity Condition would further restrict this interpretation to cases where there are at least two different neckties involved across the epistemically accessible possible worlds.

Now consider the following scenario: a person looks into John's wardrobe, sees two loud neckties, and, thinking that they are the only neckties that John has, utters (34b). If (34b) did indeed have a dependent plural reading described above, we would have probably understood the speaker as stating that John must have worn *one* of the two ties found in the wardrobe to the party (given that normally people prefer to wear one necktie at a time). But it is impossible to understand (34b) in this way. Instead, we can only understand the speaker as asserting that John must have worn *both* of the ties to the party. This demonstrates that the bare plural can't have a number-neutral interpretation with respect to the possible worlds quantified over by the modal.

The following minimal pair is illustrative in this respect:

- (37) a. If John visits his mother, he brings her presents.
 b. If John visits his mother, he will bring her presents.

Assuming, following Kratzer (1979, 1981, 1991a), that *if*-clauses are interpreted as restrictors of quantificational operators, we are led to posit covert quantifiers in both of these examples. But the nature of these quantifiers is different. In (37a) the covert operator is semantically similar to the quantificational adverb

always, quantifying over events/situation in the actual world. And like *always*, this operator is able to license dependent plurals in its scope. Thus, (37a) will be judged true relative to a situation where John brings his mother *one or more* presents on each visit. In fact, he may never bring more than one.

The covert operator in (37b) is different – it is a modal quantifier semantically close to *must*. And just like the modal *must* discussed above, this covert operator cannot serve as a licenser for dependent plurals. I.e. (37b) states that in every accessible possible world where John visits his mother, he brings her *more than one* present.

I return to this issue in section 4.7, where I propose a formal account of the contrast between situation/event and possible world quantifiers in terms of their ability to license dependent plurals.

1.4 Dependents

In this section I look at a number of different types of nominal phrases to see whether they can be interpreted as dependent plurals in the context of the types of licensers discussed in the previous section.

1.4.1 DPs with Numerals and Cardinal Modifiers

I would like to start this section by looking at DPs which do not pattern with bare plurals with respect to the range of contexts in which they allow co-distributive readings. Since these DPs do pattern with bare plurals in *some* of the contexts, this discussion will help us establish a set of differentiating contexts against which other types of DPs will need to be tested.

Consider the following example from Landman 2000:

(38) Ten chicken laid thirty eggs.

This sentence involves two DPs with numerals. It has a scopal distributive reading, under which each chicken laid thirty eggs. But it also has a non-scopal

reading, which is usually referred to as a *cumulative* reading (cf. Scha 1984, Does 1993, Landman 2000, Beck and Sauerland 2001, among many others). Under this reading (38) will be judged true if there is a set X consisting of ten chickens, a set Y consisting of thirty eggs, and each chicken in X laid one or more eggs in Y , and each egg in Y was laid by a chicken in X .

Note, that on the cumulative reading the plural DP *thirty eggs* has a number-neutral interpretation with respect to the elements of the set referred to by the subject (i.e. each chicken is required to have laid *one or more* eggs). Of course, since the number of eggs in (38) exceeds the number of chickens, it must be the case that at least some of the chickens laid more than one egg. But this is consequence of the fact that we chose sets of particular sizes, not a grammatical requirement of cumulative readings. E.g. (39) has a reading on which each chicken laid a single egg:

(39) Ten chicken laid ten eggs.

Furthermore, (38) implies that the number of eggs involved overall was more than one, more specifically, that it was thirty.

Thus, cumulative readings of examples like (38) exhibit both of the basic properties of dependent plurals: co-distributivity and overarching multiplicity. This has prompted a number of researchers to propose a unified analysis of cumulative and dependent plural readings (cf. section 2.3 for a detailed discussion of this approach).

However, if we look back at the list of expressions that license the dependent reading of bare plurals, we will find that only a subset of them license cumulative readings with DPs involving numerals. We have seen that numerical DPs license cumulative readings (example 38), so do plural definite DPs (ex. 40a), bare plural indefinites (ex. 40b), plural DPs with *certain* (ex. 40c), conjoined DPs (ex. 40d):

(40) a. The / these chickens laid thirty eggs.

b. Students brought in ten chairs.

- c. Certain students brought in ten chairs.
- d. Mary and Max brought in ten chairs.

All these examples allow for cumulative readings. On the other hand, as Zweig (2008, 2009) observes, DPs involving plural quantifiers like *all* and *most* do not license cumulative readings. Zweig (2008) cites the following contrasts:

- (41) a. Most students read thirty papers.
- b. Most students read papers.
- (42) a. All the students read thirty papers.
- b. All the students read papers.

Sentences (41b) and (42b) allow for dependent plural readings. They can be paraphrased as stating that most or all of the students read at least one paper, and more than one paper was read overall. On the other hand, (41a) and (42a) don't allow for a parallel cumulative reading. I.e. they cannot mean that most or all of the students read at least one paper, and 30 papers were read overall. These examples only have distributive readings, under which each of the students (in the relevant sets) read thirty papers.

The same pattern is exhibited by licensors involving *both*, *many*, *few* and *no*:

- (43) a. Both students read thirty papers.
- b. Both students read papers.
- (44) a. Many students read thirty papers.
- b. Many students read papers..

Sentences (43b) and (44b) have dependent plural readings, with each student referenced by the subject reading one or more papers. Sentences (43a) and (44a) only have distributive readings, with the students in the relevant sets readings thirty papers each.

In what follows, I will refer to *all*, *most*, *both*, *many*, *few* and *no* as plural quantifiers, and to the corresponding DPs as plural quantificational DPs.

Similarly, sentences involving numerical DPs in the scope of pluractional adverbials do not have cumulative readings, as noted already by de Mey (1981):

- (45) a. John often ordered pizzas for dinner.
 b. John often ordered ten pizzas for dinner.
- (46) a. John always orders pizzas for dinner.
 b. John always orders ten pizzas for dinner.

Sentence (45a) involves a bare plural noun phrase *pizzas* in the scope a frequentative adverb *often*. The bare plural can be interpreted as dependent on the adverb, in which case the sentence asserts that there was a frequently occurring event which involved John buying one or more pizzas for dinner, and overall more than one pizza was ordered. On this reading, (45a) will be judged true even if John never ordered more than one pizza for dinner.

Sentence (45b), on the other hand, involves a numerical DP *three pizzas* and lacks a cumulative reading which would be parallel to the dependent plural reading of (45a). I.e. (45b) cannot mean that there was a frequently occurring event which involved John buying one or more pizzas for dinner, and overall ten pizzas were ordered. It can only mean that each of the events involved John ordering ten pizzas.

Similarly, (46a) and (46b) involve plural nominal phrases in the scope a quantificational adverb *always*. Sentence (46a), involving a bare plural *pizzas* will be judged true if on each relevant occasion John orders one or more pizzas. Thus, it is compatible with a scenario in which John always orders just one pizza for dinner. On the other hand, sentence (46b) with a numerical plural DP *ten pizzas* will be judged true only if John orders ten pizzas on each relevant occasion.

DPs involving cardinal modifiers such as e.g. *several*, *multiple*, *a few* etc., pattern with numerical DPs:

- (47) All the students read several papers.

This sentence lacks a cumulative reading, and can only be interpreted distributively as stating that each of the students read more than one paper.

To conclude, both dependents and licensors can be divided into two distinct classes. With respect to dependents, bare plurals contrast with numerical DPs and DPs with cardinal modifiers with regards to the range of contexts where they allow co-distributive (dependent/cumulative) readings. This contrast in turn forms the basis for the distinction between quantificational (nominals with *all*, *most*, *both*, *many*, *few* and *no*, and pluractional adverbials) and non-quantificational licensors. Only non-quantificational licensors give rise to co-distributive readings in combination with numerical DPs and DPs with cardinal modifiers.

The next question that I would like to address is whether bare plurals are unique in allowing co-distributive readings in the context of quantificational licensors, and if not – what other DPs pattern with bare plurals in this respect. However, before I turn to answering this question I would like to discuss one further property of dependent bare plurals.

1.4.2 Bare Plurals: Partee's Generalisation

I have taken bare plurals noun phrases to be the prototypical case of dependent plurals, and numerous examples were given in the previous sections of bare plurals functioning as dependents of various types of licensors. In this section I discuss one further aspect of such constructions which has to do with the scopal properties of bare plurals.

Carlson (1977, 1980) has famously argued that in English bare plurals on the one hand, and non-bare singular and plural indefinites on the other, must be assigned quite different underlying semantics. One of the arguments for this comes from the fact that bare plurals, unlike other types of indefinites, can only have narrow scope with respect to a range of operators. For instance, Carlson claims that unlike non-bare indefinites, bare plural NPs which occur in intensional contexts cannot take scope over the relevant intensional operators:

- (48) a. Miles wants to meet a policeman. $want > \exists, \exists > want$
 b. Miles wants to meet sm policemen. $want > \exists, \exists > want$
 c. Miles wants to meet policemen. $want > \exists, * \exists > want$
- (49) a. Max is looking for a book on Danish cooking. $look\ for > \exists, \exists > look\ for$
 b. Max is looking for books on Danish cooking. $look\ for > \exists, * \exists > look\ for$

Sentence (48a) is ambiguous: it can either mean that there is a particular policeman that Miles wants to meet (the indefinite takes scope above the intensional operator), or that Miles' wish will be fulfilled by meeting any policeman (the indefinite scopes below the intentional operator). Example (48b) is similarly ambiguous: it can mean that there is a particular group of policemen that Miles wants to meet, or that meeting any group of policemen will be sufficient to fulfil his wish.

Sentence, (48c), on the other hand, lacks this ambiguity. It only has the narrow-scope reading, under which meeting any group of policemen will satisfy Miles' wish. The wide-scope reading under which Miles wishes to meet a particular group of policemen is absent.

Similarly, sentence (49a) is ambiguous between a wide-scope and a narrow-scope reading of the singular indefinite: it can either mean that there is a particular book on Danish cooking that Max is looking for, or that Max is seeking some book on Danish cooking or other. On the other hand in (49b) the bare plural can only take narrow scope. This sentence can't mean that there is a particular set of books that Max is looking for.⁴

⁴Carlson's claim that bare plurals always scope below intensional operators has been challenged by Kratzer (1980), who provides the following counterexample (see also Gillon 1990, Link 1991, Carlson 1996, Bosveld-de Smet 1998):

- (i) Hans wollte Tollkirschen in den Obstsalat tun, da er sie mit richtigen Kirschen verwechselte.
 'Hans wanted to put belladonnas in the fruit salad because he mistook them for cherries.'

Under the most salient reading of this sentence, Hans did not want to put poisonous berries in the salad, rather he wanted to put some berries in the salad, which he took to be cherries, but which actually were belladonnas. Kratzer argues that this reading can be captured only if the bare plural *Tollkirschen* 'belladonnas' is allowed to scope above the intensional operator introduced by *wollte* 'wanted'.

I will not attempt to provide an explanation for the apparent contrast between examples like

However, Partee (1985) observed that the pattern changes when the bare plural noun phrase acts as a dependent plural. She cites e.g. the following examples:

- (50) a. All the boys want to meet policemen. *want* > \exists , \exists > *want*
 b. All the R.A.'s are looking for books on Danish cooking. *look for* > \exists ,
 \exists > *look for*

Both these sentences have dependent readings: (50a) will be judged true if each boy wants to meet one or more policemen, and (50b) will be judged true if each R.A. is looking for one or more books on Danish cooking. Crucially, these sentences contrast with (48c) and (49b) in that in this case the bare plurals can take wide scope with respect to the intensional operators introduced by the verbs. Thus, (50a) can mean that for each boy there is a specific policeman that he wants to meet (as long as it is not the same policeman for all the boys, i.e. the Multiplicity Condition applies). Similarly, (50b) can mean that each R.A. is looking for a particular book on Danish cooking (as long as it is not the same book for all the R.A.'s). Thus dependent bare plurals pattern with singular indefinite DPs (examples 48a and 49a), rather than with non-dependent bare plurals with respect to scope.

I will refer to this observation as *Partee's Generalisation*:

- (51) *Partee's Generalisation*

In English, dependent bare plurals pattern with singular indefinites in being able to scope out of intensional contexts, while non-dependent bare plurals are confined to narrow scope.

(48c) and (i). I suspect that it has to do with the fact that (i) is most naturally understood as describing an immediate intention on the part of Hans, rather than an actual wish. In other words, the verb *want* in this case functions more like a marker of prospective aspect or immediate future, than a true intensional predicate. But whatever the ultimate explanation may turn out to be, I will assume that the contrasts between (48c) and (49b) on the one hand, and (50a) and (50b), discussed below, on the other, are valid, and need to be accounted for by a theory of dependent plurality.

1.4.3 *Certain-DPs*

English noun phrases headed by nouns modified by *certain* can also act as dependent plurals. Consider the following examples, taken from COCA and from a website on dolphins in Hawaii:

- (52) a. We all have certain talents that might be different from one another.
 b. Most of these groups live permanently along certain coastlines or bays and can therefore be spotted regularly.⁵

According to (52a), each person possesses *at least one* talent, i.e. the DP *certain talents* can have a number-neutral interpretation with respect to each member of the set referred to by the subject. Similarly, (52b) states that most groups live along one or more particular coastlines or bays. In fact, each of these groups might live permanently along just one coastline or bay, as long as it is not the same coastline or bay for all of them.

Furthermore, just like bare plurals, plural DPs with *certain* cannot be interpreted number-neutrally with respect to singular DPs (cf. the *Licensing Generalisation*, section 1.3.1):

- (53) Each group lives permanently along certain coastlines.

For this sentence to be true, each group must live along at least two different coastlines.

DPs with *certain* differ in a number of important respects from bare plurals (cf. Hintikka 1986, Kratzer 1998), and can thus help us establish which properties are consequential with respect to the ability of plural nominals to function as dependents of quantificational licensors. I will return to this question in section 1.4.7.

⁵<http://www.explore-the-big-island.com/swim-with-dolphins-in-hawaii.html>

1.4.4 Possessive NPs

Another class of DPs which can function as dependent plurals are DPs involving possessors. Two cases can be distinguished: one where the possessor of the plural dependent is itself a plural DP (either a plural pronoun bound by the licensor, or a non-bound plural), and one where the possessor is a singular non-bound DP. I will examine them in turn.

The following example is due to de Mey (1981):

(54) All the boys brought their fathers along.

In this example, the plural pronoun *their* may be interpreted as a variable bound by the subject *all the boys*. The question is whether the plural possessive DP *their fathers* can be interpreted as dependent on the subject. Clearly, each boy isn't required to have more than one father for this sentence to be judged true, i.e. the multiplicity associated with the plural possessive DP *their fathers* isn't interpreted with respect to each member of the subject set. But there is an overarching multiplicity requirement - (54) could not be used to describe a situation in which all the boys are brothers, who brought along their common father. We can conclude that the plural possessive DP *their fathers* can be interpreted as dependent on the plural quantificational subject *all the boys*.

As expected, if the plural licensor is replaced by a singular quantificational DP the dependent plural reading disappears:

(55) Each boys brought his fathers along.

This sentence will only be judged true if each boy had two or more fathers and brought them along.

Let us consider a slightly more complex example:

(56) All the students named their mothers' favourite books.

In this example the plural DP *their mothers' favourite books* is a possessive DP, whose plural possessor *their mothers'* is itself a possessive DP with a plural

possessor. The most deeply embedded possessor is a plural pronoun which can be interpreted as a variable bound by the subject *all the students*. In this case both the possessor DP *their mothers* and the full DP *their mothers' favourite books* may be interpreted as dependent plurals. E.g. this sentence may be used to represent a situation where each student named a single book which was the favourite book of her mother. It is not required for any student to have named more than one book, or for any student to have more than one mother.

Now consider the following example which involves a singular possessor within a plural DP:

(57) Most of these people are married to John's relatives.

Here, again, the plural possessive DP *John's relatives* can function as a dependent plural licensed by the plural quantificational subject, i.e. this sentence can be naturally understood as stating that for most of these people there is one relative of John that they are married to.

I conclude that possessive DPs can function as dependents, both in case the possessor is itself plural and interpreted as bound by or dependent on the licensor, and in case the possessor is singular.

1.4.5 Definites

Finally, as first noted by Roberts (1990), definite noun phrases in English can in some contexts be interpreted as dependent plurals. Consider the following examples:

- (58) a. Those men married the ex-wives of their neighbours.
 b. Most of these men married the ex-wives of their neighbours.
 c. John always buy the books that he likes.

Example (58a) is due to Roberts (1990). As Roberts notes, the plural definite DP *the ex-wives of their neighbours* in this example can be interpreted as a dependent plural. Thus, this sentence can be taken to describe a situation in which each

of the men married one woman who was the ex-wife of his neighbour (indeed, as Roberts notes, this appears to be the most salient interpretation).

Note however, that the licensor in (58a) is itself a definite DP headed by a demonstrative (*those men*), and as we have seen in section 1.4.1 such DPs can license cumulative readings even with those types of dependents which do not pattern with bare plurals in the context of quantificational licensors (e.g. DPs with numerals). Thus, to check whether definites actually pattern with bare plurals we must consider the availability of dependent plural readings in the context of quantificational licensors, nominal or adverbial. The relevant examples are given in (58b) and (58c).

Sentence (58b) differs minimally from (58a) in that the subject is a quantificational, rather than a definite, plural (*most of these men*). However, this difference does not affect the availability of a dependent plural interpretation - (58b) will be true relative to a situation in which the majority of men married a single woman who was their neighbours ex-wife.

Example (58c) illustrates the ability of definite DPs to function as dependents of quantificational adverbs. It states that on each relevant occasion John buys the book or books that he likes. Crucially, it doesn't require for John to buy more than one book on each occasion to be judged true, i.e. the plural definite *the books that he likes* can be interpreted number-neutrally with respect to the occasions quantified over by the adverb *always*.

These examples show that plural definite DPs can have dependent plural interpretations analogous to those which are available for bare plural indefinites. However, there are contexts where definite DPs lack dependent plural readings. Consider the following contrast:

(59) a. Most students read the books that the teacher had recommended to them.

b. Most students read the books that the teacher had recommended to the class.

In (59a) the plural definite DP *the books that the teacher had recommended to them* can be interpreted as dependent on the subject *most of the students*. Under this reading, the sentence will be judged true if there is a set of students each of whom read one or more books that were recommended to her by the teacher, and this set comprises more than half of all the students. For instance, it can describe a state of affairs in which each of the relevant students read just one book, as long as they didn't all read the same book.

Sentence (59b), on the other hand, lacks a dependent plural interpretation. It can only mean that most students read the plurality of books that the teacher had recommended to the class. For instance, it will not be judged true if there is a set of students which includes more than half of the total number of students, such that the students in this set cumulatively read all the books that the teacher recommended, with each of the students in this set reading just one of those books.

What accounts for the contrast between (59a) and (59b)? One obvious difference is that the definite DP in (59a) contains a pronoun bound by the restrictor, while the definite in (59b) does not. But consider the following example:

- (60) Most of the students read the books that their teacher had recommended to the class.

In the context where all the students in question attend the same class and have the same teacher, (60) patterns with (59b) in not allowing a dependent plural reading even though in this case the plural definite DP does contain a pronoun *their* which can be interpreted as bound by the subject. This shows that the mere presence of a pronoun bound by the licensor inside a plural definite DP is not sufficient to license a dependent plural reading.

What sets example (59a) apart from both (59b) and (60) is that (59a) can be understood as stating that there is a unique book (or set of books) defined *for each student separately*, while in (59b) and (60) the set of recommended books is common to all the students. Deriving this contrast is another desideratum for an adequate analysis of dependent plurality.

1.4.6 Dependent Plurality and Binding of Plural Pronouns

Kamp and Reyle (1993) note the similarity between dependent plurals and bound plural pronouns which pick out individual (atomic) discourse referents, as in the following example:

(61) Few lawyers hired a secretary who they liked.

The relevant interpretation is represented in (62), where x and y are variables ranging over atomic individuals:

(62) FEW $x[x \text{ is a lawyer }][\exists y.y \text{ is a secretary } \wedge x \text{ hired } y \wedge x \text{ liked } y]$

The parallelism between these kinds of bound pronouns and dependent plurals can be formulated in the following way: in the context of another plural DP (the binder in the case of pronouns, and the licenser in the case of dependent plurals) the plural number feature of plural pronouns and dependent plurals can be semantically vacuous (save for the overarching Multiplicity Condition for dependent plurals). Or alternatively: plural pronouns as in (61) (under the interpretation in 62), and dependent plurals are both interpreted as co-varying with respect to another plural DP (the binder in the case of pronouns, and the licenser in the case of dependent plurals).

However, as Kamp and Reyle (1993) note, there is an important contrast between bound plural pronouns and dependent plurals, which they formulate in terms of locality. They cite the following examples:

- (63) a. The women bought cars which had automatic transmissions.
 b. The women bought a car which had automatic transmissions.
 c. The women bought cars which they liked.
 d. The women bought a car which they liked.

In (63a) both *cars* and *automatic transmissions* can be interpreted as dependent on the matrix subject *the women*. On this interpretation, (63a) would be judged

true relative to a situation in which each woman bought one car which had one automatic transmission.

This kind of interpretation is unavailable in (63b). This sentence only has a pragmatically odd interpretation on which the women bought cars each of which had more than one automatic transmission. The bare plural *automatic transmissions* cannot co-vary with the matrix subject *the women*.

Kamp and Reyle (1993) interpret this contrast as indicating that dependent plurality is a clause-bounded relation, i.e. that dependents require clause-mate licensors. In (63a) the plural noun phrase *automatic transmissions* is dependent on the pronoun *which*, which presumably carries a plural feature in agreement with its head noun *cars*, and *cars* is dependent on *the women*. In (63b), on the other hand, the relative clause modifies a singular noun *car*, and hence the pronoun *which* is (underlyingly) singular. This means that there is no appropriate plural licensor within the relative clause for *automatic transmissions* to be dependent on, and it cannot be dependent on the matrix subject because of the clause-boundedness requirement.

I will argue in section 5.3.2 that the requirement that plural dependencies be clause-bounded is too strong. However, following the observations in section 1.2.3 above, the fact that *automatic transmissions* cannot be interpreted as dependent on the matrix subject *the women* in (63b) can be attributed to an intervention effect - the encompassing singular DP *a car which had automatic transmissions* blocks the relation between the matrix subject and its sub-constituent bare plural noun phrase. Indeed, as we will see, both the analysis of intervention effects proposed by Zweig (2008, 2009) (cf. section 2.5.1.3), and the analysis that I propose in section 5.2, apply directly to cases of “encompassing” interveners.

Now consider examples (63c) and (63d). Sentence (63c) has an interpretation on which each woman bought a car which she liked (as long as more than one car was bought overall). On this interpretation *cars* is interpreted as dependent on the subject *the women*, while the plural pronoun *they* is bound by the matrix subject

and picks out a singular discourse referent. Hence both *cars* and *they* can be interpreted as co-varying with the subject *the women*, just like *cars* and *automatic transmissions* can be interpreted as co-varying with the matrix subject in (63a).

Crucially, the pronoun can still be interpreted as co-varying with the matrix subject even if the encompassing DP is singular, as in (63d). Sentence (63d) can also mean that each woman bought a car that *she* liked. In this respect (63d) contrasts with (63b), where the relation between *automatic transmissions* and the matrix subject is blocked by an encompassing singular DP.

Thus, we may conclude that the relation between a bound plural pronoun picking out a singular discourse referent and its binder is less constrained than the relation between a dependent plural and its licenser. Specifically, relations between plural pronouns and their binders do not exhibit the intervention effects typical for dependent plurals.

An important observation that Kamp and Reyle (1993) do not make is that bound plural pronouns which co-vary with their binders across interveners cannot themselves license dependent plurals. Consider the following examples:⁶

- (64) a. All the women bought cars which they found in nearby stores.
 b. All the women bought a car which they found in nearby stores.

In (64a), *cars*, the pronoun *they* and the bare plural *nearby stores* can be interpreted as co-varying with the matrix subject *all the women*. On this interpretation, (64a) will be judged true e.g. in a context where each woman bought one car which she found in one nearby store. Sentence (64b), on the other hand, cannot be judged true in this context. In (64b), *a car* and *they* can be interpreted as co-varying with the matrix subject, but the bare plural *nearby stores* cannot. I.e. on the co-varying reading of the pronoun and *a car*, (64b) will be judged true if each woman bought a car that she found in *more than one* store.

I will return to a discussion of these issues in sections 2.5.1.2 and 3.12.2.

⁶I am using *all* DPs as subjects instead of simple definites to make the distributive interpretation in (64b) more salient.

1.4.7 Seeking a Generalisation

We have established that plural nominal phrases fall into two distinct classes: bare plurals, *certain* DPs, possessives and definite plurals all pattern together in allowing co-distributive dependent readings in the context of both quantificational and non-quantificational plural nominals, and pluractional adverbials. Numerical DPs and those involving cardinal modifiers like *several*, on the other hand, allow co-distributive readings (which in this case are traditionally referred to as ‘cumulative’) only with a subset of these licensors, specifically in the context of non-quantificational plural DPs. The following question immediately arises: is there something that all the nominals in the first class have in common, which distinguishes them from the types of DPs in the second class? Or to put it differently, is there some property that correlates with the ability of a nominal expression to function as a dependent in the full range of contexts?

In this section I will try to provide an answer to this question. In doing so, I will again start with English bare plurals, and look at several properties which are known to distinguish English bare plurals from numerical DPs. I will argue that neither obligatory narrow scope nor the ability to have kind readings, characteristic of English bare plurals, correlate with the ability to function as a dependent plural in the context of quantificational licensors. Rather, the crucial property will turn out to be (underlying) number-neutrality.

1.4.7.1 Obligatory Narrow Scope

As was already discussed in section 1.4.2, non-dependent bare plurals in English are confined to narrow scope with respect to a range of operators. For instance, bare plural which occur within intensional contexts cannot scope outside of these contexts. The relevant examples are repeated below:

- (65) a. Miles wants to meet policemen. *want* > \exists , $*\exists$ > *want*
 b. Max is looking for books on Danish cooking. *look for* > \exists , $*\exists$ > *look for*

Numerical DPs, on the other hand, are not restricted in this way, and can scope above intensional operators:

- (66) a. Miles wants to meet two policemen. $want > \exists, \exists > want$
 b. Max is looking for two books on Danish cooking. $look\ for > \exists, \exists > look\ for$

Sentence (66a) can mean that there are two particular policemen that Miles wants to meet, and (66b) can mean that Max is looking for two particular books on Danish cooking.

Similarly, Carlson (1977, 1980) argues that bare plurals can only have narrow scope with respect to negation and other quantified noun phrases. Again, this restriction does not apply to numerical DPs. This contrast is illustrated in (67) and (68):⁷

- (67) a. Two cats are in this room and two cats are not in this room. $NEG > \exists, \exists > NEG$
 b. Cats are in this room and cats are not in this room. $NEG > \exists, * \exists > NEG$
- (68) a. Everyone read two book on caterpillars. $\forall > \exists, \exists > \forall$
 b. Everyone read books on caterpillars. $\forall > \exists, * \exists > \forall$

Sentence (67a) is most naturally interpreted as asserting that there is a pair of cats who are in this room, and there is a (different) pair of cats who are not in this room. Under this reading, the numerical DPs take scope above negation. On the other hand, sentence (67b) can only be interpreted as a contradiction, i.e. as simultaneously asserting that there are some cats in this room and that there are no cats in this room. This is the reading which obtains if the existential quantifier associated with the bare plural scopes below negation. Crucially, a non-contradictory interpretation is absent in (67b), which indicates that the existential quantifier associated with the bare plural cannot scope above negation.

⁷Examples (67b) and (68b) are from Carlson 1977. In his paper, Carlson contrasts these examples with sentences involving singular indefinites, rather than plural numerical DPs.

In (68a) the Numerical DP can be interpreted as having either narrow or wide scope with respect to the quantificational subject. On the reading where the indefinite has narrow scope, (68a) states that every individual in the relevant set read a potentially different pair of books. On the other hand, if the indefinite is interpreted as having wide scope, (68b) asserts the existence of one particular pair of books that was read by every individual.

In contrast, in (68b) the bare plural can only be assigned narrow scope with respect to the subject, i.e. this sentence cannot be taken to assert the existence of a particular set of books that were read by each individual.

Could this contrast in scopal interpretation be related to the availability of dependent readings in the full range of contexts? When we look at other types of DPs that pattern with bare plurals with respect to dependent readings, we find that they do not pattern with bare plurals with respect to scope.

For instance, *certain* DPs in English must have wide, rather than narrow scope, when they occur in intensional contexts (cf. Hintikka 1986):

(69) Miles wants to meet certain policemen. $*want > \exists, \exists > want$

This sentence can only mean that there is a particular set of policemen that Miles wants to meet. It cannot mean that meeting any set of policemen would satisfy Miles' wish. Thus, (69) is the mirror image of (65a) in terms of the available scopal interpretations of the plural DPs.

Similarly, plural *certain* DPs in the following examples can have wide scope relative to negation (ex. 70a) and a quantificational subject (ex. 70b), in contrast to the bare plurals in (67b) and (68b):

- (70) a. Certain cats are in this room and certain cats are not in this room. $\exists >$
 NEG
 b. Everyone read certain books on caterpillars. $\forall > \exists, \exists > \forall$

Similarly, plural possessive and definite DPs are clearly not restricted to narrow scope with respect to intensional or other operators;

- (71) a. John is looking for Mary's friends.
 b. John is looking for the people he had met at the party.

The plural possessive DP in (71a) can have either a narrow-scope, or a wide-scope interpretation with respect to the intensional operator associated with the predicate *look for*. I.e. this sentence can either mean that finding any set of Mary's friends would satisfy John (e.g. if Mary is in trouble, and John wants to find someone to help her), or that there are particular people who are friends of Mary, such that John is looking for them.

The plural definite in (71b) can only have wide scope with respect to the intensional predicate, i.e. the set of people John is looking for must be constant across all the possible worlds quantified over by the intensional operator.

Now, recall that *certain* DPs, possessives and definites all pattern with bare plurals in allowing dependent readings under quantificational licensors. We may thus conclude that confinement to narrow scope is not a necessary condition for having dependent readings in these contexts.

1.4.7.2 Kind Readings

Another property that famously distinguishes English bare plurals from numerical DPs is the availability of kind readings (cf. Carlson 1977, 1980, see also Krifka et al. 1995). This is evidenced by the compatibility of bare plurals with such predicates as *be widespread* and *be extinct*, which semantically select for kinds, as in the following examples:

- (72) a. Spiders are widespread.
 b. Dinosaurs are extinct.

The following example from Krifka et al. 1995 further illustrates the kind reading of bare plurals:

- (73) Potatoes were introduced into Ireland by the end of the 17th century.

Crucially, the bare plurals in (72) and (73) can refer to a single kind, rather than to a set of sub-kinds. Numerical DPs, on the other hand, do not allow such readings:

- (74) a. #10 million spiders are widespread
 b. #Two million dinosaurs are extinct.

These examples are only felicitous if *10 million spiders* and *two million dinosaurs* refer to 10 million sub-species of spiders and two million sub-species of dinosaurs, respectively (the so called ‘taxonomic reading’, cf. Krifka et al. 1995). Crucially, *10 million spiders* cannot be taken to refer to a single species ‘spider’ comprised of 10 million individual spiders. Similarly, *two million dinosaurs* cannot refer to a single species ‘dinosaur’ comprised of two million dinosaurs.

What about other types of DPs which pattern with bare plurals with respect to dependent plural readings?

Certain DPs do not appear to have kind readings of the sort typical of English bare plurals. Consider the following examples:

- (75) a. Certain spiders are widespread.
 b. Certain potatoes were introduced into Ireland by the end of the 17th century.

Just like numerical DPs in (74), *certain* DPs in these examples can only refer to sets of sub-species of spiders and potatoes. They cannot refer to the kinds ‘spider’ or ‘potato’ like the bare plurals in (72a) and (73).

Similarly, plural definite DPs in English do not have kind readings:

- (76) a. *The spiders are widespread.
 b. *The potatoes were introduced into Ireland by the end of the 17th century.

These data show that the availability of non-taxonomic kind readings doesn’t correlate with the ability of plural nominals to function as dependents in quantificational contexts.

1.4.7.3 Number-Neutrality

A number of researchers have argued that bare plural noun phrases in English should be analysed as semantically number-neutral (Krifka 1989, 2004, Sauerland et al. 2005, Sauerland 2003, Spector 2007, Zweig 2008, 2009) or ambiguous between an exclusive (i.e. strictly plural) and inclusive (i.e. number-neutral) interpretation (Farkas and de Swart 2010). The main evidence for this claim comes from the behaviour of bare plurals in downward-entailing contexts, e.g. in the scope of negation and in the protasis of conditionals, as well as in (certain types of) question contexts. This is illustrated in the following examples from Zweig (2009):

- (77) The UN envoy did not meet senior government officials on his latest visit to the region.
- (78) Did you see bears during your hike?
 a. #No, I saw one.
 b. Yes, I saw one.
- (79) If the UN envoy meets senior government officials on his latest visit to the region, he will be surprised.

With respect to a context where the UN envoy met just one senior government official, sentence (77) is judged false. This indicates that what is negated is not that the UN envoy met more than one official, but that he met any. This is expected if the bare plural senior *government officials* is undelvingly number-neutral, referring to one or more officials. Compare sentence (77) with (80a) and (80b), where the bare plural has been replaced with a DP involving the cardinal modifier *several* and a numerical DP. These sentences would be judged true in the above context:

- (80) a. The UN envoy did not meet several senior government officials on his latest visit to the region.
 b. The UN envoy did not meet five senior government officials on his latest visit to the region.

Similarly, the question in (78) must be answered positively if the addressee saw at least one bear, as evidenced by the the infelicity of (78a) and, conversely, the felicity (78b) as potential answers. This indicates that the bare plural *bears* in this context refers to one or more bears. Compare this to the question in (81) and the potential answers in (81a) and (81b):

- (81) Did you see several / five bears during your hike?
- a. No, I saw one.
- b. #Yes, I saw one.

As the answers in (81a) and (81b) indicate, (81) will be answered negatively if the addressee saw only one bear.

Finally, (79) involves a bare plural within the protasis of a conditional sentence. This sentence is naturally read as stating that the UN envoy will surprised to meet *any* senior government officials. On the other hand, the following example indicates that the envoy will be surprised to meet *more than one* senior government official:

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

These data suggest that the English bare plural is underlyingly number-neutral, denoting a set of one or more entities, rather than strictly plural like numerical DPs and plural DPs with cardinal modifiers.⁸ The strictly plural interpretation that speakers usually derive for bare plural noun phrases outside of downward-entailing contexts is then taken to be an implicature, which arises in competition with a semantically more restricted singular indefinite form, that can only refer to atomic individuals.⁹ Consider the following example:

⁸Further evidence for the number-neutral account of English bare plurals comes from experimental studies, cf. Sauerland et al. (2005) (see also Anand et al. 2011, Grimm 2013, Pearson et al. 2011).

⁹Alternatively, Farkas (2006) and Farkas and de Swart (2010) propose that English plurals are ambiguous between a strictly plural (or exclusive) and a number-neutral (or inclusive) interpretation. Farkas and de Swart (2010) then account for the contrast between plurals in downward-entailing environments (and questions), and those in non-downward entailing environments in terms of a pragmatic competition between the two available interpretations.

(83) John saw dogs in the yard.

On a number-neutral approach to the semantics of bare plurals, (83) actually states that John saw one or more dogs in the yard. The fact that this sentence appears to be infelicitous in a context where John saw just one dog is derived as an implicature, roughly as follows: If John had seen just one dog, the speaker should have used a semantically richer and more restricted singular form *a dog* instead of the vague number-neutral form *dogs*. Since the vague term was used, the singular form must be inappropriate. Hence, John must have seen more than one dog. Of course, a theory of this sort must also explain why this implicature does not arise in downward entailing contexts and questions, as discussed above. Providing a formal account of how such an implicature is calculated is not a trivial matter, and several alternative approaches have been suggested, cf. Sauerland et al. (2005), Spector (2007), Zweig (2008, 2009). What is relevant for us here is the general conclusion about the underlying number-neutrality of bare plurals, and the fact that in this respect bare plurals contrast with DPs involving cardinal modifiers and numerals.

Putting English *certain* DPs aside for now, let us turn to plural definites. Consider the following example, where a plural definite DP occurs within an *if*-clause:

(84) If John immediately hands in the things he stole, I won't even check what's missing.

Suppose the speaker believes that John entered her room and stole something from there, but does not know what exactly. She may then utter (84) even if she does not know whether John stole one or more things. If the plural definite *the things he stole* was inherently plural, we would expect (84) to be felicitous only if the speaker believes that John stole more than one thing. Then this sentence would not be appropriate in the above context, contrary to fact.

Compare (84) with (85), which involves a singular definite DP:

(85) If John immediately hands in the thing he stole, I won't even check what's missing.

Sentence (85) does appear to commit the speaker to a belief that John had stolen only one thing, and thus this sentence would not be felicitous in the above context. This indicates that while the definite plural is number neutral, the definite singular is exclusively singular.

In fact, plural definite DPs exhibit number neutrality even in non-downward entailing intensional contexts, as long as the reference of the definite DPs varies across possible worlds:

(86) I want John to return the things he stole from me.

(86) can be felicitously uttered by the speaker in the context discussed above, where the speaker does not know whether John had stolen one or more things. Again, this contrasts with the singular definite in (87), which commits the speaker to the belief that John had stolen just one object:

(87) I want John to return the thing he stole from me.

I take these data to be sufficient to show that plural definite DPs are underlyingly number-neutral.¹⁰

Plural possessive DPs are similar to plural definites in this respect. Consider the following example due to Sauerland et al. (2005), which involves a plural possessive DP in an intensional context:

(88) You are welcome to bring your children.

Sauerland et al. (2005) discuss the following scenario: The speaker is inviting an old friend, who she hadn't seen for a long time. The speaker doesn't know how many children this friend has. In this context the speaker could felicitously utter (88) addressing that friend, without committing herself to any belief as to the actual number of children that the friend has. This indicates that the plural possessive DP does not have an exclusively plural interpretation, but is underlyingly number-neutral.

¹⁰I will return to a broader discussion of plurality in intensional contexts in section 4.7.2.

If the plural DP is replaced with a singular possessive, the sentence becomes infelicitous in the above context:

(89) You are welcome to bring your child.

This sentence commits the speaker to the belief that the addressee has exactly one child. This is expected if singular possessives, like singular definite DPs, have an exclusively singular interpretation.

We have looked at bare plurals, plural definites and plural possessive DPs, and have found evidence that all of these types of nominals are underlyingly number-neutral. This evidence came from the interpretation of plurals in downward-entailing contexts and questions (for indefinites), and intensional contexts (for definites and possessives). Furthermore, we have shown that in this respect all these types of nominals contrast with DPs involving numerals and cardinal modifiers. We have thus found a property which appears to correlate with the pattern of dependent plural readings that a nominal expression exhibits. Specifically, I would like to propose that the following generalisation holds across all types of plural nominals:

(90) *Neutrality Generalisation*

Number-neutral plurals can be dependent on the whole range of licensors, including quantificational nominal licensors and pluralational adverbials, while non-number neutral plurals can have a co-distributive (cumulative) reading only with non-quantificational nominal licensors.

However, there is still one type of DP unaccounted for, specifically plural *certain* DPs. As the following examples show, placing DPs of this kind in questions, downward-entailing contexts or under intensional operators doesn't give rise to number-neutral interpretations:

- (91) a. The UN envoy did not meet certain senior government officials on his latest visit to the region.
- b. If the UN envoy meets certain senior government officials on his latest visit to the region, he will be surprised.
- c. Mary wants John to return certain things he stole from her.

Sentence (91a) can only be understood as stating that there is a *plurality* of senior government officials, which the UN envoy did not meet. Similarly, (91b) states that there is a *plurality* of senior government officials, which the UN envoy would be surprised to meet. Finally, (91c) states that there is a non-singleton set of things that John stole from Mary and that she wants him to return. In all these cases the interpretation of plural *certain* DPs involves reference to a non-singleton set of objects.

Do these data pose a problem for the *Neutrality Generalisation* formulated above? I believe not.

Note, that for independent reasons the plural DPs in these examples are obligatorily interpreted outside the downward-entailing and intensional contexts which were constructed to induce number-neutrality. Thus, *certain* DPs obligatorily scope above negation in (91a), above the *if*-clause in (91b), and above the intensional predicate in (91c). This means that we don't expect the multiplicity implicature associated with plural DPs to be cancelled in these cases. In fact, as far as I can see, number-neutrality cannot be tested for *certain* DPs with the help of downward entailing or intensional contexts, and thus there are no empirical grounds to treat them as counter-examples to the *Neutrality Generalisation* stated in (89).

I will now turn to a discussion of some cross-linguistic data from Spanish and Brazilian Portuguese, which lends further support to the *Neutrality Generalisation* proposed in this section.

1.4.7.4 Cross-linguistic Evidence

Martí (2007) discusses the semantic properties of plural indefinite nominal phrases in European Spanish (henceforth, ESpanish) and Brazilian Portuguese (henceforth, BPortuguese). It turns out that with respect to number-neutrality, Spanish bare plurals pattern with their English counterparts, while Brazilian Portuguese bare plurals pattern with English DPs involving cardinal modifiers (cf. also Müller 2002). Consider the following examples from ESpanish and BPortuguese, cited by Martí (2007):

- (92) John: Betty says that she saw children playing in the garden, but I don't think that is true.

ESpanish

- (93) ¿Tú viste *niños* jugando en el patio?
 you saw children playing in the garden
 'Did you see children playing in the garden?'
 a. Yes, I saw one.
 b. #No, I saw one.

BPortuguese

- (94) Você viu *crianças* brincando no jardim?
 you saw children jumping in-the garden
 'Did you see children jumping in the garden?'
 a. #Yes, I saw one.
 b. No, I saw one.

Both the ESpanish question in (93) and the BPortuguese question in (94) contain bare plural noun phrases – *niños* 'children' and *crianças* 'children', respectively. In the context provided in (92), the ESpanish question in (93) must be answered positively if the person replying saw at least one child playing in the garden, as illustrated in (93a) and (93b). On the other hand, a similar question in BPortuguese given in (94) will be answered positively if the replier saw more than one

child, but negatively if she saw just one, cf. (94a) and (94b). This indicates that ESpanish bare plurals are underlyingly number-neutral, while BPortuguese bare plurals are exclusively plural.

Further evidence for this comes from the interpretation of ESpanish and BPortuguese bare plurals under negation. Martí (2007) provides the following examples:

ESpanish

- (95) Juan no tiene *hijos*
 Juan not have children
 ‘Juan does not have children.’

BPortuguese

- (96) O João não tem *filhos*
 the João not have children
 ‘João does not have children.’

According to Martí (2007), (95) from ESpanish will be judged false if Juan has one or more children. This is expected if ESpanish bare plurals are number-neutral: (95) is then equivalent to ‘It is not the case that Juan has *one or more* children’.

On the other hand, (96) from BPortuguese will be judged true if João has one child, but false if he has more than one. Again, this is what we expect if BPortuguese bare plurals are strictly plural: (96) can be paraphrased as ‘It is not the case that Juan has *more than one* child’.

Now that it has been established that ESpanish bare plurals are, while BPortuguese bare plurals are not number-neutral, the *Neutrality Generalisation* makes a prediction: ESpanish bare plurals are predicted to have dependent readings in the context of nominal quantificational and adverbial licensors, while BPortuguese bare plurals are predicted not to have dependent readings in these contexts.

This prediction is indeed borne out. Martí (2007) provides the following examples of bare plurals in the context of pluractional adverbials:

ESpanish

- (97) Jorge come *manzanas* todos los días
 Jorge eats apples all the days
 ‘Jorge eats apples every day.’

BPortuguese

- (98) Jorge normalmente come *maçãs* de sobremesa
 Jorge normally eats apples of dessert
 ‘Jorge normally eats apples for dessert.’

The ESpanish sentence in (97) will be judged true if Jorge eats *one or more* apples each day, i.e. the bare plural *manzanas* ‘apples’ can be interpreted as dependent on the adverbial *todos los días* ‘every day’. On the other hand, the BPortuguese sentence in (98) will be judged true only if Jorge normally eats *more than one* apple for dessert. This indicates that in this case the pluractional adverbial *normalmente* ‘normally’ cannot license a dependent reading of the bare plural *maçãs* ‘apples’.

To conclude, the contrast between ESpanish and BPortuguese bare plural noun phrases provides further support for the *Neutrality Generalisation*, which establishes a correlation between the underlying number-neutrality of a plural nominal expression (as observed in downward-entailing or intensional contexts), and its ability to function as a dependent plural in the context of quantificational and pluractional licensors.

1.5 Conclusion

This chapter has focused on the properties of constructions involving dependent plurals when the relation between the licensor and the dependent is a local one, i.e. confined to a single clause. First, three basic characteristics of dependent plurals were discussed: co-distributivity, overarching multiplicity, and intervention effects. I then provided an overview of the types of linguistic expressions that can function as licensors and as dependents in dependent plural constructions. A number of generalisations was proposed with regards to both of these classes of items.

With respect to nominal licensors, I have argued that only plural DPs can serve as licensors, where ‘plurality’ is best defined in terms of the features of the complement NP, rather than in terms of grammatical agreement.

With respect to non-nominal licensors, I demonstrated, following Ivlieva (2013), that while various types of pluractional adverbials can function as licensors, quantifiers over possible worlds (e.g. modals and attitude predicates) are generally incapable of licensing dependent plurals.

With regard to dependents, we have seen that they fall into two categories: those that can (like bare plurals) have dependent plural readings in the context of quantificational and adverbial licensors, and those that cannot. I argued that the first category stretches well beyond bare plurals, and includes, at least, *certain* DPs, possessives and definites. The second category includes DPs with numerals and cardinal modifiers. I argued that membership in the first category is correlated with underlying number-neutrality (rather than scopal properties or the potential for kind readings), and cited additional cross-linguistic evidence for this conclusion based on the properties of bare plurals in European Spanish and Brazilian Portuguese.

Finally, I reviewed the contrast with regards to scope, noted by Partee (1985), between English bare plurals acting as dependents and those which occur in non-dependent configurations.

Chapter 2

Existing Approaches to Dependent Plurals

2.1 Introduction

In this chapter I provide an overview of existing analyses of dependent plurals. In the course of the previous chapter we noted the semantic parallelism between dependent plurals and, on the one hand, singular indefinites under distributive quantifiers, cf. example (1b), and, on the other hand, cumulatively interpreted numerical DPs, cf. example (1c):

- (1) a. All the boys read books about Napoleon.
- b. Every boy read a book about Napoleon.
- c. Five boys read seven books about Napoleon.

The singular indefinite *a book about Napoleon* in (1b) is mereologically singular, but distributively number-neutral. For each boy it identifies a single book, but one or more books may be involved overall.

The numerical DP *seven books about Napoleon* under a cumulative reading of (1c) is, conversely, mereologically plural (denoting a set of seven books), but distributively unique, i.e. only one set of seven books is involved overall.

We may then ask whether the semantics of dependent plurals can be assimilated to one of these two types of interpretation, and if it can, which one should be chosen. Most existing analyses of dependent plurals give a positive answer to the first question. In what follows, I divide them into three broad categories. I will refer to theories that take dependent plurals to be distributively, but not necessarily mereologically non-singular, as *distributive approaches*. Conversely, I will use the term *mereological approaches* for theories that analyse dependent plurals as mereologically, but not distributively non-singular, thus unifying dependent plural and cumulative readings. The third approach that I will consider, which I call the *mixed approach*, assumes that dependent plural readings in examples like (1a) arise in the context of mixed interpretations which combine the semantics of cumulativity and distributivity.

After providing an overview of the proposals within each category, I will evaluate how each approach is able to handle the facts discussed in Chapter 1.

2.2 Distributive Approaches to Dependent Plurals

Chomsky (1975) briefly discusses the following contrasts:

- (2) The boys have living parents.
- (3) Unicycles have wheels.
- (4) Each boy has living parents.
- (5) Each unicycle has wheels.

Chomsky notes that predicates like *have living parents* and *have wheels*, apart from their ‘inherent’ sense (i.e. denoting the properties of having more than one living parent and having more than one wheel, respectively), can have the sense of the corresponding singulars (*have a living parent* and *have a wheel*). The availability of these readings depends on “the means by which the subject noun phrase

expresses quantification”. E.g. in (3) the subject is a bare plural, and the predicate can have the sense of “the corresponding singular”. This sentence does not require each unicycle to have more than one wheels, and so it is true. On the other hand, (5) is false, because it states that each unicycle has more than one wheel. In this case the subject contains the quantifier *each*, and the predicate can only have its ‘inherent’ plural sense.

Chomsky does not propose an explicit analysis of these contrasts, but suggests that in sentences like (3) plurality is “a semantic property of the sentence rather than the individual noun phrases in which it is formally expressed”. Furthermore, he considers these facts as evidence that “the principle of compositionality is suspect”, and that “global properties of the sentence” can play a role in the computation of its meaning (i.e. “global plurality” and/or the form of the subject affects the range of possible interpretations of the bare plural which is part of the predicate).

Since Chomsky limits himself to only brief and cursory remarks on this topic, it is impossible to determine what specific analysis he had in mind. Some later authors (e.g. Roberts (1990), Zweig (2008, 2009), Beck (2000a)) have focussed on the statement that bare plurals may have “the sense of the corresponding singulars”, and interpreted Chomsky’s comments as pointing towards a neutrality-based analysis of dependent plurals, with the plural marker on the dependent being semantically vacuous.

Another interpretation might be that Chomsky envisioned a system where the plural marker of the dependent is after all related to a semantic property, to what can be called ‘sentence plurality’, its just that this property is not the same as the standard ‘NP-level’ plurality one finds in examples like (5). If this interpretation is on the right track, then Chomsky’s suggestions might be taken as a precursor to the kind of analysis that I am going to propose in this dissertation.¹

¹I would like to provide the relevant passage from Chomsky 1975 in full, because it does strike me as conveying the same basic intuition as the one that lies behind the analysis proposed in this thesis:

“Compare ‘the boys have living parents’, ‘unicycles have wheels’, ‘each boy has living parents’, ‘each unicycle has wheels’. In the first two cases, plurality is, in a sense, a

Partee (1975) in a reply to Chomsky proposes a way to salvage the principle of compositionally by assuming that the two contrasting readings of bare plurals in e.g. (3) and (5) correspond to different syntactic representations. She suggests two possible ways of achieving this. One is to formulate a rule of syntactic agreement which would affect the number marking on the object noun phrase, as well as that on the verb. Such a rule would apply to a syntactic structure such as (6), and result in plural marking both on the verb *have* and on the object NP *wheel*.

(6) [Unicycles]_{NP} + [have a wheel]_{VP}.

This could be taken as the underlying structure of (3). Under this analysis the bare plural object remains semantically singular, with the plural marking being a reflex of a syntactic agreement operation. In contrast, in sentences like (5) the agreement rule would presumably be inapplicable since the subject is singular, and the plural marking of the object NP would necessarily be semantically motivated.

A purely syntactic approach along these lines would account for the co-distributivity property of dependent plurals in examples like (3), but it fails to explain the overarching Multiplicity Condition. E.g. it does not account for the fact that (2) cannot be judged true in a context where all the boys are brothers, and they have only one living parent.²

Kamp and Reyle (1993) present a valuable discussion of the empirical properties of dependent plurals, as well as develop an analysis within the DRT framework. The analysis is decidedly distributive. They discuss the following sentence, noting that it will be judged true if a majority of the speaker's friends own at least one car:

semantic property of the sentence rather than the individual noun phrases in which it is formally expressed. 'Unicycles have wheels' means that each unicycle has a wheel, and is thus true, though 'each unicycle has wheels' is false.' (Chomsky 1975:165)

²Alternatively, Partee suggests that one might posit a syntactic distinction between *have wheels* as a predicate over individuals, which would correspond to examples like (5), and *have wheels* as a predicate over sets, which would be the analysis of e.g. (3). However, it is not clear from Partee's discussion what the semantics of the bare plural object would amount to in both of these cases, so is impossible to determine which broad family of approaches this proposal belongs to.

(7) Most of my friends own cars.

However, Kamp and Reyle (1993) observe that it would also be wrong to assume that the bare plural in this case is synonymous to the singular. Instead, its denotation must include both singular and non-singular referents, i.e. it must be number-neutral. This is evident from the fact that sentence (8) would be judged true if some of the relevant students bought one book that would keep them occupied during the next two weeks, while some bought more than one (cf. the discussion of this example in section 1.2.1):

(8) Most students bought books that would keep them occupied during the next two weeks.

To account for these data, Kamp and Reyle (1993) propose a rule according to which bare plurals can introduce number-neutral discourse referents in the context of another plural noun phrase, which must be sufficiently local. The domain of locality in this case is taken to be the clause. Sentences with dependent plurals are assigned a distributive interpretation, which arises either by virtue of the licensor DP containing a distributive quantifier as in (7) and (8), or via the application of an Optional Distribution rule, which derives a distributive interpretation for non-quantificational noun phrases. This latter option is necessary to account for cases such as (9), where the licensor is a plural definite:

(9) The women bought cars with automatic transmissions.

Again, no account of the Multiplicity Condition is proposed.

Spector (2003) proposes an analysis of dependent readings of French *des*-indefinites which assimilates them to polarity items. The core observation behind his proposal is that *des*-indefinites in the scope of plural operators (plural DPs, certain “plural” aspectuo-temporal operators) are restricted to narrow scope readings. This makes *des*-indefinites similar to polarity items, which must always take narrow scope with respect to their licensing operator.

Based on this parallelism, Spector develops an analysis according to which *des*-indefinites are marked [+pl], which represents morphological plural. The [+pl] feature is licensed in the scope of an element marked as [+PL], which corresponds to semantic plural.

Consider the following example:

- (10) Tous les garçons ont lu des livres.
 all the boys have read DES books.
 ‘All the boys have read books’.

This sentence can have a dependent plural (or ‘number-neutral’, in Spector’s terms) interpretation, under which each boy has read one or more books. Spector assumes that in this case the plural indefinite *des livre* is morphologically, but not semantically plural, i.e. it is marked with [+pl], but not [+PL]. The [+pl] feature is licensed in the scope of the subject *tous les garçons*, which is semantically plural and hence carries a [+PL] feature.

Spector also proposes an account for cases where there are no [+PL] elements to license *des*-indefinites, such as the following:

- (11) Il y a une heure, Pierre a vu des filles.
 it there has a hour Pierre has seen DES girls.
 ‘One hour ago, Pierre saw some girls’.

In this sentence, *des files* must be interpreted as strictly plural, i.e. (11) is true only if Pierre saw more than one girl. To account for this, Spector assumes that in the absence of a suitable licenser for the [+pl] feature, the licensing [+PL] feature can, and must, be introduced onto the *des*-DP itself, as a last resort operation. It follows that in (11) the *des*-indefinite is semantically plural.

Spector briefly discusses an alternative approach to dependent readings based on cumulativity, and notes that it differs from his own account in posing an additional condition that in e.g. (10) the boys cannot have all read one and the same book. But he doesn’t propose a way to incorporate such a multiplicity requirement into his own analysis (cf. also the discussion of Spector’s (2003) approach in Swart 2006).

To conclude, on the distributive approach, the apparent “non-distributive” interpretation of the dependent plural is analysed as a distributive interpretation of an underlyingly non-plural DP. Consider once again example (1c), repeated in (12):

(12) All the boys read books about Napoleon.

The interpretation that this example will be assigned under the distributive approach is schematically represented in (13). Note that this is equivalent to the interpretation of (14), on the low-scope readings of the direct object:

(13) $\forall x[x \in \llbracket \text{the boys} \rrbracket \rightarrow \exists z[z \text{ is one or more books about Napoleon} \wedge x \text{ read } z]]$

(14) All the boys read one or more books about Napoleon.

The Multiplicity Condition, which requires that more than one book be involved overall in the situation described by (12), is left unaccounted for.

2.3 Mereological Approaches to Dependent Plurals

The term “dependent plural” was coined by de Mey (1981), who offers the first detailed discussion of this phenomenon. He proposes that in constructions involving dependent plurals, both the licenser and the dependent are interpreted collectively, stating that ‘the dependent reading is a special subcase of the collective-collective reading’ (cf. also Scha 1984). De Mey also considers dependent plurals in the context of non-nominal licensors, as in (15):

(15) From here, trains leave regularly for Amsterdam.

In this example there is no plural nominal licenser present, instead the bare plural appears to be dependent on the pluractional adverb *regularly*. This sentence states that at each instance one or more trains leave for Amsterdam, and such instances are located at regular intervals on the time axis. Crucially, it does not

imply that at each instance *more than one* train leaves. Drawing on the parallelism between nominal and adverbial licensors, de Mey argues that adverbials like *regularly* can denote collections of events.

Details of the formal implementation aside, de Mey assumes that dependent plurals are mereologically plural (denote non-singleton sets of individuals), and accounts for their co-distributive semantics by assuming that dependent plural readings are a sub-class of a broader type of non-distributive interpretations – specifically, collective readings.

Other authors, e.g. Bosveld-de Smet (1998), Swart (2006), Beck (2000*a*), assimilate the semantic relation between a dependent plural and its licensor to cumulative, rather than collective predication. For instance, Beck (2000*a*) discusses dependent plurals in the context of the following generalisation:

- (16) An NP headed by a count noun denotes a plurality if the head noun is morphologically plural.

If dependent plurals are mereologically singular or number-neutral, as argued by the proponents of the distributive approach, then they constitute a counter-example to this generalisation. However, Beck argues that this conclusion is not inevitable if we take cases of dependent plurality to involve cumulative readings. Under Beck’s analysis, the sentence in (17*a*) would have the LF as in (17*b*):

- (17) a. The boys married Ethiopian physicists.
 b. [[the boys][[*married][Ethiopian physicists]]]

Both the licensor *the boys* and the dependent *Ethiopian physicists* are mereologically plural, and combine with the verb which is pluralised with the help of the **** operator. The presence of this operator accounts for the cumulative reading (cf. Krifka 1989, Sauerland 1998, Sternefeld 1998, a.o.).

Finally, Zweig (2008, 2009) provides the most comprehensive discussion of dependent plurals to date. Like Beck (2000*a*), Zweig argues for analysing constructions with dependent plurals as semantically cumulative. Zweig’s formalisation is

based on Landman's (2000) theory of plurality, with the dependent plural reading of sentence (18a) represented as in (18b):

- (18) a. Five boys flew kites.
 b. $\exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge |Y| > 1 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AGENT(e)(X) \wedge *THEME(e)(Y)]$

Here, capital letters stand for variables which range over both atomic and non-atomic individuals. The star * represents Link's (1983) pluralisation operator when it combines with a one-place predicates (e.g. FLEW), and the cumulative operator when it combines with two-place predicates (e.g. THEME). In the latter case it corresponds to Beck's (2000) ** operator discussed above.

The interpretation in (18b) is the same as the one Zweig (following Landman 2000) assigns to the cumulative reading of sentence (19a):

- (19) a. Five boys flew at least two kites.
 b. $\exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge |Y| > 1 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AGENT(e)(X) \wedge *THEME(e)(Y)]$

But unlike other researchers within the mereological approach, Zweig takes bare plurals in general, and dependent plurals in particular, to be underlyingly number-neutral:

$$(20) \quad \llbracket \text{kites} \rrbracket = \lambda Y. *KITE(Y)$$

Thus, if there are three kites in total, $\{a, b, c\}$ as in (21a), then the denotation of *kites* will be the (characteristic function of) the closure of that set under the sum operation, as in (21b). This denotation includes both atomic and non-atomic individuals:³

- (21) a. $\llbracket \text{kite} \rrbracket = \{a, b, c\}$
 b. $\llbracket \text{kites} \rrbracket = * \llbracket \text{kite} \rrbracket = \{a, b, c, a \oplus b, a \oplus c, b \oplus c, a \oplus b \oplus c\}$

³Zweig (2008, 2009) uses \sqcup to represent the sum operation, I will continue to use \oplus .

The multiplicity requirement associated with the dependent is represented by the conjunct $|Y| > 1$ in (18b), where $|Y|$ is the number of atoms in Y . This condition is analysed as an implicature which arises in competition with the corresponding singular indefinite. As Zweig points out, this assumption is supported by independent evidence, e.g. by the fact that the semantics of multiplicity associated with bare plurals disappears in downward-entailing environments (cf. Krifka 2004, Sauerland et al. 2005, Spector 2007, and the discussion in section 1.4.7.3). Zweig goes on to develop an analysis of the way the multiplicity implicature is derived in such cases, which is based on Chierchia's (2004, 2006) system of recursive implicature calculation. I will briefly outline how this analysis works.

In Chierchia's (and Zweig's) system scalar implicatures are calculated (potentially) multiple times at various points of the semantic derivation. The relevant calculation points are the scope sites, i.e. the points of derivation which immediately precede the addition of a scopal operator. Zweig further assumes that the point immediately preceding the existential closure of the event variable is a calculation point.

At each such point the derivation splits. On one branch, the current logical form is compared to a set of alternatives, and it is determined which alternatives are weaker than that logical form, and which are stronger. The stronger alternatives are negated, and their negation is added to the logical form. Then the derivation proceeds to the end.

On the second branch, however, the alternatives are not calculated and the derivation proceeds until the next scopal site, where it again splits in the same way - on one branch the scalar alternatives are calculated and the meaning of the current logical form enriched, on the other branch the alternatives are not calculated at the current site and the derivation continues until the next scopal point. This process continues until the derivation reaches its final calculation point - the whole sentence, where the alternatives are calculated for the last time.

After this we are left with a set of logical forms enriched at various points of

the derivation. If this set is not singleton, a final comparison takes place, and the strongest of the available logical forms is chosen as the meaning of the sentence.

Zweig (2009) illustrates how this system derives the multiplicity requirement for bare plurals with the following example:

(22) Dogs are barking.

Before event closure is applied, we have the following predicate over events:

(23) $\lambda e \exists X[*\text{DOG}(X) \wedge *\text{BARK}(e) \wedge *\text{AG}(e)(X)]$

At this point the derivation splits. On one branch, this logical form is compared to an alternative which involves a strictly atomic agent (lower case x stands for a variable which range over atomic individuals):

(24) $\lambda e \exists x[*\text{DOG}(x) \wedge *\text{BARK}(e) \wedge *\text{AG}(e)(x)]$

Since these are predicates rather than sentence meanings, relative strength is defined via set containment rather than entailment: if a predicate p characterises a set P , and predicate q characterises a set Q , then p is stronger than q iff $P \subset Q$.

On this definition, it is clear that the predicate in (24) is stronger than the predicate in (23): the set of events of one dog barking is a sub-set of the set of events of one or more dogs barking. Hence, the meaning is enriched via negation of the stronger alternative:

(25) $\lambda e \exists X[*\text{DOG}(X) \wedge *\text{BARK}(e) \wedge *\text{AG}(e)(X)] \wedge \neg \exists x[*\text{DOG}(x) \wedge *\text{BARK}(e) \wedge *\text{AG}(e)(x)] \iff$
 $\lambda e \exists X[|X| > 1 \wedge *\text{DOG}(X) \wedge *\text{BARK}(e) \wedge *\text{AG}(e)(X)]$

Existential closure applies, which results in the following enriched meaning:

(26) $\exists e \exists X[|X| > 1 \wedge *\text{DOG}(X) \wedge *\text{BARK}(e) \wedge *\text{AG}(e)(X)]$

Now we have to go back to the branching point (the point before existential closure in 23), and continue the derivation without calculating the alternatives. This involves applying existential closure to the unenriched predicate:

$$(27) \quad \exists e \exists X [*DOG(X) \wedge *BARK(e) \wedge *AG(e)(X)]$$

At this point the alternatives are compared again, i.e. (27) is compared with (28):

$$(28) \quad \exists e \exists x [*DOG(x) \wedge *BARK(e) \wedge *AG(e)(x)]$$

It turns out that, due to the distributive nature of the predicate *bark*, these alternatives entail each other, and are hence equivalent: if there is an event of one or more dogs barking, there must be an event of one dog barking, and conversely, if there is an event of one dog barking there is an event of one or more dogs barking. Since the alternatives are equivalent, no enrichment of (27) occurs.

We are left with (26) and (27) as the potential meanings for (22). Since (26) is stronger than (27) (if there is an event of more than one dog barking there is an event of one or more dogs barking, but not vice versa), (26), which involves a multiplicity requirement, is chosen as the final meaning for (22). In this way in Zweig's system the multiplicity requirement associated with bare plurals is derived as a scalar implicature.

The Multiplicity Condition associated with dependent bare plurals is derived in the same way. Consider again the following example:

$$(29) \quad \text{Five boys flew kites.}$$

Recall, than in Landman's (2000) system which Zweig adopts, DPs can be interpreted *in situ*, entering the event description, or quantified in after the event variable is existentially closed.⁴ If the first option is taken for the subject in (29), the following event predicate is derived:

$$(30) \quad \lambda e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$$

⁴Following Landman (2000), Zweig (2008) actually distinguishes between two types of *in situ* readings: *in situ* collective and *in situ* distributive, depending on whether a group or set interpretation is chosen for the licenser. Like Zweig (2009), I will disregard the collective interpretation in the following discussion.

At this point the derivation splits, and on one branch the alternatives are compared. The predicate in (30) is weaker than the alternative involving an atomic theme:

$$(31) \quad \lambda e \exists X \exists y [|X| = 5 \wedge *BOY(X) \wedge *KITE(y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(y)]$$

Hence, the stronger alternative is canceled, and the meaning of the predicate enriched:

$$(32) \quad \lambda e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge |Y| > 1 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$$

After existential closure applies, we derive the following enriched interpretation:

$$(33) \quad \exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge |Y| > 1 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$$

Now we go back to the branching point, and instead of calculating the alternative for (30), apply existential closure directly:

$$(34) \quad \exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$$

According to Zweig (2008, 2009), this logical form cannot be enriched, so it ends up as the second potential interpretation for (29).⁵ We now compare (33) and (34), and find that (33) is stronger. So (33), which incorporates the multiplicity condition for the dependent plural, is chosen as the final interpretation for (29), as required.

Alternatively, if we choose to quantify in the subject in (29), instead of interpreting it *in situ*, we end up with the following function from events to predicates:

$$(35) \quad \lambda e \lambda x \exists Y [*KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(x) \wedge *TH(e)(Y)]$$

⁵As pointed out by Ivlieva (2013) and discussed in section 2.4, this assumption is actually false, and (34) can in fact be enriched.

At this point the derivation splits, and on one branch we calculate the alternatives. The function in (35) is weaker than the alternative involving an atomic theme, so the stronger alternative is cancelled and the meaning enriched:

$$(36) \quad \lambda e \lambda x \exists Y [|Y| > 1 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(x) \wedge *TH(e)(Y)]$$

The calculation proceeds: first, existential closure is applied to (36), and then the subject is added via the rule of quantifying in, which results in a distributive interpretation:

$$(37) \quad \exists X [|X| = 5 \wedge *BOY(X) \wedge \forall x \leq X \exists e \exists Y [|Y| > 1 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(x) \wedge *TH(e)(Y)]]$$

Now we go back to the first branching point, proceed to the next scopal site without calculating the alternatives. The next calculation point is immediately after existential closure, before the subject is added:

$$(38) \quad \lambda x \exists e \exists Y [*KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(x) \wedge *TH(e)(Y)]$$

The alternatives are calculated, but they are equivalent, which means that this logical form cannot be enriched. So the derivation continues to the end:

$$(39) \quad \exists X [|X| = 5 \wedge *BOY(X) \wedge \forall x \leq X \exists e \exists Y [*KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(x) \wedge *TH(e)(Y)]]$$

Finally, we go back to the second branching point, and instead of calculating the alternatives combine directly with the subject, which again gives rise to (39). We calculate the alternatives at this point, but they are again equivalent.

So, in the end we have to choose between two potential interpretations: the enriched version in (37) and the non-enriched version in (39). The enriched version is stronger, so it is chosen. This is the non-dependent, distributive interpretation of (29), which states that each of the boys flew more than one kite.

Thus, Zweig's system is able to derive two readings for sentences like (29): a dependent plural reading, on which the bare plural is interpreted number-neutrally

with respect to individual members of the licensor set and the multiplicity requirement applies globally, and the distributive reading on which the multiplicity requirement is calculated for each individual member of the licensor set.

A strong side of Zweig's approach is that it is able to account for the fact that in downward entailing contexts multiplicity requirements associated with both dependent and non-dependent bare plurals disappear. Consider the following examples, (40a), where is taken from Zweig 2009 (cf. also the examples and discussion in section 1.4.7.3):

- (40) a. John denied that dogs barked that night.
 b. John denied that the carpenters built tables.

Suppose John is testifying in court. Sentence (40a), which involves a non-dependent bare plural, is most naturally assigned the interpretation 'John claimed that it was not the case that any dogs barked', not 'John claimed that it was not the case that more than one dog barked'. The multiplicity requirement is omitted.

Similarly, (40b), involving a dependent plural, is interpreted as 'John claimed that the carpenters did not build any rafts', rather than 'John claimed that the carpenters did not build more than one raft'. If the carpenter did build exactly one raft, and (40b) is true, then it must be the case that John gave a false testimony.

To see how Zweig's system accounts for the semantics of bare plurals in downward entailing contexts, consider the interpretation of the following simple example:

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

The first site for implicature calculation is before event closure:

- (42) $\lambda e \exists X [*DOG(X) \wedge *BARK(e) \wedge *AG(e)(X)]$

Here, the derivation branches. On one branch the alternatives are calculated, and an enriched predicate is derived:

- (43) $\lambda e \exists X [|X| > 1 \wedge *DOG(X) \wedge *BARK(e) \wedge *AG(e)(X)]$

Then existential closure and negation is applied, giving the first potential interpretation for (41):

$$(44) \quad \neg \exists e \exists X [|X| > 1 \wedge *DOG(X) \wedge *BARK(e) \wedge *AG(e)(X)]$$

Now we go back to the first branching point, and proceed directly with existential closure:

$$(45) \quad \exists e \exists X [*DOG(X) \wedge *BARK(e) \wedge *AG(e)(X)]$$

Here, before negation is added, the derivation splits again. On one branch we calculate the alternatives. But since replacing X in (46) with an atomic variable does not produce a stronger alternative, the meaning is not enriched, and negation applies directly to (46):

$$(46) \quad \neg \exists e \exists X [*DOG(X) \wedge *BARK(e) \wedge *AG(e)(X)]$$

This is the second potential interpretation for (41).

We now go back to the second branching point, add negation, and then calculate the alternatives. This will again result in the interpretation given in (46).

So in the end, we must compare two potential interpretations: (44) and (46). (44) states that there was no barking event involving more than one dog as agent. Thus, (44) will be true if there was an event of one dog barking. On the other hand, (46) states that there was no barking event involving one or more dogs. In this case (46), with no multiplicity requirement associated with the bare plural, is the stronger interpretation, and it is chosen as the preferred reading for (41).

The absence of the multiplicity condition in examples involving dependent plurals in downward entailing contexts, as in (40b), is derived in an analogous way.

Thus, Zweig (2008, 2009) provides an explicit analysis of the semantics of dependent plurals and of the Multiplicity Condition associated with them, both in non-downward entailing and downward entailing contexts. On this account, bare plurals in non-downward entailing contexts are similar to DPs involving numerals in that they introduce variables which range over non-atomic individuals. Constructions with dependent plurals are analysed in the same way as cumulative

constructions. However, in the case of non-bare (numerical and quantitative) DPs the non-atomicity requirement is taken to be lexically encoded, while in the case of bare plurals this requirement is analysed as a scalar implicature, which does not arise in downward entailing contexts.

To conclude, the mereological approach takes dependent plurals to be plural in the same way as numerical DPs are assumed to be plural, i.e. to denote non-singleton sums or sets of individuals (either inherently, or as a result of pragmatic enrichment). This straightforwardly accounts for the Multiplicity Condition. co-distributivity of dependent plurals is assumed to arise via the same mechanisms as cumulative or collective interpretations.

2.4 Mixed Approach

The final approach that I want to discuss was proposed by Ivlieva (2013), and in many respects it is similar to the mereological theories of dependent plurals discussed above, especially to that of Zweig (2008, 2009). However, Ivlieva (2013) introduces a novel analysis of dependent plurals in quantificational contexts, which combines aspects of both mereological and distributive approaches.

Ivlieva (2013) adopts a cumulative analysis of examples like (47), which involve a non-quantificational licensor:

(47) My three friends attend good schools.

Furthermore, Ivlieva (2013) follows Zweig (2008, 2009) in taking bare plurals to be underlyingly number-neutral, and deriving the multiplicity semantics of bare plurals in non-downward entailing contexts as a scalar implicature. However, she notes a problem with the system of implicature calculation adopted in Zweig 2008, 2009. Consider the interpretation of sentence (47) in Zweig's system. The first point of implicature calculation in Zweig's system is the event predicate in (49), before event closure applies:⁶

⁶The σ -operator in (49) is defined as follows, from Landman 2000:

$$(49) \quad \lambda e \exists Y [*GOOD_SCHOOL(Y) \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge *TH(e)(Y)]$$

(Presupposition: $|\sigma(*MY_FRIEND)| = 3$)

This event predicate is compared to the one in (50):

$$(50) \quad \lambda e \exists y [*GOOD_SCHOOL(y) \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge *TH(e)(y)]$$

(Presupposition: $|\sigma(*MY_FRIEND)| = 3$)

The alternative in (50) is stronger, hence the predicate in (49) is enriched, and after event closure we arrive at the following potential interpretation for (47):

$$(51) \quad \exists e \exists Y [*GOOD_SCHOOL(Y) \wedge |Y| > 1 \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge *TH(e)(Y)]$$

(Presupposition: $|\sigma(*MY_FRIEND)| = 3$)

We now go back to the first point of implicature calculation, i.e. the predicate in (49), and directly apply event closure without calculating the alternatives:

$$(52) \quad \exists e \exists Y [*GOOD_SCHOOL(Y) \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge *TH(e)(Y)]$$

(Presupposition: $|\sigma(*MY_FRIEND)| = 3$)

At this point implicature calculation applies for the second time, and the interpretation in (52) is compared to the alternative in (53):

$$(53) \quad \exists e \exists y [*GOOD_SCHOOL(y) \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge *TH(e)(y)]$$

(Presupposition: $|\sigma(*MY_FRIEND)| = 3$)

(48) σ -operator

If P is a predicate, σP is interpreted as the sum of all the entities in P if that sum is itself an entity in P , otherwise it is undefined.

Analysing a similar example, Zweig assumes that such interpretations are equivalent, and hence no enrichment takes place (cf. the discussion of example (29) above). However, as Ivlieva (2013) points out, this assumption is incorrect. It is clear that (53) entails (54), however the converse does not hold. Suppose my three friends all attend different schools, which are all good. Then there is a non-atomic sum of schools that my three friends cumulatively attend, and (52) will be true. However, (53) will be false, since there is no single good school that all my three friends attend.

Hence, (52) must be enriched, yielding (54):

$$\begin{aligned}
 (54) \quad & \exists e \exists Y [*GOOD_SCHOOL(Y) \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge \\
 & *TH(e)(Y)] \wedge \\
 & \neg \exists e \exists y [*GOOD_SCHOOL(y) \wedge *ATTEND(e) \wedge *AG(e)(\sigma(*MY_FRIEND)) \wedge \\
 & *TH(e)(y)] \\
 & (\text{Presupposition: } |\sigma(*MY_FRIEND)| = 3)
 \end{aligned}$$

We have thus derived two potential interpretations for sentence (47): (51) and (54). According to the algorithm of implicature calculation adopted in Zweig 2008, 2009, these two interpretations must now be compared, and the strongest one chosen as the final interpretation for (47). Now, it turns out that the interpretation in (54) is stronger. Ivlieva provides the following scenario: suppose my three friends all attend two good schools: a morning school and an afternoon school. Suppose, further, that they all attend the same afternoon school, but different morning schools. Then, the formula in (51) will be true, since there is a non-atomic sum of good schools that my three friends cumulatively attend. However, (54) will be false, since there is also an atomic good school that they all attend. Thus, according to the algorithm adopted in Zweig 2008, 2009, (54) should be chosen as the final interpretation for sentence (47), and it is predicted that this sentence will be judged false in the above scenario. Ivlieva (2013) points out that in fact it is not false in this scenario, which means that the interpretation in (51) is available.

This leads Ivlieva (2013) to adopt a different system of implicature calculation. In this system implicature calculation is triggered by the insertion of a (phonologically covert) syntactic exhaustivity operator, *Exh*, with the interpretations in (55) (cf. also Fox 2007):

- (55) a. $\llbracket Exh_{ALT} \rrbracket = \lambda P_t. P \wedge \forall Q : Q \in ALT \wedge Q \models P [\neg Q]$
 b. $\llbracket Exh_{ALT} \rrbracket = \lambda P_{et}. \lambda e. P(e) \wedge \forall Q : Q \in ALT \wedge Q \subseteq P [\neg Q(e)]$
 where ALT is the set of alternatives to *P*.

The function of the exhaustivity operator is to enrich the meaning of the proposition or event predicate it combines via the negation of all the stronger alternatives. In the case of plurals, the set of alternatives contains the proposition or event predicate derived by replacing the plural with the corresponding singular DP. Moreover, Ivlieva assumes that the implicature associated with the plural feature is *obligatory*. This is captured by the following constraint on the scalar item *plural*:

- (56) Plural must be c-commanded by the exhaustification operator, whose restrictor contains the alternative obtained by replacing plural with the singular. $[Exh_{\{SING\}}[\dots -PLUR \dots]]$

Going back to example (47), Ivlieva's system predicts that both the interpretations in (51) and (54) should be possible. The former is derived by combining the *Exh*-operator with the event predicate below event closure, while the latter is generated if the *Exh*-operator is inserted above event closure at the root. Thus, Ivlieva's system is able to generate the desired dependent plural interpretation of examples like (47), which proved problematic on Zweig's approach.⁷

Consider now the simple sentence in (57):

- (57) Dogs are barking.

In Ivlieva's system, the exhaustification operator can be inserted at two points in the structure of this sentences: below or above event closure. Applying exhausti-

⁷As Ivlieva (2013) notes, it is unclear whether the stronger interpretation in (54) is available for sentence (47), and leaves this question for future research.

fication below event closure yields the desired interpretation in (58) on which more than one dog is barking (cf. the discussion in the previous section):

$$(58) \quad \exists e. \exists X [*dog(X) \wedge |X| > 1 \wedge *bark(e) \wedge agent(e)(X)]$$

However, the *Exh*-operator can also be inserted above event closure. In this case it combines with the following proposition:

$$(59) \quad \exists e. \exists X [*dog(X) \wedge *bark(e) \wedge agent(e)(X)]$$

This is compared to the alternative in (60):

$$(60) \quad \exists e. \exists X [*dog(X) \wedge atom(X) \wedge *bark(e) \wedge agent(e)(X)]$$

Now, recall that Zweig assumed that the interpretations in (59) and (60) are equivalent: if there is an event of one dog barking there is necessarily an event of one or more dogs barking, and conversely, if there is an event one or more dogs barking there is an event of one dog barking. If this is the case, then the application of the exhaustivity operator above event closure should not lead to strengthening, and (59) ('One or more dogs barked') should be a possible interpretation for sentence (57), contrary to fact.

Ivlieva solves this problem by assuming that the implicature calculation process is blind to the information on the lexical distributivity of predicates. Note the the reason that (59) and (60) turn out to be equivalent is that the predicate *bark* is lexically distributive, i.e. any event of a set of individuals barking contains a set of events of each of these individuals barking. Now, if the exhaustivity operator does not take entailments due to lexical distributivity into account, then (59) and (60) are no longer equivalent, and (60) is in fact stronger than (59) (cf. further discussion of this point in section 3.6.2). Hence, the stronger alternative is (60) negated, and we arrive at (61) as a possible interpretation for sentence (57):

$$(61) \quad \exists e. \exists X [*dog(X) \wedge *bark(e) \wedge agent(e)(X)] \wedge \\ \neg \exists e. \exists X [*dog(X) \wedge atom(X) \wedge *bark(e) \wedge agent(e)(X)]$$

This interpretation contradicts world knowledge, and is thus discarded, leaving (58) as the only viable interpretation for sentence (57).

Now, if the insertion of *Exh* is left unconstrained, the system further overgenerates in cases like (62), where a bare plural occurs in a downward entailing context:

(62) It is not true that dogs are barking.

As it stands, the system predicts that this sentence will have two readings, depending on whether the exhaustivity operator is inserted below event closure or above negation (inserting the operator above event closure but below negation leads to a tautology):

- (63) a. ‘It is not true that more than one dog is barking.’
 b. ‘It is not true that one or more dogs are barking.’

In fact, however, sentence (62) can only have the stronger reading in (63b). To rule out the undesired weak interpretation in (63a), Ivlieva adopts the following constraint on the insertion of *Exh*, which follows the proposal in Fox and Spector 2009:

(64) *Exh* is not allowed to weaken the overall meaning (a sentence with *Exh* cannot be entailed by a sentence without *Exh*).

This constraint blocks the insertion of the exhaustivity operator below event closure in examples like (63a), since its application at this point generates an overall interpretation which is weaker than the interpretation of the sentence without exhaustification.

An important innovation of Ivlieva’s (2013) theory is her analysis of the quantificational items *every* and *all*, which as we have seen contrast with respect to the ability to license dependent plurals. Ivlieva adopts the following interpretation for the DP *every boy*, based of the proposals in Schein 1993 and Kratzer 2000:

(65) $\llbracket \text{every boy} \rrbracket = \lambda P. \lambda e. \forall y [\text{boy}(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$

Consider the interpretation of sentence (66):

(66) Every boy wore sweaters.

There are three potential sites for the insertion of the *Exh*-operator in the structure of (66): below the quantificational subject DP, above the subject DP but below the event closure operator, and above event closure. Insertion of the *Exh*-operator at the lowest potential site yields the distributive interpretation in (67), which states that each boy wore more than one sweater:

(67) $\exists e. \forall y [boy(y) \rightarrow \exists e' [e' \leq e \wedge \exists X [*wear(e')(X) \wedge |X| > 1 \wedge *sweater(X) \wedge *agent(e)(y)]]]$

This is the desired interpretation for (66). However, Ivlieva's system allows for two more options. The *Exh*-operator can be attached above the quantificational subject but below event closure, in which case it will combine with a constituent denoting the following event predicate:

(68) $\lambda e. \forall y [boy(y) \rightarrow \exists e' [e' \leq e \wedge \exists X [*wear(e')(X) \wedge *sweater(X) \wedge *agent(e)(y)]]]$

This event predicate is compared with the singular alternative in (69):

(69) $\lambda e. \forall y [boy(y) \rightarrow \exists e' [e' \leq e \wedge \exists X [*wear(e')(X) \wedge atom(X) \wedge *sweater(X) \wedge *agent(e)(y)]]]$

Given the assumption that the process of implicature calculation is not sensitive to the lexical distributivity of predicates, (69) is stronger than (68), and the meaning is enriched, yielding after event closure the proposition in (70):

(70) $\exists e. \forall y [boy(y) \rightarrow \exists e' [e' \leq e \wedge \exists X [*wear(e')(X) \wedge *sweater(X) \wedge *agent(e)(y)]]] \wedge$
 $\neg forally [boy(y) \rightarrow \exists e' [e' \leq e \wedge \exists X [*wear(e')(X) \wedge atom(X) \wedge *sweater(X) \wedge *agent(e)(y)]]]$

This can be re-stated as 'For every boy there is an event of him wearing one or more sweaters, but not for every boy there is an event of him wearing an atomic

sweater'. This interpretation contradicts world knowledge due to the distributivity of *wear*, and is thus discarded.

Applying *Exh* above event closure leads to a similarly contradictory interpretation. Thus, Ivlieva's system correctly derives the fact that sentence (66) only has a pragmatically odd distributive reading, represented in (67).

Consider now Ivlieva's analysis of DPs involving *all*:

$$(71) \quad \llbracket \text{all the boys} \rrbracket = \lambda P. \lambda e. P(e)(\sigma^* \text{boy}) \wedge \forall y [y \leq \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$$

Under this analysis, *all* is similar to *every* in that its semantics involves a distributive component, i.e. the predicate *all the boys* combines with *is applied* to each atomic individual in the denotation of the restrictor DP. However, in the case of *all* the predicate is also applied directly to the sum denotation of the restrictor DP itself, which allows for a cumulative relation between the referent of the restrictor DP and other individuals in the denotation of the predicate. Consider how this difference accounts for the contrast between *all* and *every* in terms of licensing dependent plural readings:

$$(72) \quad \text{All the boys attend good schools.}$$

Unlike sentence (66), discussed above, this example allows for a dependent plural interpretation, where each boy attends one or more good school. In this sentence there are, again, three potential site for the insertion of *Exh*. If it is inserted below the subject and the event closure operator, we derive the distributive reading in (73):

$$(73) \quad \exists e \exists X [*school(X) \wedge |X| > 1 \wedge *attend(e)(\sigma^* \text{boy})(X)] \wedge \forall y [y \leq \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z) \wedge |Z| > 1]]]$$

The dependent plural interpretation is derived if the exhaustivity operator is inserted above the subject DP, but below event closure. In this case, it applies to the following event predicate:

$$(74) \quad \lambda e \exists X [*school(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z)]]]$$

This event predicate is compared to the alternative in (75), which imposes an atomicity condition on X and Z :

$$(75) \quad \lambda e \exists X [*school(X) \wedge atom(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z) \wedge atom(Z)]]]$$

The alternative in (75) is stronger than (74) since it implies that there is an atomic school that all the boys attended. Thus, it is negated, yielding the following strengthened event predicate:

$$(76) \quad \lambda e \exists X [*school(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z)]]] \wedge [\neg \exists X [*school(X) \wedge atom(X) \wedge *attend(e)(\sigma *boy)(X)] \vee \neg \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z) \wedge atom(Z)]]]]$$

As Ivlieva demonstrates, this predicate is equivalent to (77), once we factor in contextual information regarding the distributivity of *attend*:

$$(77) \quad \lambda e \exists X [*school(X) \wedge |X| > 1 \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z)]]]$$

After event closure we arrive at the following interpretation for sentence (72):

$$(78) \quad \exists e \exists X [*school(X) \wedge |X| > 1 \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z)]]]$$

This reading can be informally re-stated as follows: There is an attending event whose cumulative agent is the sum of all the boys and whose cumulative theme is a non-atomic sum of good schools, and for each boy there is one or more good school that he attends. This reading is consistent with each boy attending a single

school, as long as more than one schools is involved overall. We have thus derived the dependent plural interpretation for (72).

The final option for *Exh*-insertion in the structure of (72) is above event closure. In this case we have to compare (79) to the alternative in (80):

$$(79) \quad \exists e \exists X [*school(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z)]]]$$

$$(80) \quad \exists e \exists X [*school(X) \wedge atom(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z) \wedge atom(Z)]]]$$

The alternative is stronger, and is thus negated:

$$(81) \quad \exists e \exists X [*school(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z)]]] \wedge \\ \neg \exists e \exists X [*school(X) \wedge atom(X) \wedge *attend(e)(\sigma *boy)(X)] \wedge \forall y [y \leq \sigma *boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*attend(e')(y)(Z) \wedge *school(Z) \wedge atom(Z)]]]$$

On this interpretation, sentence (72) will be judged true if each boy attends one or more good school, and there is no single good school that all the the boys attend. This interpretation is similar to the one in (54) above, derived for sentence (47) if *Exh* is inserted above event closure. Like before, more research is needed to determine whether (81) is a possible interpretation for sentence (72).

To conclude, Ivlieva (2013) proposes an account of dependent plural readings which is similar to Zweig's (2008, 2009) in that bare plurals are treated as underlyingly number-neutral, and the semantics of multiplicity is derived via a mechanism of scalar implicature calculation. However, Ivlieva's theory differs from Zweig's in two important respects. First, she adopts a different system of implicature calculation, which is based on the insertion of a syntactic exhaustivity operator. Second, she proposes a contrasting analysis of the quantificational items *all* and *every*, accounting for the fact that the former, but not the latter, licenses dependent plural

interpretations. This analysis is based on the assumption that the semantics of *all* involves both a cumulative and a distributive component, while *every* is strictly distributive.

2.5 Previous Approaches: Successes and Failures

As pointed out above, all existing approaches provide an account of how dependent plurals receive a co-distributive interpretation, but only the mereological and Ivlieva's (2013) mixed approach succeed in capturing the Multiplicity Condition.

In this section I will go over the other empirical generalisations discussed in Chapter 1, in order to evaluate how well the approaches discussed above are able to account for them. I will focus on the proposals by Zweig (2008, 2009) and Spector (2003) as the most elaborate and explicit accounts within the mereological and distributive categories, respectively, and on Ivlieva's (2013) mixed approach.

2.5.1 Intervention Effects

For convenience, I repeat here the Intervention Generalisation established in the previous chapter (cf. section 1.2.3):

Intervention Generalisation

A singular DP blocks the dependence between a potential licensor and a dependent plural just in case it co-varies with the licensor.

Recall, that this generalisation implies two important contrasts. One is between singular and plural DPs: only singular DPs act as interveners, at least for some speakers. The other relates to co-variation: only DPs that co-vary with respect to the licensor act as interveners.

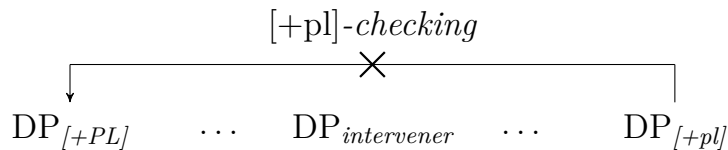
Let us examine how the alternative approaches to dependent plurals can handle this generalisation, starting with the distributive approach.

2.5.1.1 Intervention Effects: Distributive Approach

As far as I can see, there is no way to account for this Generalisation within the distributive approach advocated in Kamp and Reyle 1993 without introducing additional stipulations. For instance, a special clause may be added to the formulation of the rule for dependent plurals, which bans its application in contexts where the licenser scopes over a singular DP, in addition to the dependent. Of course, this would hardly count as an explanation for why such intervention effects exist.

In the theory proposed by Spector (2003) another option is available. Since the relation between the dependent and its licenser is taken to syntactic (i.e. it involves checking of the uninterpretable [+pl] feature on the dependent against the corresponding interpretable [+PL] feature on the licenser), one could try to reduce the observed intervention effects to syntactic intervention:

(82)



Let us dwell for a moment on how such an account might work. Since the dependent DP is c-commanded by the licenser, one must assume that feature-checking occurs from the bottom up, with the probe carrying an uninterpretable feature searching upwards in the tree for a goal with a corresponding interpretable feature. Such a theory of feature checking, called *upward Agree*, has been proposed by Zeijlstra (2012):

Upward Agree (Zeijlstra 2012)

α can Agree with β iff:

- a. α carries at least one uninterpretable feature and β carries a matching interpretable feature.
- b. β c-commands α .
- c. β is the closest goal to α .

‘Closeness’ is defined in terms of c-command. The following formulation is modelled on Heck and Richards (2010), but modified in the relevant respects to apply to upward Agree:

A goal β is closer to probe α than goal γ iff both β and γ c-command α , and γ asymmetrically c-commands β .

For a singular DP to act as an intervener it must qualify as a potential goal for the dependent. This means that it should carry a feature which in some way matches the [+pl] feature on the dependent which acts as a probe. This cannot be the [+PL] feature, because the intervener is semantically and morphologically singular, and it cannot be the [+SG] feature because it does not match [+pl]. The feature system must be modified in some way. One way to make this work is to divorce interpretability from valuation (cf. e.g. Pesetsky and Torrego 2007), and to assume that the dependent carries an uninterpretable number feature valued as plural: [$u\text{Num:pl}$]. The licensor carries an interpretable number feature valued as plural, [$i\text{Num:pl}$], while the intervener carries an interpretable number feature valued as singular, [$i\text{Num:sg}$]. Then one may define Goal and Agree in the following way:

Goal

β is a Goal for α with respect to feature F iff:

- a. α carries an uninterpretable feature uF and β carries a matching interpretable feature iF (irrespective of value).
- b. β c-commands α .

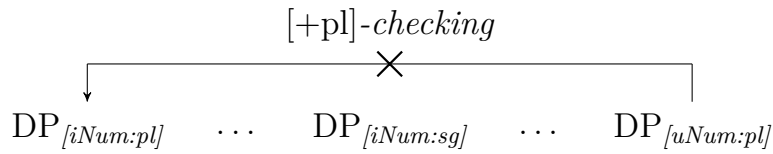
Upward Agree (revised)

α can Agree with β with respect to feature F iff:

- a. the value of F on β matches the value of F on α ;
- b. β is the closest Goal for α with respect to feature F .

Consider the following configuration:

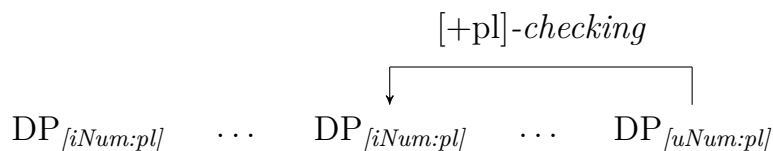
(83)



The dependent carries an uninterpretable $[uNum:pl]$ feature which needs to be checked. The licensor carries an interpretable version of the feature with a matching value $[iNum:pl]$, so condition (a) for Agree is satisfied. However, there is an intervening singular DP which carries $[iNum:sg]$. According to our definition it qualifies as a closer Goal for the dependent, because it carries an interpretable version of the same number feature – note that on our definition the status of Goal is independent of the features’ values. This means that Agree between the dependent and the licensor is blocked, because condition (b) is not satisfied (the licensor is not the closest Goal). On the other hand, Agree between the dependent and the intervener is blocked because their number features do not match in value. Hence there is no way to check the uninterpretable $[uNum:pl]$ feature on the dependent in this configuration. Following Spector’s proposal, an interpretable $[iNum:pl]$ must then be added to the dependent as a last resort to salvage the derivation.

This analysis immediately accounts for one aspect of the Intervention Generalisation – the fact the only singular DPs act as interveners. Consider the following configuration, where the ‘intervening’ DP is itself plural:

(84)



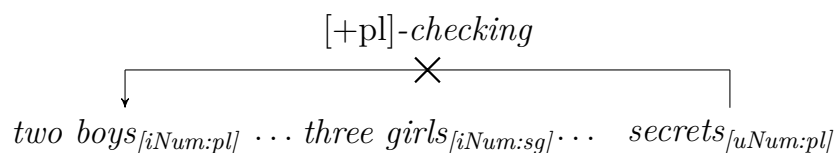
In this configuration the dependent can Agree with the ‘intervening’ DP itself, because it is the closest Goal and it carries a number feature with a matching value. Hence the dependent does not need to carry an interpretable plural feature, and is predicated to have a number neutral interpretation.

As discussed in section 1.2.3 in Chapter 1, this contrast between singular and plural potential interveners indeed obtains for a sub-set of speakers. Consider again the following examples from Zweig 2008, 2009, discussed in section 1.2.3:

- (85) a. Two boys told a girl secrets.
 b. Two boys told three girls secrets.

Take the interpretation of (85a) on which the singular indefinite *a girl* is interpreted as scoping below the subject. On this reading the boys may have talked to different girls. Then the bare plural *secrets* cannot have a number-neutral interpretation – (85a) will not be judged true if the boys told one secret each. It will only be judged true if each boy told more than one secret. This is predicted by the above analysis, because the singular indefinite blocks the feature-checking relation between the bare plural and the subject, as illustrated below:

(86)

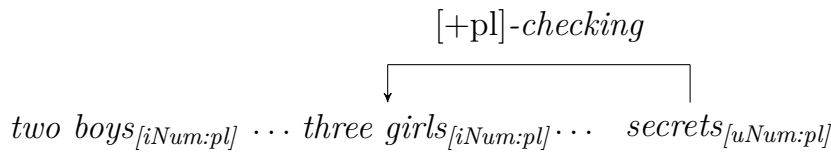


An interpretable plural feature must be assigned to the the bare plural as last resort, ruling out a number.neutral interpretation.

Now consider (85b). The indirect object DP *three girls* may again be interpreted as scoping below the subject. On this interpretation the boys may have talked to different sets of three girls. But in this case, according to Zweig (2008, 2009), the number-neutral interpretation of the bare plural is not blocked: (85b) will be judged true if each boy told a possibly different set of three girls one secret. On the above analysis, this is expected because the bare plural can check its uninterpretable feature against the interpretable plural feature on its closest Goal DP

three girls:

(87)

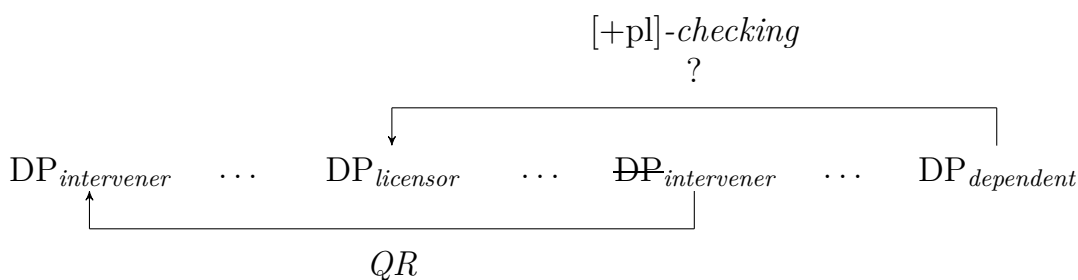


However, this analysis faces a problem when it comes to accounting for the second aspect of the Intervention Generalisation: the contrast between DPs that co-vary with the licenser, and those that do not.

Since on this approach, the licenser in dependent plural constructions is interpreted distributively, all indefinite DPs in its scope will be interpreted as co-varying with it. For an indefinite to be interpreted as not co-varying with the licenser it must take higher scope.

Now, if a DP is base generated above the licenser and thus takes wider scope, it is correctly predicted not to block plural dependencies. However, suppose a singular DP is base generated below the licenser but takes scope above it. Assuming that the mechanism for scope-taking is QR, this corresponds to a configuration where the singular DP raises (possibly, covertly) across the licenser:

(88)



This configuration corresponds to a wide-scope reading of the singular indefinite in (85a). On this reading there is single girl that both of the boys talked to. Recall that in this case the dependency between the bare plural *secrets* and the subject *two boys* is not blocked: (85a) will be judged true if there is a girl such that each of the boys told her just one secret. This fact is difficult to capture on the distributive analysis sketched out above.

The problems that arise depend partly on the view of movement that one assumes. On the widely adopted copy theory of syntactic movement (cf. Chomsky 1995, and many subsequent works), a moved element leaves a copy in its base position. There is no apparent reason why the copy of the QR-ed singular DP in configurations like (88) should not block the Agree relation between the dependent and the licensor, in the same way as the intervening DP blocks this relation in (83).

If on the other hand one rejects the copy theory of movement, and assumes that the base position of a moved DP is filled by an element that is qualitatively different from the moved DP itself, e.g. a trace, one may stipulate that this element does not act as an intervener. However, even this solution faces the problem of counter-cyclicity: Agree between the dependent and the licensor must take place *after* the intervener has moved out of the way to a position above the licensor.⁸

I conclude that Spector's (2003) syntactically grounded theory of dependent plurals can be extended to account for the fact that singular, but not plural DPs induce intervention effects in dependent plural constructions. However, this account (barring unwarranted stipulations) fails to capture the fact that only DPs that co-vary with the licensor act as interveners.

2.5.1.2 Intervention and Bound Pronouns

I would like to briefly touch on another issue related to the way the distributive approach handles intervention effects, which has to do with the functioning of bound pronouns. Recall that in section 1.4.6 we established, following Kamp and Reyle (1993), that plural pronouns can be interpreted as co-varying with their binders, and that this relation is not subject to intervention. The relevant contrast is repeated in (89):

⁸Another assumption that needs to be made is that scopeless DPs, such as pronouns and definites, may also undergo QR. This is needed to account for the fact that scopeless DPs are similar to wide-scope DPs in that they do not act as interveners. However, this assumption is less problematic, cf. e.g. Reinhart 1983 for independent support (cf. also the discussion in Heim and Kratzer 1998).

- (89) a. The women bought a car which had automatic transmissions.
 b. The women bought a car which they liked.

In (89a), the bare plural noun phrase *automatic transmissions* cannot be interpreted as dependent on (and hence, co-varying with) the matrix subject *the women*. This can be attributed to an intervention effect induced by the encompassing singular DP *a car which had automatic transmissions*, which blocks the relation between the matrix subject and the embedded bare plural. This effect is expected on the syntactic analysis of intervention sketched out above.

In (89b), on the other hand, the plural pronoun can be interpreted as co-varying with the matrix subject in spite of it being contained within an encompassing singular DP. On this interpretation (89b) will be judged true if each woman bought a car that she liked.

Crucially, as I showed in section 1.4.6, plural pronouns bound across interveners, as in (89b), cannot themselves license dependent plurals. I repeat the relevant examples in (90):

- (90) a. All the women bought cars which they found in nearby stores.
 b. All the women bought a car which they found in nearby stores.

Sentence (90a) has an interpretation on which the encompassing noun phrase *cars which they found in nearby stores*, as well as the plural pronoun and the embedded bare plural *nearby stores* are interpreted as co-varying with the matrix subject *all the women*. In this case, (90a) will be judged true if e.g. each woman bought one car that she found in one nearby store. Sentence (90b), on the other hand, lacks this interpretation. The encompassing singular DP *a car which they found in nearby stores*, as well as the plural pronoun, can be interpreted as co-varying with the DP *all the women*, but the embedded bare plural *nearby stores* cannot. On the co-varying interpretation of the encompassing DP and the pronoun, (90b) states that each woman bought a car which she found in *more than one* nearby store.

The contrast between (90a) and (90b) is on the face of it problematic for Spector’s (2003) version of the distributive approach. If the plural pronoun in (90b), on its bound-variable interpretation, carries an interpretable [+PL] feature it should be able to check the corresponding uninterpretable [+pl] feature on *nearby stores*, which should result in a number-neutral (co-varying) interpretation of the latter, contrary to fact. One way out is to assume that bound plural pronouns do not carry an interpretable [+PL] feature at the stage of feature checking. Indeed, a number of researchers developing an account of so-called ‘bound indexicals’ have proposed that phi-features on pronouns may be deleted under binding (cf. von Stechow 2003, Heim 2005), or are added at late stages of the derivation (cf. Kratzer 1998, 2009). Combining Spector’s (2003) account of dependent plurals with some of these proposals regarding phi-features on bound pronouns may lead to an account of the contrast in (90). I will not pursue this further (cf. also the discussion of the semantics of bound plural pronouns in section 3.12).

On the other hand, Kamp and Reyle (1993), as far as I can see, do not face the same problem. On their account, a DP can serve as a licenser for dependent plurals if it introduces an individual (atomic) discourse referent marked as *pl(ural)*. Recall, that according to Kamp and Reyle (1993), “whenever an individual referent is introduced by a plural NP, it is marked with a superscript *pl*”. Plural pronouns, however, are taken to introduce number-neutral discourse referents which may be set as equal either to existing non-atomic discourse referents or to atomic discourse referents marked as *pl(ural)*, as in the relevant interpretations of (90). Crucially, discourse referents introduced by plural pronouns are not themselves marked as *pl* (presumably because they are number-neutral, rather than strictly individual/atomic), and hence cannot directly serve as licensors for dependent plurals.

2.5.1.3 Intervention Effects: Mereological Approach

Zweig (2008, 2009) provides an explicit account of the intervention effects dis-

cussed in section 1.2.3. Consider again the following example:

(91) Two boys told a girl secrets.

Recall, that the dependent plural reading on Zweig's account is derived by interpreting the licenser *in situ*. The event predicate in this case will be as in (92):

$$(92) \quad \lambda e \exists X \exists Y \exists Z [|X| = 2 \wedge *BOY(X) \wedge |Y| = 1 \wedge *GIRL(Y) \wedge *SECRET(Z) *TOLD(e) \wedge *AG(e)(X) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]$$

This predicate is compared with an alternative involving a strictly atomic theme. The alternative is stronger, so it is negated and the meaning enriched. After that existential closure applies:

$$(93) \quad \exists e \exists X \exists Y \exists Z [|X| = 2 \wedge *BOY(X) \wedge |Y| = 1 \wedge *GIRL(Y) \wedge |Z| > 1 \wedge *SECRET(Z) *TOLD(e) \wedge *AG(e)(X) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]$$

This is the dependent plural reading of (91).⁹ Note, that on this reading both boys told one or more secrets to *the same* girl. I.e. the reference of the singular indefinite *a girl* does not co-vary with *two boys*. Hence this reading conforms to the Intervention Generalisation.

Another reading for (91) can be derived in Zweig's system by quantifying in the subject, rather than interpreting it *in situ*. In this case the alternatives are calculated for the following expression (with the subject scoped-out):

$$(94) \quad \lambda e \lambda x \exists Y \exists Z [|Y| = 1 \wedge *GIRL(Y) \wedge *SECRET(Z) *TOLD(e) \wedge *AG(e)(x) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]$$

The stronger alternative with an atomic theme is canceled, and the implicature added:

$$(95) \quad \lambda e \lambda x \exists Y \exists Z [|Y| = 1 \wedge *GIRL(Y) \wedge |Z| > 1 \wedge *SECRET(Z) *TOLD(e) \wedge *AG(e)(x) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]$$

⁹Recall, that the system of implicature calculation that Zweig (2008, 2009) employs requires for the alternatives to be calculated again after event closure of (92). However, this calculation does not result in any enrichment, and the stronger interpretation in (93) is chosen as the final interpretation for (91).

Then existential closure is applied, and the subject is added via the quantifying in rule:

$$(96) \quad \exists X[|X| = 2 \wedge *BOY(X) \wedge \forall x \leq X \exists e \exists Y \exists Z[|Y| = 1 \wedge *GIRL(Y) \wedge |Z| > 1 \wedge *SECRET(Z)*TOLD(e) \wedge *AG(e)(x) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]]$$

This is the second possible reading of (91).¹⁰ In this case the reference of the singular indefinite does co-vary with the subject: the boys may have talked to different girls. However, under this interpretation the multiplicity condition associated with the bare plural is not global, but rather interpreted with respect to each individual boy, i.e. each boy must have told more than one secret. Thus, (96) represents a reading on which the bare plural is not dependent on the licenser, which means that this reading, again, conforms to the Intervention Generalisation.

Crucially, it is impossible in Zweig's system to derive a reading on which the singular indefinite in (91) co-varies with the subject, and *at the same time* the theme is interpreted as dependent on the subject. To achieve a scopal interpretation of the subject with respect to the addressee it must scope outside of the domain of event closure, but this necessarily results in the multiplicity implicature being 'trapped' under the distributive operator which quantifies over the individual elements of the subject.

This account provides an explanation for the contrast between DPs that co-vary with the licenser and those that do not: if a potential intervener does not co-vary with the licenser, then the licenser can be interpreted *in situ*, and hence a dependent plural interpretation is predicted to be available. On the other hand, an interpretation where the intervener does co-vary with the licenser can only be derived via quantifying-in of the licenser, which results in a non-dependent, distributive interpretation.

However, Zweig's analysis faces a problem when it comes to the second aspect of the Intervention Generalisation: the asymmetry between singular and plural DPs,

¹⁰I am again omitting the calculation of alternatives which does not influence the final interpretation.

which we observe in the judgements of some speakers. Recall that examples like (97) which involve a plural addressee, for some speakers, have an interpretation on which the addressee co-varies with the subject – on this interpretation each boys talked to a potentially different set of three girls, so up to six girls can be involved in total. But at the same time the bare plural can be interpreted as dependent on the subject, i.e. each boy may have told just one secret. In this respect such examples contrast with sentences like (91) which have a singular DP as the addressee.

(97) Two boys told three girls secrets.

Zweig’s account cannot explain the contrast between (91) and (97). In Zweig’s system, (97) will be assigned a cumulative and a distributive interpretation, i.e. the same kinds of interpretation as we derived for (91) above:

(98) $\exists e \exists X \exists Y \exists Z [|X| = 2 \wedge *BOY(X) \wedge |Y| = 3 \wedge *GIRL(Y) \wedge |Z| > 1 \wedge *SECRET(Z) *TOLD(e) \wedge *AG(e)(X) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]$

(99) $\exists X [|X| = 2 \wedge *BOY(X) \wedge \forall x \leq X \exists e \exists Y \exists Z [|Y| = 3 \wedge *GIRL(Y) \wedge |Z| > 1 \wedge *SECRET(Z) *TOLD(e) \wedge *AG(e)(x) \wedge *ADDR(e)(Y) \wedge *TH(e)(Z)]]$

The cumulative interpretation in (98) obtains if the subject is interpreted *in situ*. On this interpretation there is a group of two boys and a group of three girls, such that each boy told one or more girls one or more secrets, and each girl was told by one or more boys one or more secrets. Crucially, the total number of girls involved must be three, which means that this is not the mixed reading described above.

The distributive reading is represented in (99). On this interpretation each of the boys talked to a potentially different set of three girls, which means that up to six different girls may have been involved in total. However, on this interpretation each boys must have told the girls *more than one* secret, which means that the bare plural is not interpreted as dependent on the subject. So again, this is not the mixed reading.

Hence, just as with example (91), there is no way in Zweig’s system to obtain a reading for (97) on which the addressee co-varies with the subject and at the same time the bare plural theme is interpreted as dependent on the subject. There is no way to derive the mixed reading of examples like (97).

To conclude, Zweig (2008, 2009) provides an account of the Intervention Generalisation, which successfully predicts that DPs that co-vary with a licensor should interrupt the relation between that licensor and a dependent plural. Furthermore, it correctly predicts that the relation between the licensor and the dependent will not be interrupted if the potential intervener does not co-vary with the licensor. However, Zweig’s approach fails to account for the ‘mixed readings’ which are available for some speakers in case the intervener is a plural, rather than singular, indefinite.

Ivlieva’s (2013) mixed theory adopts a cumulative analysis for dependent plurals in examples involving non-quantificational licensors, e.g. (91) and (97). Hence, it derives the same range of readings for these examples as Zweig’s (2008, 2009) mereological theory, failing to account for the mixed readings of examples like (97).

2.5.2 Licensing Generalisation

For convenience, I repeat the Licensing Generalisation discussed in section 1.3.1:

Licensing Generalisation

DPs that involve complement NPs in the singular do not license dependent plurals.

Consider again the familiar contrast:

- (100) a. All the boys read books about Napoleon.
 b. Every boy read books about Napoleon.

Sentence (100a) has a dependent plural reading (each child read one or more books), while sentence (100b) doesn’t (each child necessarily read more than one

book). Spector (2003) accounts for this by assuming that dependent plurals have an uninterpreted [+pl] feature, which must be licensed by a an interpreted instance of [+PL]. In (100a) the subject carries a [+PL], and licenses [+pl] on the direct object *books about Napoleon*. In (100b) the subject lacks a [+PL] feature, so an uninterpretable [+pl] feature on the direct object cannot be licensed. Instead, the object NP is forced to carry an interpretable [+PL] feature as a last resort. Thus the difference between possible and impossible nominal licensors boils down to the presence of the [+PL] feature. If restrictor NPs pass on their number features to the DP, it is expected that DPs with restrictor NPs in the singular will not be able to license dependent plurals, thus accounting for the Licensing Generalisation.

The account of the Licensing Generalisation within the mereological approach is less straightforward.

Zweig (2008, 2009) assumes the following standard interpretation for *every boy*:

$$(101) \quad \llbracket \text{every boy} \rrbracket = \lambda\phi_{\langle et \rangle} \forall x [* \text{BOY}(x) \rightarrow \phi(x)]$$

Zweig assumes that DPs with *every* cannot be interpreted *in situ*, but must scope above event closure. This may be attributed to a special requirement, e.g. the *Event type principle* in Landman 2000 which forbids ‘quantificational’ DPs from being interpreted *in situ* (cf. also Schein 1993). However, Zweig shows that if the denotation in (101) is adopted, there is no need to posit a special principle to rule out *in situ* interpretations of *every* DPs, because such interpretations almost always lead to contradictions. For instance, interpreting the subject DP *in situ* in a simple sentence like (102a) would result in the interpretation (102b):¹¹

(102) a. Every boy walked.

$$b. \exists E \forall x [* \text{BOY}(x) \rightarrow * \text{WALK}(E) \wedge * \text{AG}(E)(x)]$$

¹¹This interpretation requires the application of the the LIFT type-shifter, which Zweig (2008, 2009) adopts from Landman (2000), and which allows the verb to combine directly with quantificational DPs:

Intransitive Lift: $\lambda X \lambda E [\dots] \Rightarrow \lambda \psi_{\langle (et)t \rangle} \lambda E [\psi(\lambda X [\dots])]$

Transitive Lift: $\lambda X \lambda Y \lambda E [\dots] \Rightarrow \lambda \psi_{\langle (et)t \rangle} \lambda Y \lambda E [\psi(\lambda X [\dots])]$

This interpretation states that there is a walking event such that every boy was the agent of that event. Now, like Landman (2000), Zweig assumes that thematic roles must be unique: for any x , e , and Θ if $\Theta(e)(x) = 1$ then there is no y such that $y \neq x$ and $\Theta(e)(y) = 1$. In all cases when the set of boys is greater than 1, (102b) violates this restriction, and is thus ruled out. Given the denotation in (101), the *in situ* interpretation of an *every* DP will contradict the uniqueness requirement whenever the size of the restrictor set is greater than 1, and in the latter case the *in situ* interpretation is indistinguishable from the scopal one.

Thus, the only interpretation available for the subject DP in (100a) is the one where it scopes above event closure:

$$(103) \quad \forall x[*\text{BOY}(x) \rightarrow \exists E \exists Y[|Y| > 1 \wedge *\text{BOOK.ABOUT.NAPOLEON}(Y) \wedge *\text{READ}(E) \wedge *\text{AG}(e)(x) \wedge *\text{TH}(e)(Y)]]$$

On this interpretation each boy read more than one book about Napoleon, i.e. the bare plural is not dependent on the subject, as required.

To account for the dependent plural interpretation in (100b), one must assume that *all* DPs, as opposed to DPs with *every*, can be interpreted *in situ*. This means that they must have a different interpretation from (101). Zweig (2009) leaves this question open, but a specific proposal has been put forward by Champollion (2010). I will provide a more detailed discussion of this proposal in sections 2.5.3.2 and 4.5.4. Here I will just note that the semantic distinction that Champollion (2010) posits between *each* and *all* does not in itself account for *why* DPs involving *each* and *every* as a determiner, as opposed to those with *all*, are forced to raise outside the domain of implicature calculation for the bare plurals. Although this assumption does derive the required contrast between e.g. (100a) and (100b) in Champollion's (2010) system, it appears stipulatory, and moreover does not explain the link between the ability of a quantificational DP to license dependent plurals and the number feature borne by the restrictor NP.

I conclude that existing implementations of the purely mereological approach to dependent plurals do not provide an account of the Licensing Generalisation.

On the other hand, the mixed approach to the semantics of *all* proposed by Ivlieva (2013) appears to be more successful. Recall, that in Ivlieva's theory the contrast between *all* and *every* is attributed to the presence of a 'cumulative component' in the semantics of the former, but not the latter. I repeat the relevant interpretations here for convenience:

$$(104) \quad \llbracket \text{every boy} \rrbracket = \lambda P. \lambda e. \forall y [boy(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$$

$$(105) \quad \llbracket \text{all the boys} \rrbracket = \lambda P. \lambda e. P(e)(\sigma^*boy) \wedge \forall y [y \leq \sigma^*boy \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$$

Whereas *every* is purely distributive, the semantics of *all* is more complex and involves two distinct components: a cumulative component, where the nuclear scope predicate is applied to the whole sum denoted by the restrictor DP, and a distributive component, where the nuclear scope predicate is applied to each atomic individual in that sum. As we saw in section 2.4 above, this distinction, coupled with a specific grammatical theory of implicature calculation, can explain the contrast between *every* and *all* in terms of the licensing of dependent plurals.

The next question, in terms of the Licensing Generalisation, is whether the presence of the cumulative component in the semantics of a determiner can be linked to the number marking on its restrictor constituent. I believe that there is a plausible way of achieving this. Let us adopt the common assumption that the singular NPs can only apply to atomic individuals. Then, $\sigma \llbracket NP_{sg} \rrbracket$ will be defined for any singular NP_{sg} iff there is only one individual in the set characterised by $\llbracket NP_{sg} \rrbracket$. Now, take a determiner D that syntactically combines with a restrictor predicate P and a nuclear scope predicate Q , and includes in its semantics a cumulative component whereby $\llbracket Q \rrbracket$ is applied to $\sigma \llbracket P \rrbracket$. Then, if D combines with a singular restrictor NP, the resulting DP will only be interpretable in the special case where the restrictor denotes (the characteristic function of) a singleton set of objects. Since the presence of the cumulative component is crucial for the licensing of dependent plurals on Ivlieva's (2013) analysis, this means that we never expect

to encounter DPs involving singular restrictor NPs that are able to function as licensors, which is the desired result.

2.5.3 Quantificational Licensors and the Neutrality Generalisation

Recall that in Chapter 1 we established that both licensors and dependents can be divided into two classes. The licensors were classified into two categories: quantificational and non-quantificational. The first category includes plural DPs with the quantifiers *all*, *most*, *many*, *both*, *few*, as well as various types of pluractional adverbials, e.g. *always*, *often*, *regularly*. The second category comprises numerical DPs and DPs with cardinal modifiers, plural definites and possessive DPs, bare plurals, plural *certain* DPs etc.

With respect to dependents, a distinction was drawn between underlyingly number-neutral DPs – bare plurals, plural *certain* DPs, plural definites and possessives, – and DPs that are strictly plural – numerical DPs and DPs with cardinal modifiers.

I argued that the availability of dependent/cumulative readings with these types of licensors and dependents is governed by the Neutrality Generalisation, repeated here:

Neutrality Generalisation

Number-neutral plurals can be dependent on the whole range of licensors, including quantificational nominal licensors and pluractional adverbials, while non-number neutral plurals can have a co-distributive (cumulative) reading only with non-quantificational nominal licensors.

2.5.3.1 Neutrality Generalisation: Distributive Approach

The distributive approach may claim some degree of success in accounting for these facts. Specifically, the contrast between the two classes of licensors may be

accounted for straightforwardly by assuming that quantificational DPs only allow for distributive readings, and in this respect are similar to singular distributive quantifiers such as *each* and *every*, while non-quantificational DPs allow for both distributive and co-distributive readings.

For concreteness, let us assume the following interpretations for quantificational and non-quantificational determiners:

- (106) a. $\llbracket \text{most} \rrbracket = \lambda P_{\langle et \rangle} . \lambda Q_{\langle et \rangle} . |\{x : \text{AT}(x) \wedge P(x) \wedge Q(x)\}| > |\{y : \text{AT}(y) \wedge P(y)\}| - |\{x : \text{AT}(x) \wedge P(x) \wedge Q(x)\}|$
 b. $\llbracket \text{all} \rrbracket = \lambda P_{\langle et \rangle} . \lambda Q_{\langle et \rangle} . |\{x : \text{AT}(x) \wedge P(x) \wedge Q(x)\}| = |\{y : \text{AT}(y) \wedge P(y)\}|$
 c. $\llbracket \text{few} \rrbracket = \lambda P_{\langle et \rangle} . \lambda Q_{\langle et \rangle} . |\{x : \text{AT}(x) \wedge P(x) \wedge Q(x)\}| < n_{\text{few}}^{12}$
- (107) a. $\llbracket \text{five} \rrbracket = \lambda P_{\langle et \rangle} . \lambda Q_{\langle et \rangle} . \exists X . |\{x : \text{AT}(x) \wedge x \leq X\}| = 5 \wedge P(X) \wedge Q(X)$
 b. $\llbracket \text{several} \rrbracket = \lambda P_{\langle et \rangle} . \lambda Q_{\langle et \rangle} . \exists X . |\{x : \text{AT}(x) \wedge x \leq X\}| > 1 \wedge P(X) \wedge Q(X)$

The interpretation of quantificational determiners in (106) involves the application of the denotation of its nuclear scope constituent Q (e.g. the VP if the quantificational DP is in the subject position) to *atomic* individuals in the restrictor set P . This accounts for the distributive properties of quantificational determiners. The non-quantificational determiners in (107), on the other hand, are interpreted by applying the function denoted by the nuclear scope constituent Q to a (possibly) *non-atomic* individual in the restrictor set P .

For the purpose of illustration let us adopt Landman's (2000) and Zweig's (2008, 2009) framework for deriving cumulative and distributive readings.

Consider first non-quantificational determiners. Since the denotations in (107) are equivalent to the ones adopted by Landman (2000) and Zweig (2008, 2009), cumulative and distributive readings will be derived in the same way as in their systems. Thus, the sentence in (108a) will be assigned two interpretations (among others), depending on whether the subject is interpreted *in situ* or quantified in:

¹²Here n_{few} stands for a contextually specified number which determines what counts as 'few' in a given context.

(108) a. Five boys flew seven kites.

b. $\exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge |Y| = 7 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$

c. $\exists X [|X| = 5 \wedge *BOY(X) \wedge \forall x \leq X \exists e \exists Y [|Y| = 7 \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(x) \wedge *TH(e)(Y)]]$

Dependent readings with non-quantificational licensors are derived in the same way as distributive readings, i.e. by quantifying in the licensor:

(109) a. Five boys flew kites.

b. $\exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$

The crucial difference between (109a) and (108a) is that in (109a) the bare plural *kites* is taken to be underlyingly number-neutral. Hence, no restriction is placed on the size of Y in (109b), which accounts for the apparent non-distributivity of dependent plurals.

Let us now turn to quantificational licensors. Given the denotations in (106), it can be shown that DPs involving these quantifiers cannot be meaningfully interpreted *in situ* in the vast majority of contexts. The argument is essentially the same as the one Zweig puts forward regarding the interpretation of *every* DPs, cf. section 2.5.2 above.¹³ For example, consider the sentence in (110a):

(110) a. Most boys walked.

b. $\exists E [|\{x : AT(x) \wedge *BOY(x) \wedge *WALK(E) \wedge *AG(E)(x)\}| > |\{y : AT(y) \wedge *BOY(y)\} - \{x : AT(x) \wedge *BOY(x) \wedge *WALK(E) \wedge *AG(E)(x)\}|]$

If the subject is interpreted *in situ*, the sentence would be interpreted as in (110b). This interpretation states that there is a walking event e such that the set

¹³Alternatively, one may adopt the *Event Type Principle* proposed in Landman 2000 which stipulates that quantificational DPs cannot be interpreted *in situ*.

of boys S , where each boy in S is an agent of e , is greater than half the set of boys. However, this interpretation contradicts the assumption that roles must be unique, and is hence ruled out.¹⁴

Thus, the only option available for quantificational licensors is to be quantified in giving rise to distributive interpretations, as in (111) for sentence (110a):

$$(111) \quad |\{x : AT(x) \wedge *BOY(x) \wedge \exists E.[*WALK(E) \wedge *AG(E)(x)]\}| > |\{y : AT(y) \wedge *BOY(y)\} - \{x : AT(x) \wedge *BOY(x) \wedge \exists E.[*WALK(E) \wedge *AG(E)(x)]\}|$$

This states that for more than half of the boys there exist walking events where they are agents.

Since quantificational licensors must be quantified in, sentences like (112a) are correctly predicted to lack cumulative readings. Only distributive readings are allowed, represented in (112b):

$$(112) \quad \text{a. Most boys flew seven kites.}$$

$$\text{b. } |\{x : AT(x) \wedge *BOY(x) \wedge \exists E \exists Y.[*WALK(E) \wedge |Y| = 7 \wedge *KITE(Y) \wedge *TH(E)(Y) \wedge *AG(E)(x)]\}| > |\{y : AT(y) \wedge *BOY(y)\} - \{x : AT(x) \wedge *BOY(x) \wedge \exists E \exists Y.[*WALK(E) \wedge |Y| = 7 \wedge *KITE(Y) \wedge *TH(E)(Y) \wedge *AG(E)(x)]\}|$$

This states that for more than half of the boys there exist flying events where they are agents, and whose themes are sums of seven kites.

Since dependent plural readings are taken to be distributive on this approach, they are predicted to be possible with quantified in licensors:

$$(113) \quad \text{a. Most boys flew kites.}$$

$$\text{b. } |\{x : AT(x) \wedge *BOY(x) \wedge \exists E \exists Y.[*WALK(E) \wedge *KITE(Y) \wedge *TH(E)(Y) \wedge *AG(E)(x)]\}| > |\{y : AT(y) \wedge *BOY(y)\} - \{x : AT(x) \wedge *BOY(x) \wedge \exists E \exists Y.[*WALK(E) \wedge *KITE(Y) \wedge *TH(E)(Y) \wedge *AG(E)(x)]\}|$$

¹⁴**Role Uniqueness:**

For any x , e , and Θ if $\Theta(e)(x) = 1$ then there is no y such that $y \neq x$ and $\Theta(e)(y) = 1$.

This captures the dependent plural reading (barring the Multiplicity Condition): for more than half of the boys there exist flying events where they are agents, and whose themes are sums of one or more kites.¹⁵

There is however an important complication. It turns out, that the system sketched above when combined with Spector's (2003) theory of dependent plurals overgenerates. Specifically, it predicts that bare plurals in the context of non-quantificational licensors should have a number-neutral *cumulative* interpretation. This is illustrated in (114):

(114) a. Five boys flew kites.

b. $\exists e \exists X \exists Y [|X| = 5 \wedge *BOY(X) \wedge *KITE(Y) \wedge *FLEW(e) \wedge *AG(e)(X) \wedge *TH(e)(Y)]$

Recall, that on Spector's (2003) approach bare plurals like *kites* in (114a) can carry an uninterpretable [+pl] feature which must be checked against a plural licensor. In (114a) such a licensor is available – it is the plural subject *five boys*. Hence, it is predicted that *kites* can be interpreted number-neutrally. Now, the subject *five boys* can either be quantified in, which results in a standard dependent plural interpretation given in (109b), or they can be interpreted *in situ*. Recall, that the latter option is necessary to account for cumulative readings which are available for this type of licensors, cf. (108b). Hence, it is predicted that (114a) should have an interpretation where the licensor and the bare plural are interpreted cumulatively, and *at the same time* the bare plural is number-neutral. This interpretation is represented in (114b). It states that there is a sum if events where five boys are

¹⁵One complication for this analysis is the existence of a class of collective predicates which can combine with plural quantificational subjects (cf. Dowty 1987, Winter 2001, 2002, Hackl 2002, Brisson 2003, Champollion 2010 a.o.). In this context plural quantificational DPs pattern with individual-denoting plurals as opposed to singular distributive quantifiers:

- (i) All the students / most of the students gathered in the hall.
- (ii) Thirty students gathered in the hall.
- (iii) *Each student gathered in the hall.

I will return to a detailed discussion of collective predicates in Chapter 4.

the cumulative agent, and a sum of one or more kites are the cumulative theme. Thus, (114a) is predicted to be true in a situation where five boys flew one and the same kite. Of course, (114a) will not be judged true in such a scenario.

This problem is intuitively related to the inability of the distributive approach to provide an account of the Multiplicity Condition, and indeed the mereological approach offers a unified solution to both of these problems. Note however, that from the point of view of the distributive approach these issues are distinct: one problem is to provide an account for the overarching multiplicity requirement of the dependent plural which is interpreted distributively, as in (109b) and (113b), the other is to rule out cumulative readings like (114b).¹⁶

I conclude that the distributive approach can claim a certain degree of success in accounting for the contrast between quantificational and non-quantificational licensors. However, when the syntax-based version of this approach is combined with an explicit system incorporating both distributive and cumulative readings, it generates a class of unwanted interpretations.

When it comes to the the second aspect of the Neutrality Generalisation – the classification of dependents – the distributive approach faces further difficulties. Recall, that we established in Chapter 1 that the ability of a certain type of nominal phrase to have a dependent plural interpretation under quantificational licensors is linked to its underlying number-neutrality which emerges in downward entailing or intensional contexts.

Let us first consider Spector’s (2003) theory. According to Spector’s approach, dependents in dependent plural constructions are indeed semantically number neutral. Spector explains this by assuming that their plural feature is uninterpretable, and must be checked against its interpretable counterpart on the licensor. The fact

¹⁶This point is well illustrated by the theory of dependent plurals proposed by Kamp and Reyle (1993), who advance a different version of the distributive approach. Kamp and Reyle (1993) are aware that it is necessary to restrict number-neutral interpretations of bare plurals to cases where the licensor is interpreted distributively, and stipulate this condition as part of their rule for dependent plurals (in the form of the requirement that the licensor must be an *individual* discourse referent marked plural). In this way their approach is able to rule out cumulative readings like (114b). However, it still fails to account for the Multiplicity Condition in distributive examples like (109b) and (113b).

that the same types of noun phrases can have number-neutral interpretations in downward entailing or intensional contexts indicates that in these cases their number feature is again uninterpretable. But, this entails that in downward entailing and intensional contexts number-neutral noun phrases should also require plural licensors to check off their uninterpretable features. In fact, no licensor is required in these cases. Consider the following example, repeated from section 1.4.7.3:

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

In this sentence, the bare plural NP *senior government officials* occurs in the scope of negation. This sentence will be judged true if the UN envoy did not meet *any* senior government officials, and will be judged false if she met at least one. This indicates that the bare plural has a number neutral interpretation, i.e. ‘one or more senior government officials’. Note, however, that (115) does not contain any plural DP or pluractional adverbial that could serve as an appropriate licensor for the bare plural. Spector’s (2003) distributive approach predicts that in the absence of an appropriate licensor the bare plural will be assigned an interpretable plural feature as last resort, which in the case of (115) should lead to the loss of the number-neutral interpretation, contrary to fact.

The distributive approach in Kamp and Reyle 1993 faces similar problems. Recall that to account for constructions involving dependent plurals, Kamp and Reyle (1993) posit a special rule which allows for a number-neutral interpretation of bare plural noun phrases in the (local) context of other plurals. In sentences like (115) bare plurals also have a number-neutral interpretation, but since there is no local plural licensor, this interpretation cannot arise via the application of the same rule. Number-neutral interpretations of plural noun phrases in downward entailing and intensional context must then arise via some different mechanism. But if this is the case, we are left with no explanation for why exactly the same types of nominals are able function as dependent plurals and can have number-neutral readings in downward entailing and intensional contexts.

To conclude, on the one hand, the distributive approach to dependent plurals can provide a plausible account for the inability of quantificational licensors to have cumulative interpretations with DPs containing numerals and cardinal modifiers (albeit at the cost of overgeneration for the syntax-based version of the approach). On the other hand, it cannot explain the link between dependent readings of plural noun phrases and number-neutral readings of the same types of nominals in downward entailing and intensional contexts.

2.5.3.2 Neutrality Generalisation: Mereological Approach

When it comes to the Neutrality Generalisation, the mereological approach faces an immediate challenge: since dependent plural readings are analysed as a sub-type of cumulative readings, and they are allowed in the context of quantificational licensors, we need to explain why quantificational licensors don't allow for cumulative readings with the whole range of plural DPs, including those involving numerals and cardinality modifiers.

A solution to this problem was proposed by Champollion (2010).¹⁷ Champollion discusses the quantifier *all*, and proposes that its distributive properties should be captured via a presupposition, rather than be embodied as part of its truth conditions, as in (106). This presupposition is formulated in terms of *Stratified Reference* (*SR*), a notion that Champollion introduces in a general form to account for the properties of a wide range of linguistic expressions. The following is the interpretation of the prenominal (i.e. non-floating) *all* in agent position, and the definition of *Stratified Reference* as parametrised to the predicate *Atom* and thematic role agent (*ag*):¹⁸

¹⁷Zweig (2008) offers an account of the contrast between the availability of dependent plural and cumulative readings under *all*, but it does not deliver the correct results as shown in Champollion 2010:204-205.

¹⁸Note that following Landman (2000), Champollion assumes that theta-roles are (partial) functions of type $\langle ve \rangle$, which map an event to the individual that bears a certain role in that event.

- (116) a. $\llbracket \text{all}_{ag} \rrbracket = \lambda x. \lambda P_{\langle vt \rangle}. \lambda e : \text{SR}_{ag, Atom}(P). [P(e) \wedge *ag(e) = x]$
 b. $\text{SR}_{ag, Atom}(P) \stackrel{\text{def}}{=} \forall e. [P(e) \rightarrow e \in * \lambda e'. (P(e') \wedge Atom(*ag(e')))]$
 (Every event in P consists of one or more events, which are also in P and whose agents are atomic.)

Let us see how this interpretation captures the properties of DPs with *all*. First, recall that DPs with *all* do not allow cumulative readings with numerical DPs in their scope. Thus, the following example from Champollion 2010 cannot be interpreted as stating that each safari participant saw one or more zebras, and thirty zebras were seen altogether. It can only be read distributively, as stating that each participant saw thirty zebras:

- (117) All the safari participants saw thirty zebras.

Champollion (2010) provides the following interpretation for (117):

- (118) $\exists e [*see(e) \wedge *ag(e) = \oplus \text{safari.participant} \wedge *zebra(*th(e)) \wedge |*th(e)| = 30]$
 Presupposition: $\text{SR}_{ag, Atom}(\lambda e [*see(e) \wedge *zebra(*th(e)) \wedge |*th(e)| = 30])$
 (Every event in which thirty zebras are seen consists of one or more seeing events whose agents are atomic and whose themes are sums of thirty zebras.)

(118) spells out the presupposition that *all* imposes on the interpretation of the VP. This presupposition is not satisfied, i.e. not every event of seeing thirty zebras is the sum of one or more events each of which has an atomic agent and is itself an event of seeing thirty zebras. For instance, suppose there are thirty safari participants each of whom saw one zebra, and all the safari participants saw different zebras. The VP in (117) would be true of this event, i.e. it is an event of seeing thirty zebras. But if we divide it into sub-events whose agents are atomic, i.e. individual safari participants, we will end up with a set of events of seeing *one* zebra. These sub-events are not in the denotation of the the VP in (117).

Thus, the unavailability of a cumulative reading in (117) is explained by fact that the denotation of the VP does not satisfy the presupposition imposed by *all*. Non-

quantificational licensors, on the other hand, don't impose such presuppositions, and thus allow for cumulative readings as in the following example:

- (119) a. Thirty safari participants saw thirty zebras.
 b. $\exists e[*\text{see}(e) \wedge *\text{safari.participant}(*\text{ag}(e)) \wedge |*\text{ag}(e)| = 30] \wedge *\text{zebra}(*\text{th}(e)) \wedge |*\text{th}(e)| = 30]$

What about dependent plurals? Consider again the following example:

- (120) All the boys flew kites.

As already discussed, this example allows for a dependent plural interpretation on which each boy flew one or more kites, and more than one kite was flown overall.

Champollion adopts the theory of dependent plurality developed in Zweig 2008, 2009. Recall, that on Zweig's theory dependent plurals are semantically number-neutral, with the multiplicity requirement added as a scalar implicature at a stage preceding the existential closure of the event variable. The key to Champollion's account of the availability of dependent plurals under *all* DPs in examples like (120), is the assumption that the presupposition associated with *all* is checked against the denotation of the VP without the added multiplicity implicature, e.g. one may assume that the checking of the presupposition occurs *before* the implicature is added. Sentence (120) is interpreted in the following way:

- (121) $\exists e[*\text{fly}(e) \wedge *\text{ag}(e) = \oplus \text{boy} \wedge *\text{kite}(*\text{th}(e)) \wedge |*\text{th}(e)| > 1]$

Presupposition: $\text{SR}_{ag,Atom}(\lambda e[*\text{fly}(e) \wedge *\text{kite}(*\text{th}(e))])$

(Every event in which one or more kites are flown consists of one or more seeing events whose agents are atomic and whose themes are sums of one or more kites.)

The condition $|*\text{th}(e)| > 1$ in (121) represents the multiplicity implicature, and is not included in the denotation of the VP when the presupposition is checked. In the absence of the multiplicity requirement, the event predicate denoted by the VP satisfies the Stratified Reference presupposition in (121): any event of

seeing one or more zebras can be divided into sub-events of seeing one or more zebras involving atomic agents. For instance, consider the example discussed above of an event in which thirty safari participants each saw one zebra, and all the participants saw different zebras. This event belongs to the set represented as $\lambda e[*\text{fly}(e) \wedge *\text{kite}(*\text{th}(e))]$ in (121), i.e. it is an event of seeing one or more zebras (thirty, in this case). If this event is divided into sub-events involving individual (i.e. atomic) safari participants as agents, each of these sub-events would involve a single zebra as theme, and would also belong to that set.

A strong side of this approach is that it immediately accounts for the Neutrality Generalisation. Specifically, it predicts that only noun phrases which are semantically number-neutral, and whose plurality is derived as an implicature, should allow for co-distributive readings with *all*. On the other hand, cumulative readings with DPs involving unmodified numerals and cardinal modifiers like *several*, where plurality is lexically encoded, are ruled out as cases of presupposition failure.

There is, however, a complication, which I will now briefly address. Consider the following example:

(122) All the boys flew fewer than ten kites.

(123) $\exists e[*\text{fly}(e) \wedge *\text{ag}(e) = \oplus \text{boy} \wedge *\text{kite}(*\text{th}(e)) \wedge |*\text{th}(e)| < 10]$

Presupposition: $\text{SR}_{ag,Atom}(\lambda e[*\text{fly}(e) \wedge *\text{kite}(*\text{th}(e)) \wedge |*\text{th}(e)| < 10])$

(Every event in which fewer than 10 kites are flown consists of one or more seeing events whose agents are atomic and whose themes are sums of fewer than 10 kites.)

The presupposition in (123) is satisfied: dividing any event of flying fewer than 10 kites will result in sub-events which involve flying fewer than 10 kites. Thus, Champollion's approach predicts that *fewer than n* DPs should pattern with bare plurals in allowing cumulative readings with *all* DPs. Thus, (122) should have a reading on which each boy flew one or more kites and fewer than 10 kites were flown overall. This predication is not borne out.

To see this clearly, consider the following scenario: A student competition is

being held. The students are divided into teams, and each student is given her own task. Then the number of mistakes of all the students on a team is summed up, giving the total sum of mistakes for the whole team. To succeed a team must make fewer than three mistakes in total. Now, suppose someone points at a particular team and asks the question in (124):

(124) Did that team succeed?

Now consider the sentence in (125):

(125) Well, all the students on that team made fewer than 3 mistakes.

Intuitively, sentence (125) cannot function as an informative answer to the question in (124) – it cannot be understood as providing the information about the *total* number of mistakes the team made, it can only be read as stating that each of the students made fewer than 3 mistakes. This indicates that *fewer than n* DPs are similar to DPs with unmodified numerals in that they do not allow cumulative readings in the context of DPs with *all*, contra Champollion’s predications.

One may attempt to solve this problem by appealing to Hackl’s (2000) analysis of comparative numeral determiners.¹⁹ Hackl (2000) observes that sentences involving DPs with comparative numerical quantifiers, e.g. *more/fewer than n*, are ruled out whenever sentences involving corresponding non-comparative numerals are ruled out. Hackl cites the following contrasts:

(126) a. ??More than one student is meeting.

b. At least / no fewer than two students are meeting

(127) a. ??More than two students were forming a triangle.

b. At least / no fewer than three students were forming a triangle.

In (126b), a DP involving a comparative quantifier *at least / no fewer than two* is allowed in the subject position of the predicate *be meeting*. On the other

¹⁹I thank L. Champollion (p.c.) for pointing out this possibility to me.

hand, a DP with the comparative quantifier *more than one* is infelicitous in this position. This correlates with the fact that sentence (128b) is acceptable, while sentence (128a) is not:

- (128) a. #One student is meeting.
 b. Two students are meeting

Similarly, the contrast in acceptability between (127a) and (127b) mirrors the contrast between (129a) and (129b):

- (129) a. #Two students were forming a triangle.
 b. Three students were forming a triangle.

Generally, Hackl concludes that a sentence involving a DP of the form “Quant n NP”, where Quant is comparative quantifier (e.g. *fewer / more than, at least, no fewer / more than* etc.), is acceptable only if the corresponding sentence involving a DP of the form “n NP” is acceptable.

Based on this generalisation, one could argue that (125) lacks a cumulative reading, because the corresponding sentence with a non-modified numeral (i.e. *All the students on that team made 3 mistakes*) lacks a cumulative reading, which in turn is attributed to a presupposition violation.

But this move does not solve the whole problem. Hackl’s constraint only applies to comparative determiners which combine directly with numerals, but it does not apply if the cardinality compared to is provided in a different form. Consider the following examples from Hackl 2000:

- (130) a. More students than there are even prime numbers are meeting.
 b. More students than there are primes smaller than 3 were forming a triangle.

Hackl (2000) observes that in contrast to (126a) above, sentence (130a) is felicitous despite the fact that the number of even prime numbers is one. Similarly, (130b) contrasts in acceptability with (129a).

So if Champollion’s account, supplemented with Hackl’s constraint, is correct, we expect the cumulative reading to re-appear in (125) if *fewer than 3 mistakes* is replaced with *fewer mistakes than there are primes smaller than 5*. Consider (131) as an (admittedly, extravagant) answer to (124):

(131) Well, all the students on that team made fewer mistakes than there are primes smaller than 5.

In fact, (131) is equally un-informative as an answer to (124), indicating that it too lacks a cumulative reading. Crucially, in this case the lack of a cumulative reading cannot be attributed to Hackl’s constraint.

Summing up, Champollion’s (2010) presuppositional approach to the semantics of *all* allows to account for the lack of cumulative readings between *all* DPs and DPs involving unmodified numerals, without giving up the central tenet of the mereological approach – that dependent plurality is essentially a sub-type of cumulativity. Moreover, this approach capitalises on the distinction between underlyingly number-neutral and strictly plural dependents, and thus provides an account for the Neutrality Generalisation. However, it faces problems when it comes to the properties of DPs involving modified numerals such as *fewer than n*, incorrectly predicting that they should pattern with bare plurals in allowing cumulative readings in the context of DPs with *all*.

2.5.3.3 Neutrality Generalisation: Mixed Approach

Recall, that in Ivlieva’s (2013) theory DPs involving *all* have the following ‘mixed’ interpretation, with the nuclear scope predicate being applied both to the sum individuals denoted by the restrictor DP and distributively to each atomic individual in that sum:

(132) $\llbracket \text{all the boy} \rrbracket = \lambda P. \lambda e. P(e)(\sigma^* \text{boy}) \wedge \forall y [y \leq \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$

This interpretation correctly predicts the lack of cumulative readings in sentences like (133), where the object DP contains a numeral:

(133) All the boys flew seven kites.

Given the interpretation of the subject DP in (132), sentence (133) will be interpreted as follows:

(134) $\exists e \exists Y [*kite(Y) \wedge |Y| = 7 \wedge *fly(e) \wedge *agent(e)(\sigma *boy) \wedge *theme(e)(Y) \wedge \forall x [x \leq \sigma *boy \wedge atom(x) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*kite(Z) \wedge |Z| = 7 \wedge *fly(e')(x) \wedge *theme(e')(Z)]]]]$

This interpretation requires for there to be a flying event e whose cumulative agent is the maximal sum of boys and whose cumulative theme is a sum of seven kites, such that for each boy x there is a sub-event e' in e which is also a flying event, whose agent is x and whose theme is, again, a sum of seven kites. This is only possible if there is a sum of seven kites K such that each boy flew K .

Another reading for (133) for will be derived if the predicate that the subject combines with is itself pluralised with the help of the *-operator (cf. Kratzer 2007 and the relevant discussion in Ivlieva 2013:69-70). This would account for the distributive interpretation of (133), where each boy flew a possibly different set of 7 kites. However, there is no way, given the interpretation in (132), to derive a cumulative reading for sentences like (133).

Recall that on this account co-distributive interpretations in sentences like (135) are available due to the underlying number-neutrality of bare plurals and to the fact that exhaustification can be applied after the VP combines with the quantificational subject, but before event closure (cf. section 2.4 for details):

(135) All the boys flew kites.

Thus, the mixed approach successfully accounts for the contrast between bare plurals and DPs with unmodified numerals with respect to the availability of co-distributive readings in the context of DPs involving *all*. However, like Champollion's

(2010) theory discussed in the previous section, Ivlieva's (2013) account makes an incorrect prediction with respect to the semantics of sentences like (136):

(136) All the boys flew fewer than ten kites.

This sentence will be interpreted as follows:

(137) $\exists e \exists Y [*kite(Y) \wedge |Y| < 10 \wedge *fly(e) \wedge *agent(e)(\sigma *boy) \wedge *theme(e)(Y) \wedge$
 $\forall x [x \leq \sigma *boy \wedge atom(x) \rightarrow \exists e' [e' \leq e \wedge \exists Z [*kite(Z) \wedge$
 $|Z| < 10 \wedge *fly(e') \wedge *agent(e')(x) \wedge *theme(e')(Z)]]]$

This interpretation states that there is a flying event e whose cumulative agent is the maximal sum of boys and whose cumulative theme is a sum of less than 10 kites, such that for each boy x there is sub-event e' in e which is also a flying event, whose agent is x and whose theme is again a sum of less than 10 kites. This is equivalent to a cumulative interpretation on which the boys cumulatively flew a sum of kites, and the cardinality of this set is less than 10. However, as we have seen in the previous section, cumulative readings of sentences like (137) are in fact unavailable.

2.5.4 Partee's Generalisation

In section 1.4.2 I discussed the following generalisation, due to Partee (1985):

Partee's Generalisation

In English, dependent bare plurals pattern with singular indefinites in being able to scope out of intensional contexts, while non-dependent bare plurals are confined to narrow scope.

As far as I am aware, no existing proposal provides an explicit account of Partee's Generalisation. But we can nevertheless speculate what such an account could be within each of the approaches to dependent plurals discussed in this chapter.

An accounts within the distributive approach is facilitated by the fact that dependent and non-dependent plurals are already taken to be underlyingly different. While non-dependent plurals denote non-singleton sums/sets of individuals, dependent plurals are assigned a singular or number-neutral interpretation.

For instance, there appears to be a straightforward way to modify Spector's (2003) theory to reflect the contrast between dependent and non-dependent bare plurals in English. Spector (2003) already posits a difference in the feature specification of dependent and non-dependent bare plurals – dependent plurals carry an uninterpretable [+pl] feature (which accounts for their 'number-neutrality'), while non-dependent bare plurals are assigned an interpretable [+PL] feature.

However, instead of assuming that the interpretable [+PL] feature is added to the bare plural as a last resort in the absence of appropriate licensors, one may take the bare plural form to be ambiguous, being the spell-out of two different underlying forms. One form carries an uninterpretable [+pl] feature, which must be licensed by its interpretable [+PL] counterpart. This means that this form may only occur in the context of an appropriate licensor. This is the form that functions as a dependent plural. The other form has an interpretable [+PL] feature, which does not need licensing. Only the [+PL] form may occur in the absence of appropriate plural licensors.

Once this ambiguity of the bare plural has been posited, one can stipulate that it is the [+pl] underlying form that is restricted to narrow scope, e.g. it is essentially kind-referring (cf. Carlson 1977, Chierchia 1998). The [+PL] form on the other hand, is similar to non-bare indefinites in having quantificational and maybe even choice-functional readings. Of course these restrictions on the co-occurrence of features should ideally receive a principled explanation rather than be bluntly stipulated, but it seems that a proposal along these lines has a potential to incorporate Partee's Generalisation into the distributive account of dependent plurals.

An account within the mereological and mixed approaches appears to be more

problematic. On these approaches, no difference is posited between bare plurals in dependent and non-dependent contexts. Hence, these theories do not provide an immediate basis for explaining the scopal contrast between dependent and non-dependent bare plural NPs.

I conclude, that the distributive approach appears to be better poised to account for Partee's Generalisation, although it is not clear whether such an account could be made truly explanatory.

2.6 Conclusion

I began this chapter with an overview of three basic approaches to the analysis of constructions involving dependent plurals. The distributive approach assumes that the plural marking on the dependent is semantically vacuous, and the dependent is interpreted distributively with respect to the licensor. The mereological approach, on the other hand, takes the dependent to denote a mereologically plural individual. The semantic relation between the dependent and the licensor is captured via the same mechanisms that are used to account for cumulative readings in constructions involving multiple plural noun phrases. Finally, in Ivlieva's (2013) 'mixed approach', constructions involving dependent plurals licensed by quantificational items are analysed as combining the semantics of cumulativity and distributivity.

We have seen that all of these approaches can successfully account for the fact that dependent plurals do not impose a multiplicity requirement evaluated relative to each individual in the set of witnesses introduced by the licensor, but instead allow for a co-distributive interpretation. However, only the mereological and mixed approaches, but not the distributive approach, are able to capture the overarching Multiplicity Condition associated with dependent plurals.

Next, with respect to intervention effects we were able to conclude that all the discussed approaches are only partly successful. The distributive approach, on its syntactised version, can be naturally extended in a such a way as to account for the fact that, at least for a sub-set of speakers, only singular, but not plural,

DPs give rise to intervention effects in constructions involving dependent plurals. However, this kind of syntactic approach fails to explain why the intervention effect disappears if the potential intervener does not semantically co-vary with the licensor.

The mereological and mixed approaches face the opposite problem. They correctly predict that DPs which do not co-vary with the licensor should not induce intervention effects in dependent plural constructions. However, they fail to capture the contrast between singular and plural DPs in cases where the potential intervener *does* semantically co-vary with the licensor.

I then discussed how the three approaches could deal with the Licensing Generalisation, i.e. the observation that DPs that involve complement NPs in the singular cannot function as licensors for dependent plurals. Neither of the two approaches directly predicts this to be the case. However, the distributive approach can be easily extended to account for this restriction by stipulating that the number feature of the complement NP is inherited by the DP. Hence, if the complement NP carries the feature [+SG], the DP cannot carry [+PL] which in Spector's (2003) theory is a necessary condition for licensing dependent plurals. Zweig's (2008, 2009) mereological approach, on the other hand, faces a tougher challenge. While the contrast between singular and plural quantifiers can be attributed to the availability of *in situ* readings for the latter, but not the former (cf. Champollion 2010), this explanation appears stipulative and does not account for the role of number marking on the restrictor NP. Finally, on Ivlieva's (2013) mixed approach the contrast between *all* and *each* is attributed to the presence of a cumulative component in the semantics of the former, but not the latter. Assuming that singular NPs apply exclusively to atomic individuals, this theory is able to provide a plausible account of the link between the number marking on the restrictor NP and the ability of a DP to license dependent plurals.

Next, with respect to the Neutrality Generalisation I showed that although the distributive approach can capture the unavailability of cumulative readings in the

context of quantificational licensors, it cannot account for the link between the availability of dependent plural readings and number-neutrality effects in downward-entailing and intensional contexts. The mereological approach on the other hand, supplemented with the presuppositional treatment of plural quantificational licensors proposed by Champollion (2010), successfully captures both aspects of the Neutrality Generalisation. Similarly, Ivlieva's (2013) mixed approach correctly predicts the lack of cumulative readings between plural quantificational licensors and DPs involving unmodified numerals, as well as accounting for the link between the number-neutrality of bare plurals and their ability to function as dependents. However, both Champollion's (2010) and Ivlieva's (2013) accounts make incorrect predications when it comes to DPs involving modified numerals such as *fewer than n*.

Finally, Partee's Generalisation hasn't, as far as I know, been explicitly addressed within either approach to dependent plurals. Nevertheless, I have argued that the distributive approach may be better poised to provide an account of this phenomenon.

In sum, each existing approaches to the semantics of dependent plurals is successful in accounting for certain parts of the data presented in 1, but none of them is can successfully account for the full range of data.

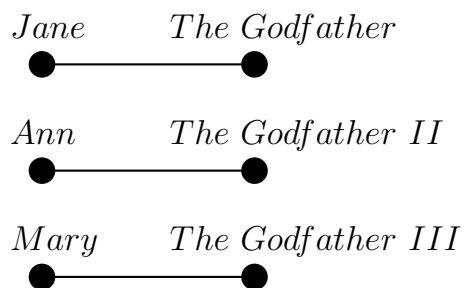
Chapter 3

Weak and Strong Distributivity

3.1 Introduction

Before delving into the technical details of my own analysis I would like to take a step back, and consider the empirical and theoretical landscape that has emerged from the discussion in the previous chapters. Let us begin by reviewing the means that the grammar of e.g. English employs to represent situations which involve an interaction between two (non-singleton) sets of individuals. Suppose we want to describe the following situation:

(1)



Here, the three dots on the left represent three girls, Jane, Ann, and Mary, while the three dots on the right represent three movies, *The Godfather*, *The Godfather II*, and *The Godfather III*. Each line connects a girl to the movie she watched.

The following two sentences can both be used to describe the situation in (1):

- (2) a. Three girls watched three films.
 b. Three girls (each) watched one film.

These two sentences illustrate two distinct grammatical mechanisms that many languages employ for capturing relations between sets of individuals. Both sentences contain two DPs which refer (in a very broad sense) to two sets of objects, which stand in a particular relation, as illustrated in (1). I will use the terms *lower set-DP* and *higher set-DP* as theory-independent labels for such DPs.

Sentence (2a), when used to describe the situation in (1), has a *cumulative* interpretation – in this case the lower set-DP specifies the cardinality of the whole set of films involved in the situation. Sentence (2b), on the other hand, is interpreted *distributively* – here the lower set-DP specifies the cardinality of certain sub-sets of the set of films, namely those sub-sets which are related to the individuals in the set of girls by the *watch* relation. This difference in the way the lower set-DPs refer is central to the distinction between cumulative and distributive interpretations. However, as we have seen in previous chapters, there are further important contrasts. I will review three such contrasts here.

First, the two constructions impose different restrictions on what types of nominal expressions are allowed to function as higher set-DPs. Namely, DPs involving singular quantifiers, such as *each* and *every*, when used as higher set-DPs allow for a distributive interpretation, but not for a cumulative one. Thus, while sentence (3b) will be judged true in situation (1), sentence (3a) will be judged false:

- (3) a. Every girl watched three films.
 b. Every girl watched one film.

Similarly, the presence of the floating quantifier *each* blocks the cumulative reading, enforcing a distributive interpretation.

Second, as we will see in Chapter 5 (cf. the discussion in section 5.3), the two constructions are associated with different locality restrictions. For a cumulative

interpretation to be possible, the two set-DPs must occur in a sufficiently local syntactic configuration with respect to each other, either as co-arguments of a single lexical predicate or at least at a distance which can be covered by quantifier raising. A distributive interpretation, on the other hand, is possible even if the two set-DPs are separated by barriers impervious to QR, e.g. by a finite clause or island boundary. Thus, sentence (4), where two set-DPs are separated by an adjunct clause boundary, allows for a distributive interpretation. It can mean that for each of the three girls there exists a set of four magicians, such that the girl left when these magicians were performing. A cumulative interpretation, on the other hand, is not available. If it were, this sentence would be judged true in a situation where e.g. Mary left the circus when magician *A* was performing, Ann left the circus on a different occasion when magician *B* was performing, and finally Jane left the circus on a third occasion when a pair of magicians *C* and *D* were performing. In fact, this is not a possible interpretation for (4).

(4) Three girls left the circus when four magicians were performing.

Finally, distributive and cumulative constructions differ with respect to the interpretation of noun phrases intervening between the higher and lower set-DPs. Under the cumulative interpretation, intervening DPs must also be interpreted cumulatively, i.e. they must encode the cardinality of the whole set of individuals taking part in a situation. In the case of distributive interpretations, on the other hand, intervening DPs can be interpreted distributively, i.e. as specifying the cardinality of sub-sets corresponding to each individual in the higher set-DP. For instance, sentence (5) has a cumulative reading on which three girls each gave the same boy one or more books, and four books were given overall. In this case both the low set-DP *four books* and the intervening DP *one boy* are interpreted cumulatively. It can also have a reading on which both of these DPs are interpreted distributively, i.e. there are three girls, and each girl gave a possibly different boy a possibly different set of four books. The meaning that is not available, however, is one where the DP *four books* is interpreted cumulatively, but the intervening DP

one boy is interpreted distributively, i.e. (5) cannot mean that there are three girls who each gave a possibly different boy one or more books, and four books were given overall.

(5) Three girls gave a boy four books.

All these contrasts are successfully accounted for by existing theories of distributivity and cumulativity. Enter dependent plurals. Descriptively, dependent plurals differ from garden-variety cumulative constructions like (2a) in that the lower set-DP does not contain numerals or cardinal modifiers like *several*. Thus, the following sentence is an example of a dependent plural construction, which can, on a par with (2a) and (2b), be used to describe the situation depicted in (1):

(6) Three girls watched films.

If we now compare the dependent plural construction with cumulative and distributive ones in terms of the properties discussed above, we will find that it consistently lands somewhere in the middle. Indeed, with respect to the semantics of the lower set-DP, constructions involving dependent plurals pattern with cumulative constructions: the plural marking on the lower, dependent, set-DP reflects the overall cardinality of a set of individuals involved in a situation. For instance, in (6) the plural marking on the DP *films* signals that more than one film was watched overall, not that each girl necessarily watched more than one film. In Chapters 1 and 2 I referred to this property as the overarching Multiplicity Condition associated with dependent plurals.

On the other hand, with respect to locality, dependent plurals appear to pattern with distributive readings. As will be discussed in detail in section 5.3, the two set-DPs in a dependent plural construction can be separated by finite clause and island boundaries. For instance, the following sentence can be truthfully uttered in a context where Mary left the circus when magician *A* was performing, Ann left the circus on a different occasion when magician *B* was performing, and finally Jane left the circus on a third occasion when magician *C* was performing.

(7) Three girls (all) left the circus when magicians were performing.

Next, consider the restrictions on the higher set-DP in these three constructions. The following table summarises the availability of cumulative, dependent plural and distributive interpretations in the context of three types of higher set-DPs: non-quantificational plurals, plural quantificational DPs involving quantifiers such as *all* and *most*, and singular quantificational DPs headed by determiners such as *each* and *every*:

(8)

Higher Set-DP	Cumulative	Dep. Plural	Distributive
Non-Quantificational	✓	✓	✓
Quantificational Plural	*	✓	✓
Quantificational Singular	*	*	✓

The data in this table incorporate the Neutrality Generalisation and the Licensing Generalisation discussed in Chapter 1. We can see that dependent plural readings pattern with distributive and contrast with cumulative ones, in that they are allowed in the context plural quantificational DPs. On the other hand, they are similar to cumulative readings in that they are blocked under singular quantificational DPs, while distributive readings are allowed in this context. Again, dependent plurals appear to land somewhere halfway between cumulative and distributive constructions.

Finally, consider the interpretation of intervening DPs in constructions involving dependent plurals. The relevant data was discussed in section 1.2.3, where it was shown that in at least some dialects the availability of a distributive interpretation of an intervening DP in dependent plural constructions depends on the grammatical number of that DP. Specifically, a distributive interpretation is blocked for singular interveners, but allowed to plural ones. The following table presents a comparison of dependent plurals with cumulative and distributive constructions with respect to the interpretation of intervening DPs (cf. also the discussion in section 5.2,

below):

(9)

Distributive Interpretation	Cumulative	Dep. Plural	Distributive
SG interveners	*	*	✓
PL interveners	*	✓	✓

We see that with respect to the interpretation of singular interveners, dependent plurals pattern with cumulative constructions. On the other hand, plural interveners can be interpreted distributively in distributive and dependent plural constructions (in the discussed dialects), but not in cumulative constructions.

Given the fact that dependent plurals are in some respects similar to cumulative constructions while in others pattern with constructions interpreted distributively, it is perhaps not surprising that researchers have had conflicting intuitions regarding the correct analysis of this phenomenon. Some, e.g. Beck (2000*b*), Swart (2006) and Zweig (2008, 2009), analyse dependent plural readings as a sub-type of cumulative ones. Others, such as Kamp and Reyle (1993) and Spector (2003), conversely, treat dependent plural constructions as underlyingly distributive. Finally, Ivlieva (2013) proposes that dependent plural readings occur in contexts that combine the semantics of cumulativity and distributivity. However, given the mixed properties of dependent plurals, it is again not unexpected that all these approaches face difficulties in accounting for the full range of data, as discussed in detail in Chapter 2. I will take all the discussed facts to indicate that dependent plural readings should *not* be equated with either cumulative or distributive ones, but rather involve a distinct semantic mechanism. The challenge, then, is to define this mechanism, and to specify its relation to the semantics of cumulativity and distributivity.

In the following chapters I will argue for an approach which takes seriously the three-way distinction between cumulative, dependent plural and distributive interpretations. The analysis is based on the ideas first proposed in a series of works by Martin van den Berg (van den Berg 1990, 1994, 1996*a,b*). Van den Berg

develops a Dynamic Predicate Logic for Plurals (DPLP), which is inspired by Groenendijk and Stokhof's (1991) Dynamic Predicate Logic (DPL) but includes a crucial innovation – whereas formulas in DPL are interpreted as relations between assignments, formulas in van den Berg's DPLP are interpreted as relations between *sets of assignments*, or plural information states. This extension is crucial in light of the facts discussed above in that it adds a new level for representing the semantics of plurals.

This chapter introduces the core ideas of the analysis. I start with a presentation of the formal framework, which I call PCDRT*. It is a modified version of Plural Compositional DRT (PCDRT), proposed in Brasoveanu (2007, 2008) as an extension of Muskens' (1996) Compositional DRT which incorporates van den Berg's idea of plural information states. I then present a treatment of a fragment of English, including singular and plural number features, definite and indefinite determiners, plurals, numerals, floating quantifiers etc., and demonstrate how the proposed system is able to account for the basic properties of dependent plural constructions.

3.2 PCDRT*

3.2.1 Basic Idea: Plural Info States

My analysis will be couched within PCDRT*, a modified version of Plural Compositional DRT (PCDRT) of Brasoveanu (2007, 2008), which is itself an extension of Muskens' (1996) Compositional DRT. The main innovation of PCDRT in comparison with Muskens' (1996) system is the introduction of *plural information states* (or info states), as originally proposed by van den Berg (1994, 1996*b*). A plural information state is a set of assignments which can be represented as a matrix where the rows correspond to individual assignments, and the columns correspond to discourse referents (drefs). The cells in this matrix contain values of discourse referents with respect to assignments, e.g. a cell in row i_m and column u_n will store

the value of the discourse referent u_n with respect to the assignment i_m :

(10)

Info state I	...	u_1	u_2	u_3	...
i_1	...	x_1 ($= u_1 i_1$)	y_1 ($= u_2 i_1$)	z_1 ($= u_3 i_1$)	...
i_2	...	x_2 ($= u_1 i_2$)	y_2 ($= u_2 i_2$)	z_2 ($= u_3 i_2$)	...
i_3	...	x_3 ($= u_1 i_3$)	y_3 ($= u_2 i_3$)	z_3 ($= u_3 i_3$)	...
...

Thus, a plural info state stores multiple values for each dref (the columns in Table 10), and the correspondence between the values of multiple drefs (the rows in Table 10).

3.2.2 Types and Domains

PCDRT* has four basic types. These include the three basic types of Brasoveanu's (2007, 2008) PCDRT:

(11)

- type t (truth-values);
- type e (atomic and non-atomic individuals);
- type s (variable assignments).

The domain of type t is the set of two values $\{0,1\}$. Variable assignments are modelled as basic entities of type s . The domain of type e , \mathcal{D}_e , is the powerset of a non-empty set of entities \mathbf{IN} minus the empty set: $\mathcal{D}_e = \wp(\mathbf{IN}) \setminus \emptyset$. The sum operation is then identified with set union: the sum $x_e \oplus y_e$ is the union of sets x and y . Similarly, the part-of relation \leq over individuals is identified with the subset relation \subseteq over \mathcal{D}_e . Thus, we follow Brasoveanu (2008) in allowing for *domain level plurality*. Brasoveanu (2007), on the other hand, follows van den Berg (1996b) in assuming that the domain of individuals \mathcal{D}_e is restricted to atomic individuals. In

this system plurality is uniformly modelled as *state level plurality* via plural info states. In my analysis of dependent plurals the distinction between domain level and state level plurality will play an important role.

To the basic types in (11), PCDRT* adds type v for events:

- type v (events)

The domain of type v , \mathcal{D}_v , is defined in the same way as the domain of individuals, i.e. as the powerset of the set of atomic events \mathbf{EV} minus the empty set: $\mathcal{D}_v = \wp(\mathbf{EV}) \setminus \emptyset$. The sum and part-of relations over events are analogous to the corresponding relations over individuals.

I will use the following definitions for sets of types, identical to those in Brasoveanu 2007, 2008 save for the addition of v as a basic static type:

- (12) a. The set of basic static types **BasSTyp**: $\{t, e, v\}$ (truth-values, individuals and events)
- b. The set of static types **STyp**: the smallest set including **BasSTyp** such that if $\sigma, \tau \in \mathbf{BasSTyp}$, then $(\sigma\tau) \in \mathbf{STyp}$
- c. The set of dref types **DRefTyp**: the smallest set such that if $\tau \in \mathbf{STyp}$, then $(s\tau) \in \mathbf{DRefTyp}$
- d. The set of basic types **BasTyp**: $\mathbf{BasSTyp} \cup \{s\}$
- e. The set of types **Typ**: the smallest set including **BasTyp** such that if $\tau, \sigma \in \mathbf{Typ}$, then $(\sigma\tau) \in \mathbf{Typ}$

3.2.3 Drefs and DRSs

Discourse referents, or drefs, are modeled as functions of type $s\tau$, where τ is a static type. For instance, individual drefs are functions from assignments to individuals. Thus, a dref u_{se} applied to an assignment i_s , written as $u_{se}i_s$, returns an individual of type e . I will write uJ to mean the set of values that the dref u returns when applied to the assignments in the plural info state J , i.e. $uJ = \{x : \exists j \in J. u_j = x\}$.

I will also use $\oplus uJ$ to mean the sum of these values. Similarly, an event dref ε_{sv} applied to an assignment i_s , i.e. $\varepsilon_{sv}i_s$, returns an event of type v . As a convention, I will use the symbols u, u', u'', \dots and u_1, u_2, u_3, \dots both for individual dref constants of type se , and dref constants in general, and the symbols $\varepsilon, \varepsilon', \varepsilon'', \dots$ and $\varepsilon_1, \varepsilon_2, \varepsilon_3, \dots$ for event dref constants of type sv . I will specify the type of drefs using subscripts when necessary to avoid confusion. I will also use v, v', v'', \dots and v_1, v_2, v_3, \dots for variable of type se , and $\zeta, \zeta', \zeta'', \dots$ and $\zeta_1, \zeta_2, \zeta_3, \dots$ for variable of type sv .

Drefs come in two varieties: *specific* and *unspecific* (cf. also Muskens 1996). Specific discourse referents are constant functions, which return the same individual for every assignment. For instance, the specific dref $John_{se}$ will map any assignment i_s to the individual $john_e$. Conversely, unspecific drefs are non-constant functions which may map different assignments to different individuals.

Each sentence is interpreted as a Discourse Representation Structure (DRS), which is taken to be a function of type $(st)((st)t)$. In other words, a sentence denotes a relation between two sets of assignments (or functions of type st), which correspond to the input plural information state and the output plural information state. A standard DRS can fulfil two functions – introduce new drefs and impose conditions on the output info state:

$$(13) \quad \lambda I_{st}.\lambda J_{st}. I[\mathbf{new\ drefs}]J \wedge \mathbf{conditions}J$$

This is abbreviated in the following way:¹

$$(14) \quad [\mathbf{new\ drefs} \mid \mathbf{conditions}]$$

The following is a simplified DRS corresponding to the sentence *A boy chose a film*:²

¹In the following, I will try to provide the abbreviated form of expressions when possible, since this format should be more familiar to readers acquainted with regular DRT. However, the abbreviated language is less expressive than full PCDRT*, and consequently not all expressions that we encounter will allow for an abbreviated form.

²Here and throughout this thesis I disregard the semantics of tense and aspect. I am also for now disregarding the role of number on DPs.

$$(15) \quad [u, u', \varepsilon \mid \text{boy}\{u\}, \text{film}\{u'\}, \text{choose}\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}] \\ := \lambda I_{st}. \lambda J_{st}. I[u, u', \varepsilon]J \wedge \text{boy}\{u\}J \wedge \text{film}\{u'\}J \wedge \text{choose}\{\varepsilon\}J \wedge \\ \mathbf{Ag}\{u, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J$$

This DRS introduces two new individual drefs, u and u' , and one new event dref ε , and places a set of conditions on the output info state J : the dref u applied to the assignments in J must return a boy-individual, dref u' applied to the assignments in J must return a film-individual, and ε applied to the assignments in J must return a choosing event, whose agent is the boy returned by u and whose theme is the film returned by u' .

DRSs that do not introduce any new drefs, and only include conditions on the output info state, are called *tests*, and have the following form:

$$(16) \quad [\mathbf{conditions}] := \lambda I_{st}. \lambda J_{st}. I = J \wedge \mathbf{conditions}J$$

Let us consider the two functions of a DRS in more detail.

3.2.4 Introduction of New Drefs

Introduction of a new dref is modelled as an arbitrary reassignment of the values of that dref. In other words, introduction of a new dref u means that the output info state is allowed to differ from the input state with respect to the values of u . In familiar systems which do not involve plural info states, this is formalised with the help of the following two-place predicate over assignments:

$$(17) \quad [u] := \lambda g_s. \lambda h_s. \forall v_{se} (vg \neq vh \rightarrow v = u)$$

Informally, $g_s[u]h_s$ means that assignments g and h differ at most with respect to the value for u . In such cases, we will say that g is u -different from h .

Our system allows for non-singleton info states, which means that the predicate in (17) is not directly applicable. Brasoveanu (2007) discusses two alternative ways of defining dref introduction in PCDRT:

$$(18) \quad \begin{aligned} \text{a. } [u] &:= \lambda I_{st}.\lambda J_{st}.\forall i_s \in I (\exists j_s \in J (i[u]j)) \wedge \forall j_s \in J (\exists i_s \in I (i[u]j)) \\ \text{b. } [u] &:= \lambda I_{st}.\lambda J_{st}.\exists X_{et} \neq \emptyset (J = \{j_s : \exists i_s \in I (i[u]j \wedge u_j \in X)\}) \end{aligned}$$

The first definition simply requires for every individual assignment in the input info state to have a corresponding u -different assignment in the output state, and conversely, for every individual assignment in the output info state to have a corresponding u -different assignment in the input info state. No additional restrictions are placed on the output info state.

The second definition is more restrictive. It says that there must exist a set of individuals X , such that the output info state is the set of all the possible assignments which are u -different from some assignment in the input info state, and whose u -value is a member of X . As in the previous definition, this implies that for each assignment in the output info state there must be at least one corresponding u -different assignment in the input info state, and vice versa. But in addition to that, (18b) implies that if X is the set of all the values of u for the assignments in the output info state J , i.e. $X = uJ$, then for each assignment in the input info state there is a (non-empty) subset K of u -different assignments in J , such that the set of values of u for the assignments in K is X , i.e. $uK = X$. Informally, this means that if a new set of values is introduced for a discourse referent, it must be introduced *distributively* with respect to each individual assignment in the input info state.

The definition in (18b) is adopted in van den Berg 1996*b* and Nouwen 2003. On the other hand, Brasoveanu (2007) provides a number of arguments for preferring the definition in (18a). I will not discuss these arguments here, and refer the reader to Brasoveanu's exposition. What both of these definitions of the \llbracket -relation have in common, is that they allow for an increase in the cardinality of the output info state as compared to the input info state. So for instance, if the input info state I is singleton, i.e. contains a single assignment i , then according to both definitions in (18), $I[u]J$ may be true for J of potentially any cardinality.

In the system that I will use, the function of increasing the cardinality of an

info state is reserved for distributivity operators and quantificational expressions. In the absence of such operators, all DRS's are interpreted relative to *singleton* info states. This is one of the core differences between the system that I adopt and Brasoveanu's (2008) version of PCDRT. This restriction will play an important role in the account of Partee's Generalisation, and of the semantics of plural indefinite DPs with numerals and cardinal modifiers, cf. sections 5.2 and 5.4, respectively, and further discussion of this point in Chapter 6.

I will implement this general restriction by modifying the definition of the $\llbracket _ \rrbracket$ -relation in the following way:³

(19) *New Dref Introduction*

$$[u] := \lambda I_{st}. \lambda J_{st}. \exists f_{ss}. (\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = J \wedge \forall i \in I. i[u]f(i)),$$

where f is a partial function from \mathcal{D}_s to \mathcal{D}_s , $\mathbf{Dom}(f) := \{i_s : \exists j_s. f(i) = j\}$ and $\mathbf{Ran}(f) := \{j_s : \exists i_s. f(i) = j\}$.

This definition is conceptually closer to the one in (18a) than the one in (18b), in that the introduction of new drefs is not required to be distributive. However, under this definition, a DRS introducing a new dref u maps every assignment in the input info state onto a single u -different assignment in the output info state, and thus cannot return an output info state of a cardinality greater than that of the input info state.

Multiple dref introduction (as in example (15) above) is defined on the basis of dynamic conjunction of multiple introduction predicates. The definition of dynamic conjunction and multiple dref introduction is given in (20):

$$(20) \quad \text{a. } D_{st((st)t)}; D'_{st((st)t)} := \lambda I_{st}. \lambda J_{st}. \exists H_{st}. (DIH \wedge D'HJ)$$

$$\text{b. } [u_1, \dots, u_n] := [u_1]; \dots; [u_n]$$

Then, for example (15) the following holds:

$$(21) \quad \frac{I[u, u', \varepsilon]J := \exists H_{st}. \exists H'_{st}. I[u]H \wedge H[u']H' \wedge H'[\varepsilon]J}{}$$

³Implementing this restriction will also require us to amend the definition of truth of a DRS (cf. section 3.2.6).

3.2.5 Conditions and Lexical Relations

The second part of a DRS contains conditions on the output info state, i.e. predicates of type $(st)t$ applied to the output info state of type st . In example (15) above, these predicates are lexical relations, i.e. $boy\{u\}$, $film\{u'\}$ and $choose\{u, u'\}$. Such relations are interpreted by universally quantifying over the assignments in the plural info state which they apply to. More formally, for any non-logical constant R of type e^nt , the following convention holds:⁴

$$(22) \quad R\{u_1, \dots, u_n\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I. (R(u_1 i, \dots, u_n i))$$

Thus, $boy\{u\}J$ will be true iff $boy(uj)$ is true for every assignment j in J , i.e. the dref u maps every assignment j in J to an individual who is a boy (or more accurately, a sum of boys, cf. the discussion of lexical cumulativity in section 3.2.9 below). Similarly, $walk\{\zeta\}J$ will be true iff $walk(\zeta j)$ is true for every j in J .

Translations of most common nouns and verbs involve lexical relations of this type, e.g.:⁵

$$(23) \quad \begin{aligned} \text{a. } \mathbf{boy} &\rightsquigarrow \lambda v_{se}. [boy\{v\}] := \lambda v_{se}. \lambda I_{st}. \lambda J_{st}. I = J \wedge boy\{v\}J \\ &:= \lambda v_{se}. \lambda I_{st}. \lambda J_{st}. I = J \wedge \forall j \in J. (boy(vj)) \\ \text{b. } \mathbf{walk} &\rightsquigarrow \lambda v_{se}. \lambda \zeta_{sv}. [walk\{\zeta\}, \mathbf{Ag}\{v, \zeta\}] \\ &:= \lambda v_{se}. \lambda \zeta_{sv}. \lambda I_{st}. \lambda J_{st}. I = J \wedge walk\{\zeta\}J \wedge \mathbf{Ag}\{v, \zeta\}J \\ &:= \lambda v_{se}. \lambda \zeta_{sv}. \lambda I_{st}. \lambda J_{st}. I = J \wedge \forall j \in J. (walk(\zeta j) \wedge \mathbf{Ag}(vj, \zeta j)) \end{aligned}$$

3.2.6 Truth of a DRS

In Brasoveanu 2008, truth is defined with respect to a DRS and an input info state in the following way:

⁴ e^nt is defined as the smallest set of types s.t. $e^0t := t$ and $e^{m+1}t := e(e^mt)$, cf. Muskens (1996), Brasoveanu (2007, 2008).

⁵There are, however, lexical items, e.g. collective predicates such as *gather*, which as I will argue below, are interpreted collectively with respect to plural info states. This means that they impose conditions on the set of values a dref has across the individual assignments in a plural info state. I will return to this issue in section 4.5.

(24) *Truth (to be revised)*

A DRS D of type $(st)((st)t)$ is *true* with respect to an input info state I_{st} iff $\exists J_{st} (DIJ)$.

Thus a DRS D is true with respect to an input info state I iff there is an output info state J , such that D applies to I and J .

As pointed out above, in the current system we want non-singleton info states to arise only as a result of the application of distributivity operators and quantifiers. Thus, we have to make sure that the initial info state in any discourse is singleton. I will do this by re-defining the notion of truth in such a way that it allows a DRS to be evaluated only with respect to *singleton* input info states:

(25) *Truth*

For a DRS D of type $(st)((st)t)$ and an input info state I_{st} , such that I is a singleton set of assignments, D is *true* with respect to I iff $\exists J_{st} (DIJ)$.

Thus, truth is defined only with respect to singleton input info states, and a DRS D is true with respect to a singleton input info state I iff there is an output info state J , such that D applies to I and J .

For instance, the DRS in (15), repeated in (26), will be true with respect to a singleton input info state $I = \{i\}$ iff there exists an output info state J such that $I[u, u', \varepsilon]J \wedge \mathbf{boy}\{u\}J \wedge \mathbf{film}\{u'\}J \wedge \mathbf{choose}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J$:

(26) $[u, u', \varepsilon \mid \mathbf{boy}\{u\}, \mathbf{film}\{u'\}, \mathbf{choose}\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}]$
 $:= \lambda I_{st}.\lambda J_{st}. I[u, u', \varepsilon]J \wedge \mathbf{boy}\{u\}J \wedge \mathbf{film}\{u'\}J \wedge \mathbf{choose}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J$

Given the definition of new dref introduction in (19), J must also be singleton, i.e. $J = \{j\}$ for some assignment j , and j must differ from i at most with respect to the values returned by u , u' and ε . Then, following (22), the conditions on J will be satisfied if the individual that u returns for j , i.e. uj , is a boy, the individual that u' returns for j , i.e. $u'j$, is a film, and the event ε that returns for j , i.e. εj

is a choosing event whose agent is uj and whose them is $u'j$. In combination with the axioms discussed in the next section, these truth conditions amount to the requirement for there to exist a boy and a firm, and an event of the boy choosing the film.

3.2.7 Axioms

Models M for PCDRT* must satisfy a number of axioms. The following formulations follow those in Brasoveanu 2007, 2008:

(27) a. *Axiom 1 (Unspecific drefs)*

undref(d), for any unspecific dref name d of any type (se).

b. *Axiom 2 (Drefs have unique dref names)*

undref(d) \wedge **undref**(d') $\rightarrow d \neq d'$, for any two distinct dref names d and d' of type (se)

c. *Axiom 3 (Identity of assignments)*

$\forall i_s. \forall j_s. (i[]j \rightarrow i = j)$

d. *Axiom 4 (Enough assignments)*

$\forall i_s. \forall v_{se}. \forall x_e. (\mathbf{undref}(v) \rightarrow \exists j_s. (i[v]j \wedge vj = x))$

Axiom 1 uses the non-logical constant **undref** to identify the unspecific drefs. Axiom 2 ensures that drefs with different names correspond to different functions. Axiom 3 states that if every dref return the same value for some two assignments, these assignments must be identical. Finally, Axiom 4 ensures that for any assignment i , unspecific dref v and individual x , we can always find an assignment j v -different from i , such that $vj = x$.

3.2.8 Common Nouns and Verbs

In discussing the types of the expressions that serve as translations of the various lexical and syntactic categories in PCDRT*, it may be useful to adopt a simplifying

convention, proposed in Brasoveanu 2007, 2008: let us use **e** to stand for the type of individual drefs, i.e. *se*, **v** to stand for the type of event drefs, i.e. *sv*, and **t** to stand for the type of DRSs, i.e. $(st)((st)t)$. This convention makes clear the parallelism between the type system of PCDRT* and the type systems of more familiar static logics.

Common nouns are translated into functions of type $(se)((st)((st)t))$ in PCDRT*, i.e. functions from individual drefs of type *se* to DRSs of type $(st)((st)t)$, cf. the example in (23a) above. This corresponds to type **et** in the simplified form, the familiar type for common nouns and intransitive verbs in the the standard Montgovian system.

Similarly, determiners such as *the* and *every* translate into functions of type $(\mathbf{et})(\mathbf{et})\mathbf{t}$ in PCDRT*, i.e. $((se)((st)((st)t))(((se)((st)((st)t))((st)((st)t)))$.

Intransitive verbs are translated into functions of type $(se)((sv)((st)((st)t)))$, which corresponds to type **e(vt)** in the simplified notation (cf. the example in 23b). Similarly, transitive verbs are translated as functions of type **e(e(vt))**:

$$(28) \quad \mathbf{choose} \rightsquigarrow \lambda v_e. \lambda v'_e. \lambda \zeta_v. [choose\{\zeta\}, \mathbf{Th}\{v, \zeta\}, \mathbf{Ag}\{v', \zeta\}]$$

As evident from this translation, I adopt the Neo-Davidsonian system of verb interpretation, where verbs are taken to introduce predicates over events, and arguments are related to events via thematic relations (cf. Parsons 1990). I will also assume Role Uniqueness, which states that for any thematic relation Θ and any event e , there is a unique individual x such that $\Theta(x, e)$ (cf. Carlson 1984, Parsons 1990, Landman 1996, 2000). The following formulation is modelled on Landman 2000:

(29) **Role Uniqueness:**

For any x , e , and Θ if $\Theta(x, e) = 1$ then there is no y such that $y \neq x$ and $\Theta(y, e) = 1$.

DPs are uniformly translated into functions of type $(\mathbf{et})\mathbf{t}$. This means that in order to combine with their arguments verbs need to type-shifted to a higher type.

I will use an adapted version of the LIFT type-shifters from Landman 2000:

- (30) a. **Intransitive Lift:** $\lambda v_{se}.\lambda\zeta_{sv}.[...] \Rightarrow \lambda Q_{(et)t}.\lambda\zeta.Q(\lambda v.[...])$
 b. **Transitive Lift:** $\lambda v_{se}.\lambda v'_{se}.\lambda\zeta_{sv}.[...] \Rightarrow \lambda Q_{(et)t}.\lambda v' .\lambda\zeta.Q(\lambda v[...])$

3.2.9 Lexical Cumulativity

I will assume that most lexical predicates, e.g. *boy*, *girl*, *walk*, as well as thematic relation such as **Ag** and **Th** are closed under the sum operation, i.e. that they are cumulative at the domain level. Cumulativity for one-place and two-place lexical relations is defined as follows (cf. e.g. Krifka 1989, Landman 1996):

- (31) *Lexical Cumulativity*
 $\forall x, y (R(x) \wedge R(y) \rightarrow R(x \oplus y))$
 $\forall x_1, x_2, y_1, y_2. (R(x_1, y_1) \wedge R(x_2, y_2) \rightarrow R(x_1 \oplus x_2, y_1 \oplus y_2))$

Thus, the predicate *boy* applies to sums of boys, as well as to individual boys. Similarly, *walk* applies both to individual walking events, and to sums of such events.

3.2.10 Lexical Distributivity

In the following, I will often make reference to the *lexical distributivity* of predicates. This is the property that ensures e.g. that whenever the predicate *dog* is true of a sum of individuals it is also necessarily true of each atomic sub-individual in that sum, and when there is an event of a sum of dogs barking then for each atomic sub-individual *d* in that sum there must be an event of *d* barking. Generally, verbal predicates may or may not be lexically distributive with respect to a particular argument (i.e. theta-role). For instance, the transitive verb *carry* is lexically distributive with respect to its theme (i.e. if an individual carries a sum of boxes that individual necessarily carries each individual box), however it is not lexically distributive with respect to its agent (i.e. if a sum of individuals carries a box it

does not follow that each of these individuals carries that box, because they may be carrying it together).

Formally, the lexical distributivity of particular predicates is encoded as a set of constraints (i.e. axioms or meaning postulates) on appropriate models, in the following way:

$$\begin{aligned}
 (32) \quad & \text{a. } \forall x. (dog(x) \rightarrow \forall x'. (x' \leq x \wedge \mathbf{atom}(x') \rightarrow dog(x'))) \\
 & \text{b. } \forall x. \forall e. (bark(e) \wedge \mathbf{Ag}(x, e) \rightarrow \forall x'. (x' \leq x \wedge \mathbf{atom}(x') \rightarrow \exists e'. (e' \leq \\
 & \quad e \wedge bark(e') \wedge \mathbf{Ag}(x', e')))) \\
 & \text{c. } \forall x. \forall y. \forall e. (carry(e) \wedge \mathbf{Ag}(x, e) \wedge \mathbf{Th}(y, e) \rightarrow \forall y'. (y' \leq y \wedge \mathbf{atom}(y') \rightarrow \\
 & \quad \exists x'. \exists e'. (x' \leq x \wedge e' \leq e \wedge carry(e') \wedge \mathbf{Ag}(x', e') \wedge \mathbf{Th}(y', e'))))
 \end{aligned}$$

3.2.11 Compositionality

Non-terminal syntactic constituents are translated with the help of a set of rules, which define the translation of the mother node based on the translations of its daughter nodes:

Non-Branching Nodes (NN)

If $A \rightsquigarrow \alpha$ and A is the only daughter of B , then $B \rightsquigarrow \alpha$.

Functional Application (FA)

If $A \rightsquigarrow \alpha$ and $B \rightsquigarrow \beta$ and A and B are the only daughters of C , then $C \rightsquigarrow \alpha(\beta)$, provided that this is a well-formed term.

Generalised Sequencing (GSeq) (Sequencing + Predicate Modification)

If $A \rightsquigarrow \alpha$, $B \rightsquigarrow \beta$, A and B are the only daughters of C in that order, and α and β are of the same type τ of the form \mathbf{t} or $(\sigma\mathbf{t})$ for some type σ , then $C \rightsquigarrow \alpha; \beta$ if $\tau = \mathbf{t}$ or $C \rightsquigarrow \lambda v_\sigma. \alpha(v); \beta(v)$ if $\tau = (\sigma\mathbf{t})$, provided that this is a well-formed term.

The definition of one other rule, *Quantifying-In* (or *Predicate Abstraction*), is crucially tied to the technical implementation of indexing and the movement operation in syntax, an issue to which I turn in the next section.

3.2.12 Indexing, Traces, and *Quantifying-In*

I will follow Muskens (1996) in assuming that the syntactic component provides indexation for all proper names, determiners, pronouns, and traces. However, following Brasoveanu (2007, 2008) and unlike Muskens (1996), I will take drefs to serve as indices directly:

- (33) a. John^{*u*} saw a^{*u'*} rabbit. It_{*u'*} was eating.
 b. Every^{*u*} boy saw himself_{*u*} in a^{*u'*} mirror.

Proper names and determiners introduce new discourse referents which may serve as antecedents, and their indices are written as superscripts, while the drefs associated with pronouns and traces are written as subscripts.

Dislocated (moved) DPs are assigned additional indices by the movement rule(s), and leave behind co-indexed traces. Traces and corresponding dislocated DPs are different from other index-bearing elements in that their, and only their, indices are *variables* of the dref type (*se*), rather than constants:

- (34) John^{*u*} found a^{*u'*} letter which^{*v*} Mary^{*u''*} had lost t_{*v*}.

Traces are translated as a functions of type $\mathbf{et}(\mathbf{t})$, which correspond to the quantifier-lift of the drefs that serve as their indices:

- (35) $t_v \rightsquigarrow \lambda P_{\mathbf{et}}. P(v)$

We are now in the position to formulate the Quantifying-In translation rule:

- (36) *Quantifying-In (QIn) (Predicate Abstraction)*

If $DP^v \rightsquigarrow \alpha$, $B \rightsquigarrow \beta$ and DP^v and B are daughters of C , then $C \rightsquigarrow \alpha(\lambda v.\beta)$, provided that this is a well-formed term.

This rule provides the translation for structures like (37):

$$(37) \quad \begin{array}{c} C \rightsquigarrow \alpha(\lambda v.\beta) \\ \diagdown \quad \diagup \\ DP^v \rightsquigarrow \alpha \quad B \rightsquigarrow \beta \end{array}$$

3.2.13 Event Closure

Binding of the event dref variable introduced by the verb is performed by a designated \exists_{ev} operator with the following translation:

$$(38) \quad \exists_{ev}^\varepsilon \rightsquigarrow \lambda V_{\mathbf{vt.}} [\varepsilon]; V(\varepsilon)$$

The event closure operator introduces a new event dref, ε in (38), and applies the verbal predicate to this event dref. I will assume that this operator is inserted at some level above the vP, after the verb has combined with all its arguments, but I will remain agnostic about its exact position with respect to other functional heads.

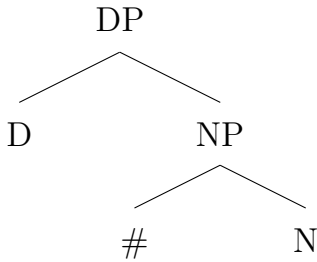
As a notational convention, I will indicate the event dref introduced by the null event closure operator in a sentence as a superscript on the verb, e.g.:

$$(39) \quad A^u \text{ chose}^\varepsilon \text{ a}^{u'} \text{ film.}$$

This concludes the general exposition of the formal framework, PCDRT*, that I will use to formulate my analysis. In the following sections I lay out an account of the semantics of grammatical number features, numerals, determiners, and distributivity operators, which together forms the core of my proposal.

3.3 Number

I will take grammatical number to be interpreted at the position where it is spelled-out phonologically, i.e. adjacent to the noun:

(40) *N-Number*

The #-head has two variants in English: #:sg and #:pl, with the following translations:

- (41) a. #:sg $\rightsquigarrow \lambda v_e. [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]$
 b. $\mathbf{atom}\{u\} := \lambda I_{st}. \forall i \in I. \mathbf{atom}(ui)$
 c. $\mathbf{unique}\{u\} := \lambda I_{st}. \forall i, i' \in I. ui = ui'$
 d. #:pl $\rightsquigarrow \lambda v_e. \lambda I_{st}. \lambda J_{st}. I = J$

The singular number feature imposes two conditions on its argument dref: it requires it to be distributively atomic (i.e. the value that the dref returns for each assignment in a plural info state must be atomic), and unique. Uniqueness is satisfied if the dref returns the same value for all the assignments in a plural info state. Together, distributive atomicity and uniqueness amount to a global, state-level atomicity requirement.⁶

Plural number, on the other hand, is semantically vacuous.⁷

⁶Note that this definition of **atom** differs from that in Brasoveanu 2008, where it is treated it as a state-level predicate. However, the combination of **atom** and **unique** conditions in the current system produces the same effect as the state-level **atom** condition in Brasoveanu 2008. This way of splitting the global atomicity condition into two components will prove useful, e.g. in the analysis of numerical DPs and intervention effects, cf. section 5.2, and Partee's Generalisation, cf. section 5.4.

⁷Here, number features are translated as predicates of type **et**, which means that they will combine with their sister nouns via Generalised Sequencing (or Predicate Modification). This will allow for a straightforward account of pronouns as morphological variants of anaphoric definite determiners (of type **(et)((et)t**) without positing a null noun in the structure of pronominal DPs, see below. Alternatively, one could adopt a translation for number features as expressions of type **(et)(et)**, allowing them to combine with the sister noun via Functional application:

- (42) a. #:sg $\rightsquigarrow \lambda P_{et}. \lambda v_e. [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]; P(v)$
 b. #:pl $\rightsquigarrow \lambda P_{et}. \lambda v_e. P(v)$

In this case the analysis of pronouns would have to be somewhat more complicated. We would either have to lift the type of the pronoun to take an expression of type **(et)(et)** (the translation of

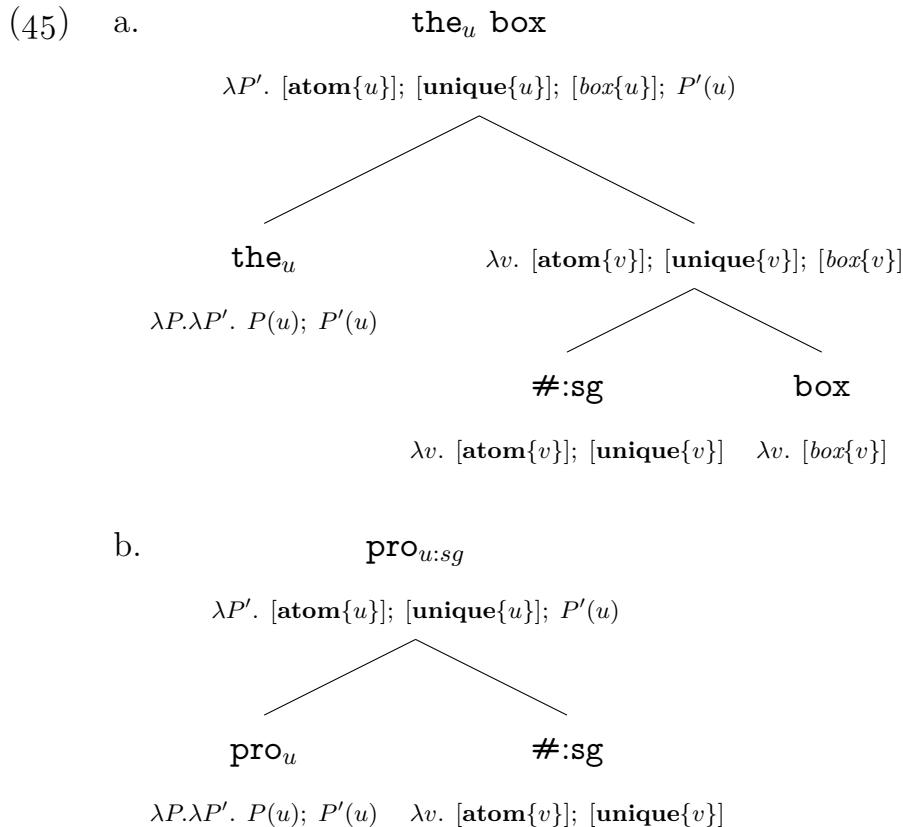
3.4 Anaphoric Definite DPs and Pronouns

I will take pronouns to be morphological variants of the anaphoric definite article which occur in the absence of nominal complements (cf. e.g. Postal 1966):

(43) *Anaphoric Definite Article / Pronoun*

(44) $\mathbf{the}_u/\mathbf{pro}_u \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}. P(u); P'(u)$

Examples (45a) and (45b) illustrate the compositional translation of an anaphoric definite DP and a pronoun, respectively:



This brief exposition is sufficient for our current purposes. A more detailed discussion of various issues related to the interpretation of pronouns can be found in section 3.12. The translation of the non-anaphoric definite article and issues of maximality will be discussed in section 3.10.1.

the number feature) as argument, posit a phonologically null noun as complement of the number node, or make use of type-shifting.

I have chosen what seems to me to be the simplest option.

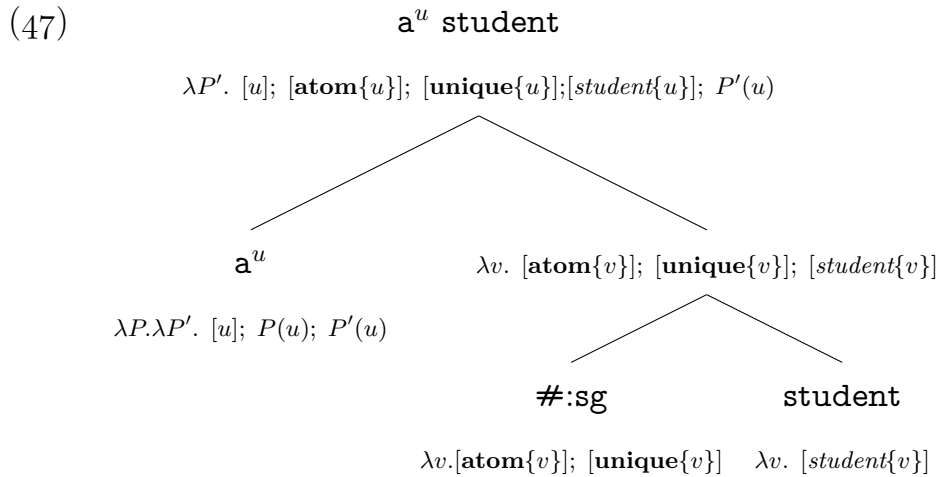
3.5 Indefinite DPs

3.5.1 Indefinite Determiners

I will analyse the indefinite article as having the following translation:

$$(46) \quad \mathbf{a}^u \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. [u]; P(u); P'(u)$$

The sole function of the indefinite article is to introduce a new dref. In English, its distribution is restricted by a syntactic selectional requirement, which allows it to combine only with phrases headed by $\#$:sg, e.g.:



To account for plural indefinite DPs, I will assume the existence of a null version of the indefinite article with the same interpretation as in (46):

$$(48) \quad \mathbf{Indef}^u \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. [u]; P(u); P'(u)$$

\mathbf{Indef}^u syntactically combines with phrases headed by $\#$:pl and NPs with numerals and cardinal modifiers, to which I turn in the next section.

3.5.2 Numerals and Cardinal Modifiers

I will assume that numerals and cardinal modifiers like *several* are translated as expressions of type **et** which impose cardinality conditions on the values of a dref. Importantly, these conditions are applied distributively, in the same way as standard lexical predicates. This means that in this case the cardinality requirement

is applied distributively at the domain level, not globally, as in the case of the singular number feature:

$$(49) \quad \text{a. two} \rightsquigarrow \lambda v_e. [\mathbf{2_atoms}\{v\}]$$

$$\text{b. } \mathbf{2_atoms}\{u\} := \lambda I_{st}. \forall i \in I. \mathbf{2_atoms}(ui),$$

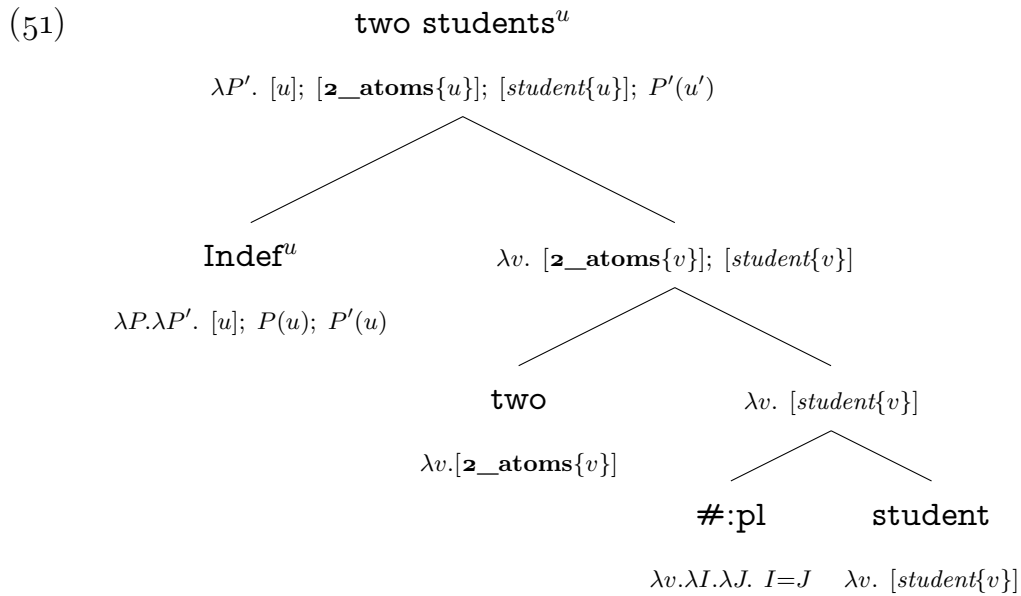
$$\text{where } \mathbf{2_atoms}(x_e) := |\{y_e : y \leq x \wedge \mathbf{atom}(y)\}| = 2.$$

$$(50) \quad \text{a. several} \rightsquigarrow \lambda v_e. [\mathbf{several_atoms}\{v\}]$$

$$\text{b. } \mathbf{several_atoms}\{u\} := \lambda I_{st}. \forall i \in I. \mathbf{several_atoms}(ui),$$

$$\text{where } \mathbf{several_atoms}(x_e) := |\{y_e : y \leq x \wedge \mathbf{atom}(y)\}| > 1.$$

The structure of indefinite DPs with numerals and cardinal modifiers involves a null Indef head, cf. (48) above:



3.6 The Multiplicity Implicature

3.6.1 Ivlieva's (2013) System of Implicature Calculation

I will follow Spector (2007), Zweig (2008, 2009) and Ivlieva (2013) and derive the multiplicity semantics associated with the plural number feature as a *scalar implicature* which arises in competition with a semantically more restrictive singular number feature. On this account, in order to derive the multiplicity implicature

for a plural DP in structure α we must show that the corresponding structure β , where the plural DP has been replaced with its singular counterpart, has a *stronger* interpretation than α . Then, the interpretation of α can be strengthened (or *enriched*) via the negation of the stronger alternative.

More formally, I will adopt (an adapted version of) Ivlieva's (2013) system of calculating scalar implicatures since in certain cases it delivers superior results as compared to Zweig's (2008, 2009) approach. The details of this system, and its advantages, were discussed in section 2.4. For convenience, I will repeat its main tenets here:

a) The comparison and negation of alternatives is encoded as the semantics of a covert exhaustivity operator *Exh*, which can be inserted at various levels in the syntactic structure. Ivlieva (2013) defines two versions of the *Exh* operator:

$$(52) \quad \text{a. } \llbracket Exh_{ALT} \rrbracket = \lambda P_t. P \wedge \forall Q : Q \in ALT \wedge Q \models P \neg Q$$

$$\text{b. } \llbracket Exh_{ALT} \rrbracket = \lambda P_{\langle et \rangle}. \lambda e. P(e) \wedge \forall Q : Q \in ALT \wedge Q \subseteq P \neg Q(e)$$

where ALT is the set of alternatives to P .

According to these definitions, the *Exh* operator can apply either at the sentence or the predicate level. In both cases, its function is to assert the truth of its complement and to negate all of its stronger alternatives.

b) The insertion of the *Exh* operator is restricted by the following principle, which is a simplified version of a constraint proposed by Fox and Spector (2009):

$$(53) \quad Exh \text{ is not allowed to weaken the overall meaning of a sentence (a sentence with } Exh \text{ cannot be entailed by a sentence without } Exh).$$

This principle is invoked to account for the fact that the *Exh* operator cannot be inserted in the scope of downward entailing operators in sentences like (54a). If *Exh* could be inserted below negation in this sentence, we would expect it to have an interpretation as in (54b):

- (54) a. It is not true that dogs are barking.
 b. ‘It is not true that more than one dog is barking.’
 c. ‘It is not true that one or more dogs are barking.’

In fact, (54b) is not a possible interpretation for (54a). The absence of this interpretation is explained in the following way: inserting the *Exh* operator below negation results in a reading that is weaker than the reading of the sentence without the *Exh* operator, given in (54c), hence insertion at this site is blocked by the principle in (53).

c) The following principle is assumed to hold:

- (55) Implicature calculation is blind to information pertaining to common knowledge, and specifically to the fact that certain predicates are lexically distributive.

To see why this principle is necessary, take sentence (56a) with the interpretation in (56b). Suppose that the *Exh* operator is inserted at the root level, i.e. after event closure has applied. The alternative to (56b) is represented in (56c). We have seen that (56b) and (56c) are equivalent due to the distributive nature of the predicate *bark*. However, since *Exh* does not take into account lexical distributivity, the alternative in (56c) is taken to be stronger than (56b), and is negated. The resulting enriched meaning is given in (56d):

- (56) a. Dogs are barking.
 b. $\exists e.\exists x.[*DOG(x) \wedge *BARK(e) \wedge *AG(e)(x)]$
 c. $\exists e.\exists x.[*DOG(x) \wedge \mathbf{atom}(x) \wedge *BARK(e) \wedge *AG(e)(x)]$
 d. $\exists e.\exists x.[*DOG(x) \wedge *BARK(e) \wedge *AG(e)(x)] \wedge \neg\exists e.\exists x.[*DOG(x) \wedge \mathbf{atom}(x) \wedge *BARK(e) \wedge *AG(e)(x)]$

Since the meaning in (56d) contradicts contextual knowledge it is ruled out as a possible interpretation for (56a).

More formally, taking into account the lexical distributivity of a predicate when comparing alternatives amounts to excluding the models where the distributive condition for that predicate is not satisfied from the set of appropriate models relevant for the calculation of strength. If we disregard lexical distributivity, we conversely include such models in the set of appropriate models for strength comparison (see section 3.6.3 for a formalisation of this notion of strength).

d) Finally, Ivlieva (2013) assumes that the implicature associated with the plural feature is *obligatory*. This is captured by the following constraint on the scalar item *plural*:

- (57) Plural must be c-commanded by the exhaustification operator, whose restrictor contains the alternative obtained by replacing plural with the singular.

$$[Exh_{\{SING\}}[\dots -PLUR \dots]]$$

3.6.2 Multiplicity and Definite Plurals

There is a complication with Ivlieva's (2013) system that will be relevant to us. Consider the following example:

- (58) The dogs are barking.

Let us for the moment assume the standard Linkian analysis of definite DPs via the σ -operator, with the following definition from Landman (2000):⁸

- (59) σ -operator

If P is a predicate, σP is interpreted as the sum of all the entities in P if that sum is itself an entity in P , otherwise it is undefined.

Then, the interpretation of (58) in the absence of exhaustification should be the following:

⁸This is consistent with Ivlieva's (2013) use of the σ -operator for the interpretation of definite DPs.

$$(60) \quad \exists e. [*BARK(e) \wedge *AG(e)(\sigma\lambda x.*DOG(x))]$$

There are two possible insertion sites for the *Exh*-operator: below and above event closure. Suppose we insert it below event closure. Then, we need to compare the strength of (61a) with that of the alternative in (61b), derived by substituting the plural noun *dogs* for the singular *dog*. Again, following the classical analysis, I assume that the singular feature imposes an atomicity requirement on the individuals that the predicate applies to:

$$(61) \quad \text{a. } \lambda e. [*BARK(e) \wedge *AG(e)(\sigma\lambda x.*DOG(x))]$$

$$\text{b. } \lambda e. [*BARK(e) \wedge *AG(e)(\sigma\lambda x. [*DOG(x) \wedge \mathbf{atom}(x)])]$$

And here we run into problems. It turns out, that under Ivlieva's (2013) assumptions on implicature calculation, neither of these predicates is stronger than the other. It is clear that (61a) is not stronger than (61b): take a model M which respects the lexical distributivity of the predicates $*BARK$ and $*DOG$. Suppose further, that there are two dogs in M , and they both barked. Then the set of events characterised by (61b) will be empty, while that characterised by (61a) will contain the event of the two dogs barking.

But recall that the principle in (55) requires us to check strength against all possible models, not only those that respect the distributivity of lexical predicates. Take, then, a more exotic model M' which contains two atomic individuals x and y , such that x and $x \oplus y$ belong to the set of dogs in M' , but y alone does not. Now, suppose there is a single barking event e in M' , whose agent is x . Then, the set of events characterised by the predicate in (61b) will include e , since it is the case that x is the unique atomic individual that qualifies as a dog and x barked. On the other hand, the set of events characterised by (61a) will be empty, since it is not the case that the maximum sum of dogs ($x \oplus y$) barked. Consequently, we are forced to conclude that (61b) is not stronger than (61a). Since the singular alternative is not stronger, it is not negated, and we incorrectly predict the number-neutral interpretation in (60) to be possible for sentence (58).

The same problem occurs if we apply the *Exh*-operator above event closure, directly to (60).

The root of the problem lies of course in the principle (55), which requires us, in the process of calculating strength, to consider models like M' above, which do not respect the lexical distributivity of predicates. We can see from the above example that this principle is in conflict with Link's (1983) unified analysis of the definite article.

There are several possible ways to solve this problem. Since the development of a general system of implicature calculation is not the central theme of this thesis, I will simply reject the principle in (55), and assume that only those models that respect the lexical distributivity of predicates qualify as appropriate for the task of strength comparison. To rule out undesired readings in cases like (56), I will substitute the principle in (55) with the following restriction on the insertion of *Exh*:

(62) *Locality of Exh-Insertion*

The *Exh*-operator must occur in the most local (in terms of c-command) configuration with respect to the plural, where its insertion is consistent with the principle in (53).

This principle requires for the *Exh*-operator to be inserted as locally as possible with respect to the plural, as long as its insertion does not lead to a weakening of the overall meaning. This, then, blocks the insertion of the *Exh*-operator above event closure in examples like (56).

Note, that I do not take the principle in (62) to be generally applied to all cases of scalar implicature calculation. Indeed, there are cases where exhaustification at a higher, non-local level is preferred (cf. Chierchia et al. 2012, and the discussion in Ivlieva 2013). Rather, I would like to suggest that something like the Locality Principle applies to elements associated with *obligatory* scalar implicatures, plural being one such element (cf. Ivlieva 2013 for an argument that the implicature associated with plurals must be distinguished from instances of non-obligatory

scalar implicatures).

3.6.3 The Multiplicity Implicature in PCDRT*

To incorporate (the modified version of) Ivlieva's (2013) system of implicature calculation into PCDRT* we must modify the definition of the *Exh* operator to apply to terms of the relevant types, e.g. the types of DRSs. Moreover, we will want *Exh* to apply at different levels of structure, and to terms of different semantic types. To achieve this, I will define a family of **Exh** operators in PCDRT* in the following way:

(63) *Generalised Exhaustification*

For any conjoinable type α , such that $\alpha = (\tau_1, (\tau_2(\dots \tau_n \mathbf{t}) \dots))$,

$$\mathbf{Exh}_{\text{ALT} \langle \alpha, \alpha \rangle} := \lambda Q_\alpha. \lambda k_{\tau_1}^1. \lambda k_{\tau_2}^2 \dots \lambda k_{\tau_n}^n. \lambda I_{st}. \lambda J_{st}. Q(k^1) \dots (k^n) IJ \wedge \forall Q'_\alpha. (Q' \in \text{ALT} \wedge Q' \succ Q \rightarrow \neg Q'(k^1) \dots (k^n) IJ),$$

where ALT is the set of alternatives to Q , and $Q' \succ Q$ means that Q' is stronger than Q .

For instance, if **Exh** combines with a DRS of type \mathbf{t} , the result is a DRS of the following form:

$$(64) \quad \mathbf{Exh}_{\text{ALT} \mathbf{tt}}(D_{\mathbf{t}}) := \lambda I_{st}. \lambda J_{st}. DIJ \wedge \forall D'_{\mathbf{t}}. (D' \in \text{ALT} \wedge D' \succ D \rightarrow \neg D' IJ)$$

The syntactic *Exh* operator is translated as one of the **Exh** operators as defined in (63).

Two comments are in order. First, the definition in (63) makes reference to *conjoinable types*. The definition of conjoinable types is modelled on that in Partee and Rooth 1983:

(65) *Conjoinable Type*

(i) \mathbf{t} (i.e. $st((st)t)$) is a conjoinable type

(ii) if σ is a conjoinable type, then for all types $\tau \in \mathbf{DRefTyp}$, $(\tau\sigma)$ is a conjoinable type.

Note, that this definition imposes an additional restriction, requiring for τ to be a *dref type*, see (12) for the relevant definition.

Second, the definition of strength \succ must be made explicit and sufficiently general to be applicable to terms of all conjoinable types. To simplify the exposition, I will first introduce an auxiliary relation of *dref-equivalence* between info states:

$$(66) \quad J =_U J' := J \neq \emptyset \wedge J' \neq \emptyset \wedge \forall j \in J. \exists j' \in J'. \forall u \in U. (uj = uj') \\ \wedge \forall j' \in J'. \exists j \in J. \forall u \in U. (uj = uj'),$$

where U is a set of drefs.

The $=_U$ relation is true of two info states J and J' if for each assignment j in J there is a corresponding assignment j' in J' , such that each dref in U returns the same value for j and j' , and vice versa. If U is empty, $=_U$ holds for any pair of non-empty info states.

Now we can give a formal definition of the relative strength of two expressions:

(67) *Generalised Strength*

For any conjoinable type α , such that $\alpha = (\tau_1, (\tau_2(\dots \tau_n \mathbf{t}) \dots))$,

$Q'_\alpha \succ Q_\alpha$ iff:

a) For any appropriate model M and assignment function g , and any a_1 of type τ_1 , \dots , a_n of type τ_n , and I_{st} :

if there exists a J'_{st} such that $\llbracket Q'(a_1) \dots (a_n) IJ' \rrbracket^{M,g} = 1$, then there exists a J_{st} , such that $J =_{\{a_1, \dots, a_n\}} J'$ and $\llbracket Q(a_1) \dots (a_n) IJ \rrbracket^{M,g} = 1$.

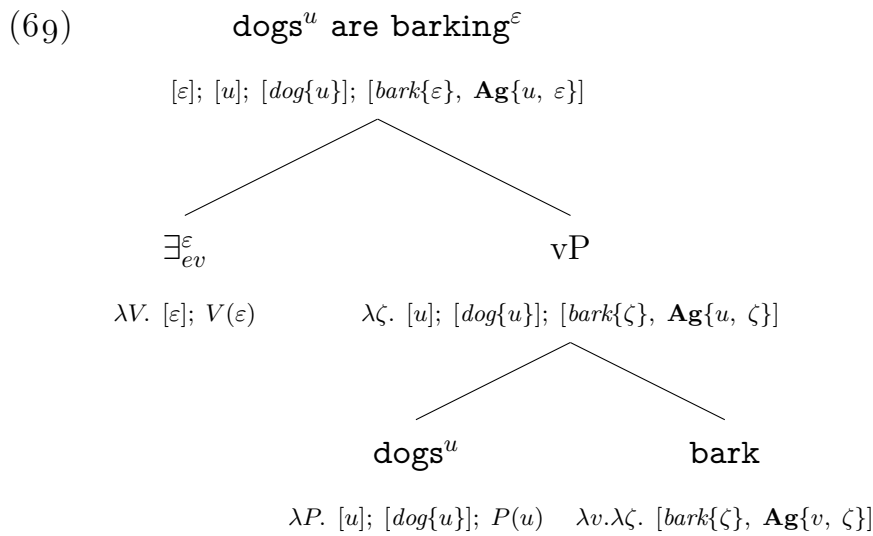
b) There is an appropriate model M , assignment function g , a_1 of type τ_1 , \dots , a_n of type τ_n , I_{st} and J_{st} , such that $\llbracket Q(a_1) \dots (a_n) IJ \rrbracket^{M,g} = 1$ and there does not exist a J'_{st} , such that $J =_{\{a_1, \dots, a_n\}} J'$ and $\llbracket Q'(a_1) \dots (a_n) IJ' \rrbracket^{M,g} = 1$.

As a limiting case, for two DRSs D and D' , $D' \succ D$ will be true if for any appropriate model and input info state, if there is an output info state that satisfies D' then there is an output info state that satisfies D , while the converse does not hold.

3.6.4 Calculating the Multiplicitiy Implicature in Simple Sentences

As means of illustration, consider again the following simple example from Zweig 2009, with its compositional translation in (69) (disregarding exhaustification for the moment):

(68) Dogs are barking.



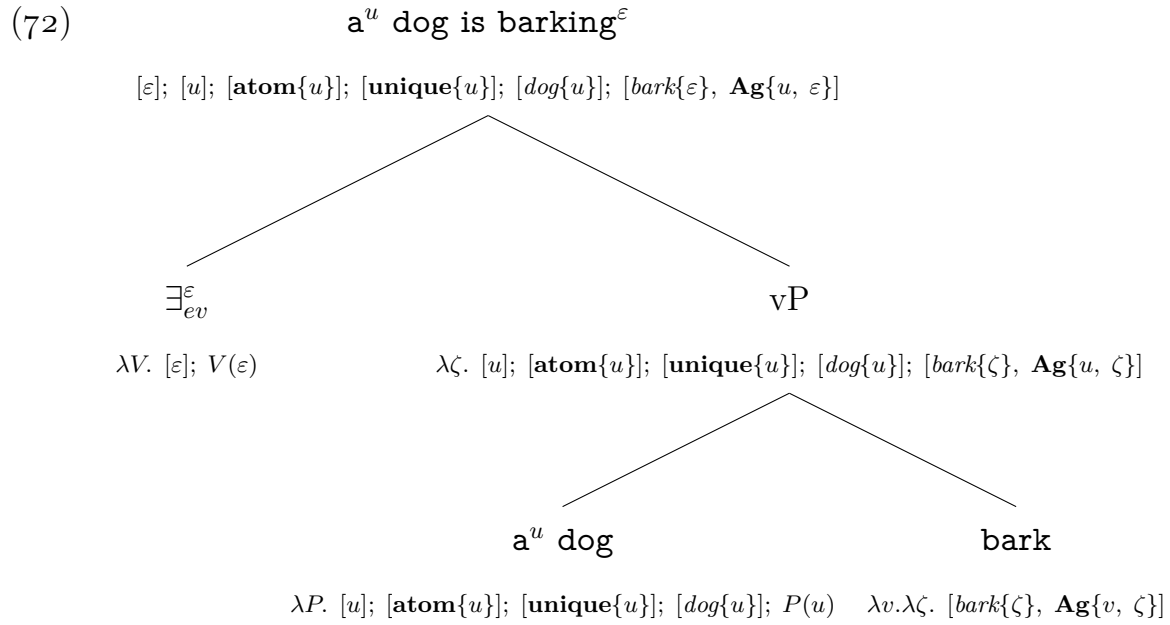
By assumption the plural feature on the subject must occur in the scope of an exhaustification operator whose set of alternatives contains the translation of the structure with the plural noun phrase replaced with its singular counterpart. There are two potential sites for the insertion of the $\text{Exh}_{\{\text{SG}\}}$ operator in (69): below and above event closure. The Locality Principle in (62) states that it must be inserted as locally as possible with respect to the plural feature, as long as its insertion does not lead to the weakening of the overall meaning. Thus, let us first consider the possibility of inserting $\text{Exh}_{\{\text{SG}\}}$ below event closure, which is the more local of the two available options.

In this case the $\text{Exh}_{\{\text{SG}\}}$ combines directly with the vP, which is translated as an expression of type (\mathbf{vt}) . Hence it will be translated as $\mathbf{Exh}_{\text{SG}}(\mathbf{vt})(\mathbf{vt})$, which is defined as follows, following (63):

$$(70) \quad \mathbf{Exh}_{\{\text{SG}\}(\text{vt})(\text{vt})}(V_{\text{vt}}) := \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. V(\zeta)IJ \wedge \forall V'_{\text{vt}}. (V' \in \{\text{SG}\} \wedge V' \succ V \rightarrow \neg V'(\zeta)IJ)$$

This operator takes a predicate of event drefs, and returns a predicate of event drefs combined with the negation of the singular alternative in case that alternative is stronger than the original predicate. The singular alternative to sentence (68) is sentence (71), with the translation in (72):

(71) A dog is barking.



To calculate the result of applying the $\mathbf{Exh}_{\{\text{SG}\}(\text{vt})(\text{vt})}$ operator in (70) to the the vP translation in (69), we must determine whether the alternative vP translation in (72) is stronger. I repeat the two vP translations here for convenience:

$$(73) \quad \begin{array}{l} \text{a. } \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. [u]; [dog\{u\}]; [bark\{\zeta\}, \mathbf{Ag}\{u, \zeta\}] \\ \text{b. } \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. [u]; [\mathbf{atom}\{u\}]; [\mathbf{unique}\{u\}]; [dog\{u\}]; [bark\{\zeta\}, \mathbf{Ag}\{u, \zeta\}] \end{array}$$

The translation in (73b) is indeed stronger than that in (73a). Representing (73a) as Q and (73b) as Q' , consider the first condition in (67). Take a model M , assignment function g , event dref ε , and info states I and J , such that the interpretation of (73b) applied to ε , I and J is true in M . This means that there

is an event of one dog barking in M . Since (73b) differs from (73a) only in that it imposes additional restrictions on the values of u , it follows that the interpretation of (73a) applied to ε , I and J is also true in M , i.e. that there is an event of one or more dogs barking in M . The condition $J =_{\{\varepsilon\}} J$ is trivially satisfied (this condition ensures that we are considering the same event in both cases), thus we can conclude that the first condition in (67) is met.

Now consider the second condition in (67). Take a model M , assignment function g , event dref ε , and info states I and J , such that the interpretation of (73a) applied to ε , I and J is true in M , and ε returns the same barking event involving a non-atomic sum of dogs as agent for every assignment in J . Then, there is no J' such that ε returns the same barking event for every assignment in J' , and the interpretation of (73b) applied to ε , I and J' is true in M . This is so because by assumption the event returned by ε involves non-atomic agents, while the conditions in (73b) require the agent to be atomic.

Since (73b) is stronger than (73a), the application of $\mathbf{Exh}_{\{\text{sg}\}(\text{vt})(\text{vt})}$ to (73a) involves negation of the stronger alternative:

$$\begin{aligned}
(74) \quad & \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \text{dog}\{u\}J \wedge \text{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J \wedge \\
& \neg(I[u]J \wedge \mathbf{atom}\{u\}J \wedge \mathbf{unique}\{u\}J \wedge \text{dog}\{u\}J \wedge \text{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J) \\
& := \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \text{dog}\{u\}J \wedge \text{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J \\
& \wedge (\neg\mathbf{atom}\{u\}J \vee \neg\mathbf{unique}\{u\}J)
\end{aligned}$$

This strengthened vP translation then combines with the event closure operator, yielding the following DRS for sentence (68):

$$\begin{aligned}
(75) \quad & \lambda I_{st}.\lambda J_{st}. I[\varepsilon, u]J \wedge \text{dog}\{u\}J \wedge \text{bark}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \\
& \wedge (\neg\mathbf{atom}\{u\}J \vee \neg\mathbf{unique}\{u\}J)
\end{aligned}$$

According to the definition of truth in section 3.2.6, the DRS in (75) will be true with respect to a singleton input info state I iff:

$$\begin{aligned}
(76) \quad & \exists J_{st}. I[\varepsilon, u]J \wedge \text{dog}\{u\}J \wedge \text{bark}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \\
& \wedge (\neg\mathbf{atom}\{u\}J \vee \neg\mathbf{unique}\{u\}J)
\end{aligned}$$

Given that I is singleton and \square is defined as in (19), J must also be singleton, which means that the uniqueness condition on u is trivially satisfied. Consequently, u must be non-atomic with respect to J . I.e. (76) will be true iff there is a barking event whose agent is a non-atomic sum of dogs. This adequately capture the meaning of (68).

This example demonstrates how the definition of strength in (67) allows us to recapture Zweig's (2008, 2009) event-based account of the multiplicity implicature in a dynamic framework.

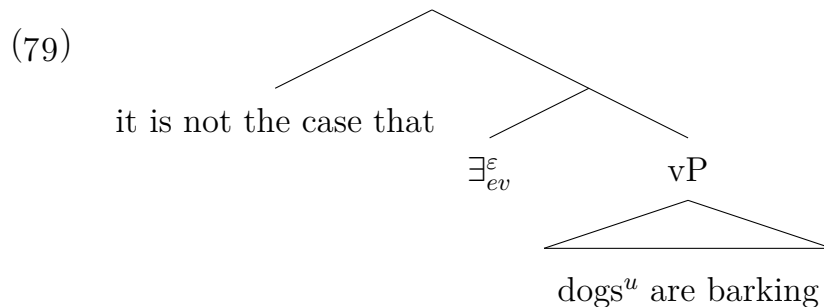
Let us now consider the calculation of the multiplicity implicature in downward entailing contexts, specifically under negation:

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

For convenience, I will assume that the whole segment *it is not the case that* is translated as DRS-negation in PCDRT, which is treated in the same way as in Brasoveanu 2007, 2008:

- (78) a. **it is not the case that** $\rightsquigarrow \lambda D_t. [\sim D]$
 b. $\sim D := \lambda I_{st}. I \neq \emptyset \wedge \forall H_{st}. (H \neq \emptyset \wedge H \subseteq I \rightarrow \neg \exists K_{st}(DHK))$

Since negation takes a DRS as argument, it must be attached above event closure:



Let us first calculate the translation of (77) in the absence of exhaustification. To do this we must apply negation, as defined in (78), to the DRS already calculated in (69). We arrive at the following DRS:

$$(80) \quad [\sim ([\varepsilon]; [u]; [dog\{u\}]; [bark\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])] := \\ \lambda I_{st}.\lambda J_{st}. I = J \wedge J \neq \emptyset \wedge \forall H_{st}(H \neq \emptyset \wedge H \subseteq J \rightarrow \neg \exists K_{st}(H[\varepsilon, u]K \wedge \\ dog\{u\}K \wedge bark\{\varepsilon\}K \wedge \mathbf{Ag}\{u, \varepsilon\}K))$$

This DRS will be true with respect to a singleton input info state $I = \{i\}$ if there is no output info state $K = \{i\}$, such that $I[\varepsilon, u]K$, uk is a (possibly atomic) sum of dogs, εk is a barking event, and uk is the agent of εk . This amounts to the condition there be no events of one or more dogs barking.

Let us now consider how exhaustification applies in sentences like (77). There are three potential site for the insertion of the *Exh* operator in (79): above the vP but below event closure, directly above the event closure operator, and at the root above negation. I will start with the first option.

We have already calculated the non-negated DRS that arises if the exhaustification operator is applied to the vP, cf. (75). Combining it with negation, we obtain the following DRS:

$$(81) \quad \lambda I_{st}.\lambda J_{st}. I = J \wedge J \neq \emptyset \wedge \forall H_{st}(H \neq \emptyset \wedge H \subseteq J \rightarrow \neg \exists K_{st}(H[\varepsilon, u]K \wedge \\ dog\{u\}K \wedge bark\{\varepsilon\}K \wedge \mathbf{Ag}\{u, \varepsilon\}K \wedge (\neg \mathbf{atom}\{u\}K \vee \neg \mathbf{unique}\{u\}K)))$$

This DRS will be true in a model M if there are no barking events involving more than one dog as agent in M . This DRS is weaker than that in (80), obtained in the absence of exhaustification: for any model M , if an input/output info state I satisfies (80), it will also satisfy (81). The converse is, however, not the case. Take a model M that includes a single barking event, and that event has an atomic dog as its agent. Then (81) will be true for any non-empty input/output info state I , since there are no barking events in M that have non-atomic sums of dogs as agents. On the other hand, (80) will be false for any non-empty input/output info state I , since there is a barking event in M involving a sum of dogs (an atomic sum, in this case) as its agent.

Now recall that, by assumption, insertion of the *Exh* operator in a certain position is blocked if it leads to the weakening of the overall meaning. We have

seen that this is exactly what happens if we insert *Exh* directly above the vP in (79). It follows, that *Exh* cannot be inserted in this position.

Out of the two remaining sites for *Exh*-insertion in (79), the most local one with respect to the plural is directly above event closure, below negation. Let us consider this option. In this case, exhaustification is applied to the DRS calculated in (69), repeated in (82a). Its alternative is the DRS calculated in (72), repeated in (82b).

- (82) a. $[\varepsilon]; [u]; [dog\{u\}]; [bark\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]$
 b. $[\varepsilon]; [u]; [\mathbf{atom}\{u\}]; [\mathbf{unique}\{u\}]; [dog\{u\}]; [bark\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]$

Now we have to determine whether the alternative in (82b) is stronger than (82a). Since these DRSs differ only in that (82b) imposes additional atomicity and uniqueness conditions on u , for any appropriate model M and any input info state I , if there is an output info state J that satisfies (82b), then there is necessarily also an output info state J' that satisfies (82a), e.g. J itself will also satisfy (82a) (in more familiar terms, if there is a barking event in M whose agent is an atomic sum of dogs, then there is a barking event in M whose agent is a sum of dogs). However, the converse is also true: for any appropriate model M and any input info state I , if there is an output info state J that satisfies (82a), there is necessarily also an output info state J' that satisfies (82b). This holds because we are only considering models that respect the lexical distributivity of predicates. Since *bark* is lexically distributive, it follows that if a model M includes a barking event whose agent is a non-atomic sum of dogs, it must necessarily also include the sub-events of that event whose agents are atomic dogs. It follows that neither of the DRSs in (82) is stronger than the other.

Since the singular alternative is not stronger, combining the DRS in (82a) with the exhaustification operator does not lead to strengthening, and results in a DRS that is equivalent to (82a). This DRS is then combined with negation, yielding (80) as the final exhaustified DRS for sentence (77).

Note that inserting the exhaustification operator directly above event closure

does not lead to *weakening* of the overall meaning, and is thus legitimate. Since this is the most local site where *Exh* can be inserted without violating the non-weakening restriction, it follows from the Locality Principle in (62) that it must be chosen. Hence, our theory derives (80) as the translation of sentence (77), which correctly captures its truth conditions.⁹

To conclude, in this section I presented a system for deriving the multiplicity implicature for plural DPs in PCDRT*. The system is based on Ivlieva's (2013) proposal, with two modifications. First, I have argued that Ivlieva's (2013) system runs into problems when it is applied to sentences involving plural definite DPs, if we assume Link's (1983) analysis of definites. I have proposed to solve this problem by restricting the set of models invoked for the calculation of relative strength to those that respect the distributivity of lexical predicates, and by adopting a locality restriction on the insertion of the exhaustification operator. Second, I have formalised the notions of exhaustification and relative strength in a way that is compatible with the dynamic semantic framework adopted here. Finally, I have demonstrated that the proposed system generates correct interpretations for simple sentences involving bare plurals in upward entailing and downward entailing contexts.

3.7 Weak and Strong Distributivity

In this section I introduce the distinction between weak and strong distributivity. This distinction will play a crucial role in our analysis of the properties of dependent plurals. Somewhat informally, weak distributivity involves distribution of individuals in a sum across the assignments in a single info state, while strong distributivity involves distribution across info states. We will start by defining a weak and a strong distributivity operator in PCDRT*, and then use these to provide the translations of syntactic distributivity operators. Finally, to account for

⁹Inserting the *Exh*-operator above negation also yields (80) as the overall translation. However, this option is blocked by the Locality Principle in the current system.

distributive interpretations of moved DPs, I will introduce the rule of *Distributive Quantifying-In*. In the next chapter, I will also show how the contrasting properties of singular and plural quantificational determiners can be captured in terms of weak and strong distributivity.

Although conceptually, the distinction between weak and strong distributivity in the above sense is very natural in semantic frameworks that involve plural info states, its application to the analysis of different types of distributivity operators and quantificational determiners in natural language is, to my knowledge, new.

3.7.1 Weak and Strong Distributivity Operators

Before I provide the definitions of the distributivity operators themselves, I will define an auxiliary relation between info states:

$$(83) \quad \langle u \rangle := \lambda I_{st} . \lambda J_{st} . \exists f . (I = \mathbf{Dom}(f) \wedge J = \cup \mathbf{Ran}(f) \wedge \forall i_s . \forall H_{st} . (f(i) = H \rightarrow \forall h_s \in H . (i[u]h \wedge \mathbf{atom}(uh)) \wedge \oplus uH = ui)),$$

where f is a partial function from the domain of assignments \mathcal{D}_s to the set of info states $\wp(\mathcal{D}_s)$.

I will write $I \langle u \rangle J$ to mean that $\langle u \rangle$ applies to I and J . In a sense, what $\langle u \rangle$ does is ‘split’ each assignment in the input info state into multiple assignments, where the values for u are the atomic sub-parts of its value for the original assignment. For instance, suppose an input info state I contains two assignments i_1 and i_2 , such that ui_1 returns the sum individual $john \oplus mary$ and ui_2 returns the sum individual $jane \oplus bob$. Then an info state J such that $I \langle u \rangle J$ will contain four assignments, j_1, j_2, j_3, j_4 , where: a) j_1 and j_2 are identical to i_1 , except that uj_1 is $john$ and uj_2 is $mary$; b) j_3 and j_4 are identical to i_2 , except that uj_3 is $jane$ and uj_4 is bob :

(84)

Info state I	...	u	...
i_1	...	$john \oplus mary$	...
i_2	...	$jane \oplus bob$	...

↓

Info state J , such that $I\langle u \rangle J$	...	u	...
j_1 (such that $j_1[u]i_1$)	...	$john$	...
j_2 (such that $j_2[u]i_1$)	...	$mary$	...
j_3 (such that $j_3[u]i_2$)	...	$jane$	...
j_4 (such that $j_4[u]i_2$)	...	bob	...

The definitions of the distributivity operators are then the following:

$$(85) \quad \begin{aligned} \text{a. } \mathbf{dist}_w(D)(u) &:= \lambda I_{st}. \exists J_{st}. (\langle u \rangle; D)IJ \\ &:= \lambda I_{st}. \exists J_{st}. \exists H_{st}. I\langle u \rangle H \wedge DHJ \\ \text{b. } \mathbf{dist}_s(D)(u) &:= \lambda I_{st}. \exists J_{st}. (\langle u \rangle; \mathbf{dist}(D))IJ \\ &:= \lambda I_{st}. \exists J_{st}. \exists H_{st}. I\langle u \rangle H \wedge \mathbf{dist}(D)HJ \end{aligned}$$

The definition of the **dist** operator used in (85b) is the same as in Brasoveanu 2008:

$$(86) \quad \mathbf{dist}(D) := \lambda I_{st}. \lambda J_{st}. \exists R_{s((st)t)} \neq \emptyset (I = \mathbf{Dom}(R) \wedge J = \bigcup \mathbf{Ran}(R) \wedge \forall k_s \forall L_{st} (RkL \rightarrow D\{k\}L)),$$

where D is a DRS, $\mathbf{Dom}(R) := \{k_s : \exists L_{st}(RkL)\}$, $\mathbf{Ran}(R) := \{L_{st} : \exists k_s(RkL)\}$, and $\{k\}$ is the singleton set of assignments (of type st) containing only k .

The weak distributivity operator combines with a dref, a DRS, and an input info state, e.g. I , and states that there exists a pair of info states H and J , such that $I\langle u \rangle H$, and D applies to H and J . The strong distributivity operator is similar, except that it splits H into a set of singleton info state, and applies D separately to each of these info states. Thus, for the info state I in (87), $\mathbf{dist}_s(D)(u)I$ will be true if D is true with respect to each of the four singleton info states H_1, H_2, H_3, H_4 :

(87)

Info state I	...	u	...
i_1	...	$john \oplus mary$	...
i_2	...	$jane \oplus bob$	...

↓

Info state H_1	...	u	...
h_1 (such that $h_1[u]i_1$)	...	$john$	...

Info state H_2	...	u	...
h_2 (such that $h_2[u]i_1$)	...	$mary$	...

Info state H_3	...	u	...
h_3 (such that $h_3[u]i_2$)	...	$jane$	...

Info state H_4	...	u	...
h_4 (such that $h_4[u]i_2$)	...	bob	...

An important property of distributivity operators is that if they are ‘stacked’, the following equivalences hold:

$$(88) \quad \text{a. } \mathbf{dist}_w([\mathbf{dist}_w(D)(u)])(u) := \mathbf{dist}_w(D)(u)$$

$$\text{b. } \mathbf{dist}_s([\mathbf{dist}_s(D)(u)])(u) := \mathbf{dist}_s(D)(u)$$

$$\text{c. } \mathbf{dist}_w([\mathbf{dist}_s(D)(u)])(u) := \mathbf{dist}_s(D)(u)$$

$$\text{d. } \mathbf{dist}_s([\mathbf{dist}_w(D)(u)])(u) := \mathbf{dist}_s(D)(u)$$

3.7.2 Syntactic Distributivity Operators

Following Link (1987) and Roberts (1990), I will assume that predicates can combine with distributivity operators, which modify the way the predicate is applied to its argument (cf. also Landman 1989, 2000, Schwarzschild 1996, Lasnik 1998, Kratzer 2007, a.o.). Furthermore, I will assume that distributivity operators exist as syntactic objects which can be attached to any constituent along the verbal spine.

I will posit two types of such operators: weak and strong. I will take the floating quantifier *all* to be an instantiation of the weak distributivity operator, and the floating quantifier *each* to be an instantiation of the strong distributivity operator. Furthermore, I will assume that both of these operators have phonologically null counterparts, represented as δ_w and δ_s respectively.

The two types of distributivity operators receive the following translations:

(89) *Distributivity operators*

- a. δ_w , *all* $\rightsquigarrow \lambda P_{\text{et}}.\lambda v_{\text{e}}. [\mathbf{dist}_w(P(v))(v)]$
 $:= \lambda P_{\text{et}}.\lambda v_{\text{e}}.\lambda I_{\text{st}}.\lambda J_{\text{st}}. I = J \wedge \exists H_{\text{st}}.[J\langle v \rangle H \wedge \exists H'_{\text{st}}.(P(v))HH']$
- b. δ_s , *each* $\rightsquigarrow \lambda P_{\text{et}}.\lambda v_{\text{e}}. [\mathbf{dist}_s(P(v))(v)]$
 $:= \lambda P_{\text{et}}.\lambda v_{\text{e}}.\lambda I_{\text{st}}.\lambda J_{\text{st}}. I = J \wedge \exists H_{\text{st}}.[J\langle v \rangle H \wedge \exists H'_{\text{st}}.(\mathbf{dist}(P(v)))HH']$

Both distributivity operators are defined as tests which take a one-place predicate as argument, and return another one-place predicate. The weak distributivity operator δ_w / *all* checks for a predicate P , dref u and an input/output state J that there exists a pair of info states H and H' , such that $J\langle u \rangle H$ and the DRS $P(u)$ applies to H and H' .

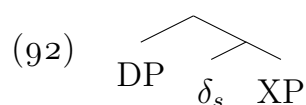
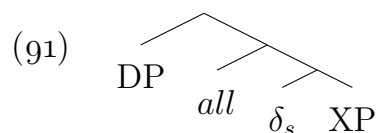
The strong distributivity operator δ_s / *each* is different from δ_w / *all* in that it checks the truth of $P(u)$ with respect to H *distributively*, i.e. separately with respect to (the singleton set consisting of) each individual assignment in H .

Floating *both* is also analysed as a weak distributivity operator, with the added condition that the distributed dref return a sum of two atomic individuals for every assignment in the input info state:¹⁰

- (90) *both* $\rightsquigarrow \lambda P_{\text{et}}.\lambda v_{\text{e}}. [\mathbf{2_atom}\{v\}]; [\mathbf{dist}_w(P(v))(v)]$
 $:= \lambda P_{\text{et}}.\lambda v_{\text{e}}.\lambda I_{\text{st}}.\lambda J_{\text{st}}. I = J \wedge \mathbf{2_atom}\{v\}J \wedge \exists H_{\text{st}}.[J\langle v \rangle H \wedge \exists H'_{\text{st}}.(P(v))HH']$

¹⁰In a system that implements the distinction between assertive and presuppositional content, this condition would be part of the presupposition.

Now, given the equivalences in (88), it follows that if in a syntactic structure a strong distributivity operator δ_s is stacked on top of a weak distributivity operator δ_w / *all*, or the other way round, the translation of that structure will be equivalent to that involving a single strong distributivity operator. For instance, the translation of (91) will be equivalent to that of (92):



I will assume that such stacking accounts for strong distributive readings of structures involving overt weak distributivity operators.¹¹

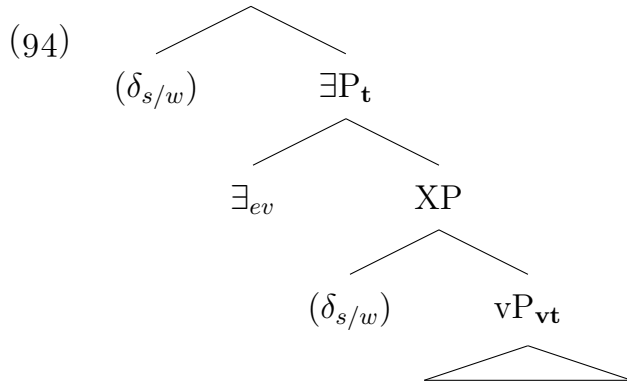
3.7.3 *Distributive Quantifying-In*

As things stand at the moment, the system predicts that distributivity operators can only combine with predicates of individual drefs, i.e. with expressions of type **et**. However, given that verbs are predicated over event drefs in the current system, there is no way of directly combining distributivity operators with verbal projections below event closure. Similarly, inserting distributivity operators above event closure, when all the verb's argument positions have already been filled, results in a type mismatch:

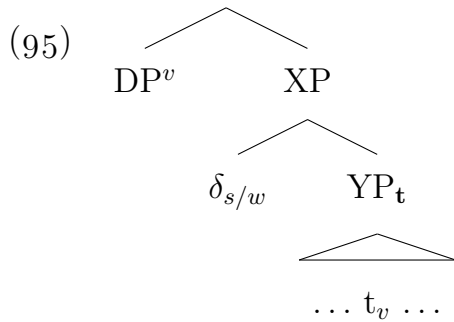
¹¹Syntactic constraints should restrict the availability of stacking, ruling out sentences like (93), which involve two overt distributivity operators:

(93) *Three students all each carried a box.

I leave this issue for future investigation.



To solve this problem, I will introduce a new rule of translation that targets structures like (95), where a distributivity operator is inserted below a DP that has undergone syntactic movement:



Then distributive interpretations can be captured by assuming that the distributed DP quantifier-raises from its base position within the vP to a position above event closure. As the system stands at the moment, structures like (95) are problematic, due to the way the *Quantifying-In* rule was defined above in section 3.2.12. For convenience, I repeat the definition here:

(96) *Quantifying-In (QIn) (Predicate Abstraction)*

If $DP^v \rightsquigarrow \alpha$, $B \rightsquigarrow \beta$ and DP^v and B are daughters of C , then $C \rightsquigarrow \alpha(\lambda v.\beta)$, provided that this is a well-formed term.

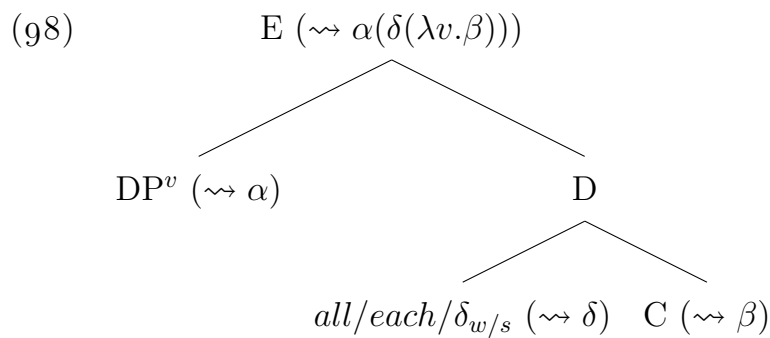
In order to get a distributive interpretation for the DP^v in (95) we need the sister constituent of the distributivity operator, i.e. YP , to be translated as a predicate, specifically a predicate of v . The *Quantifying-In* rule, however, translates the sister constituent of the DP^v itself, i.e. XP , as a predicate of v , which renders structures like (95) essentially uninterpretable.

To solve this problem, I will adopt the following rule of translation, referred to as *Distributive Quantifying-In*:

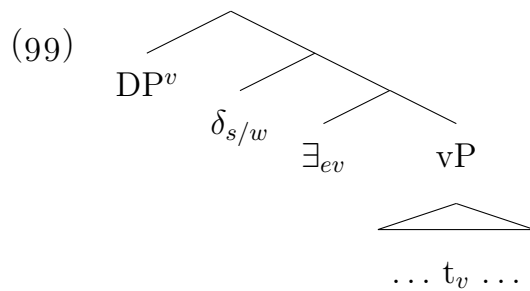
(97) *Distributive Quantifying-In (DistrQIn)*

If $DP^v \rightsquigarrow \alpha$, B is a distributivity operator (i.e. $B \in \{all, each, \delta_w, \delta_s\}$), $B \rightsquigarrow \delta$, $C \rightsquigarrow \beta$, B and C are daughters of D, and DP^v and D are daughters of E, then $E \rightsquigarrow \alpha(\delta(\lambda v.\beta))$, provided that this is a well-formed term.

This rule targets structures like (98), and defines the translation of E as $\alpha(\delta(\lambda v.\beta))$:



In the following sections we will see how the *Distributive Quantifying-In* rule as defined above delivers the desired distributive interpretation for structures like (99):

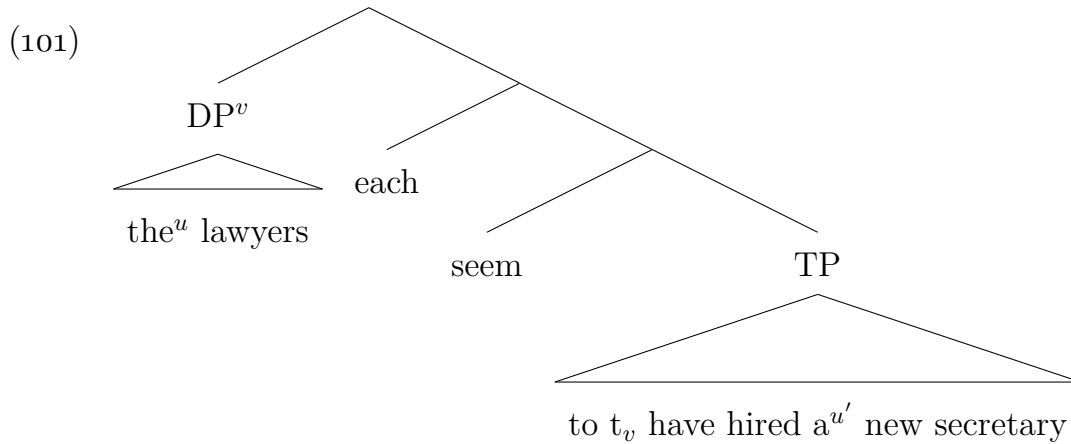


There is more direct evidence that distributivity operators can be inserted below DPs that have undergone syntactic movement, and thus that a rule like (97) is necessary. Consider example (100), where the subject must be interpreted distributively:

(100) The lawyers each seem to have hired a new secretary.

Given the standardly assumed analysis of *seem* as a raising verb taking a sentential, i.e. TP, complement (going back to Rosenbaum 1967, Chomsky 1973, Postal

1974), the derivation of (100) must involve movement of the subject DP from within the non-finite complement clause into the subject position of *seem*. Thus, abstracting away from irrelevant details, the structure of (100) is the following:



Given our analysis of floating *each* as the overt version of the strong distributivity operator, this structure is an instantiation of the schema in (95), and will be interpreted via the *Distributive Quantifying-In* rule.¹²

3.8 Singular Indefinites under Distributivity Operators

In this section, I will illustrate the functioning of the proposed system by presenting the compositional translation of the simple sentence in (102), which involves a singular indefinite direct object:

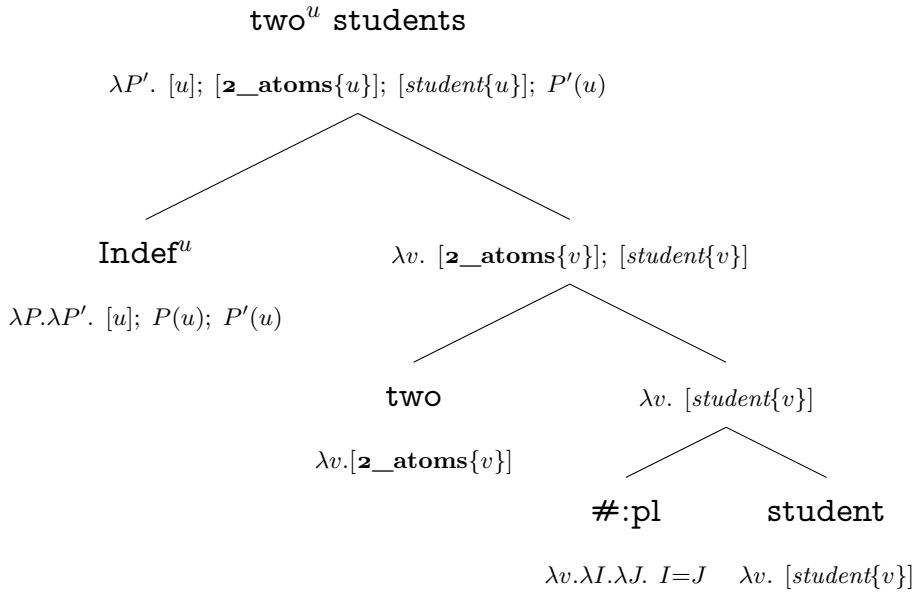
(102) Two^u students carried a^{u'} box.

First, let us derive the translations of the two DPs involved in this sentence. Recall, that by assumption the syntactic component marks each determiner with the name of the dref that the DP introduces or refers back to:¹³

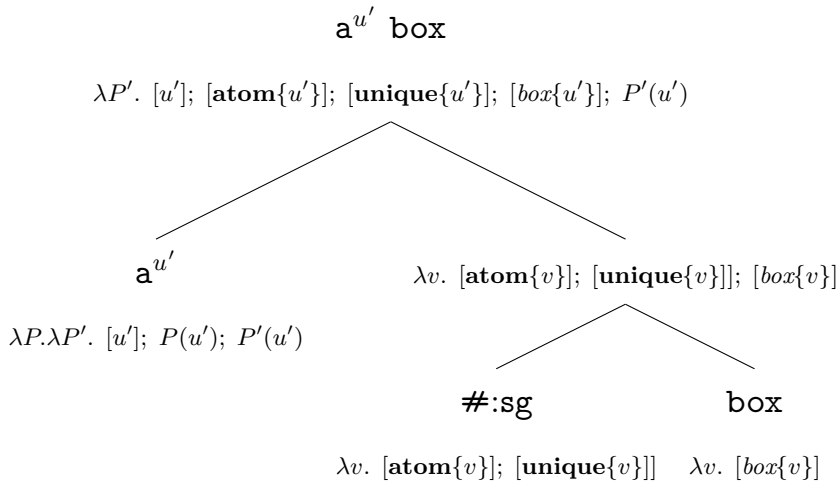
¹²In fact, even simpler distributive sentences like *The lawyers each have hired a new secretary* conform to the schema in (95) under the standard assumption that the subject raises from a vP-internal position to the specifier of the auxiliary (cf. Sportiche 1988, Koopman and Sportiche 1991, and much subsequent work).

¹³Since I assume that the actual indefinite determiner marked with a dref is null in the case of numerical DPs such as *two students*, I shift the dref superscript to the numeral in the examples, as in (102). Similarly, in the case of bare plural DPs I place the dref superscript on the noun.

(103)



(104)

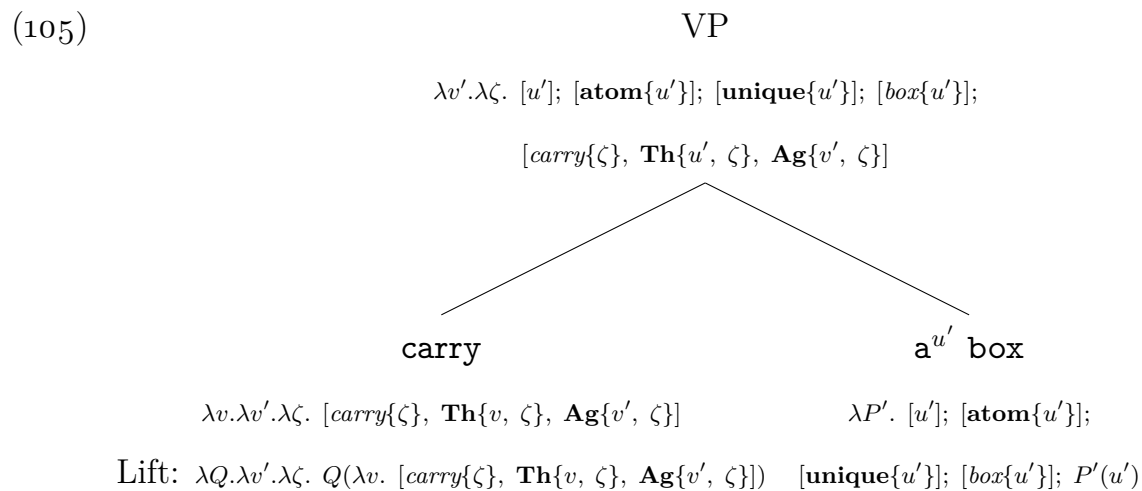


The DP *two students* introduces a dref, which for each assignment in the output info state returns a sum of students consisting of two atomic sub-parts. The DP *a box* introduces a dref which returns an atomic box for each assignment in the output info state, and moreover returns the same box for all the assignments.

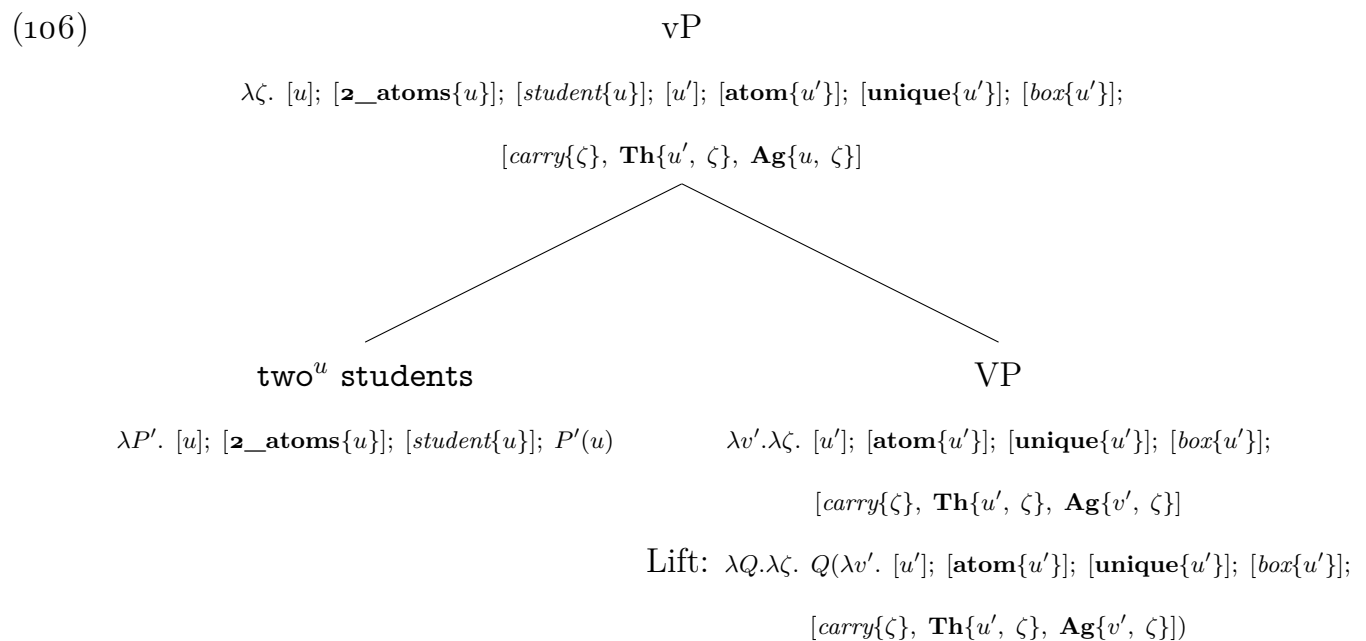
Let us now examine how these DPs combine with the verb, resulting in a DRS. First, note that since we assume the existence of freely inserted and phonologically null distributivity operators, and the availability of covert quantifier-raising of DPs, the sentence in (102) in fact corresponds to several different underlying structures in the current system. As means of illustration, I will consider the translation of three of them: one that involves no distributivity operators and no quantifier raising, one involving a weak distributivity operator inserted in the position below

the quantifier-raised subject, and one involving a strong distributivity operator inserted in that position. I will disregard additional structures that result, e.g., from covert raising of the object DP, but it should be clear that the same translation mechanisms apply to them as well.

Consider, first, the compositional translation of (102) if no distributivity operators are involved. In order to combine with the object DP, the verb translation must be type-shifted via the Transitive Lift rule (cf. 30):



The resulting translation is then again type-shifted via the Intransitive Lift rule, to combine with the subject:



Finally, event closure applies yielding the following DRS:

$$\begin{array}{c}
(107) \quad \text{two}^u \text{ students carried}^\varepsilon \text{ a}^{u'} \text{ box} \\
[\varepsilon]; [u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [box\{u'\}]; \\
[carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}] \\
\begin{array}{ccc}
& \diagdown & \diagup \\
\exists_{ev}^\varepsilon & & \forall P \\
\lambda V. [\varepsilon]; V(\varepsilon) \quad \lambda \zeta. [u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [box\{u'\}]; \\
& [carry\{\zeta\}, \mathbf{Th}\{u', \zeta\}, \mathbf{Ag}\{u, \zeta\}]
\end{array}
\end{array}$$

The final DRS in (107) can be represented in an ‘unpacked’ form in the following way:

$$(108) \quad \lambda I_{st}. \lambda J_{st}. I[\varepsilon, u, u']J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \mathbf{atom}\{u'\}J \wedge \mathbf{unique}\{u'\}J \wedge box\{u'\}J \wedge carry\{\varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J$$

Following the definition of truth given in section 3.2.6, this DRS will be true with respect to a singleton input info state I if there exists an output info state J such that the following conditions hold:

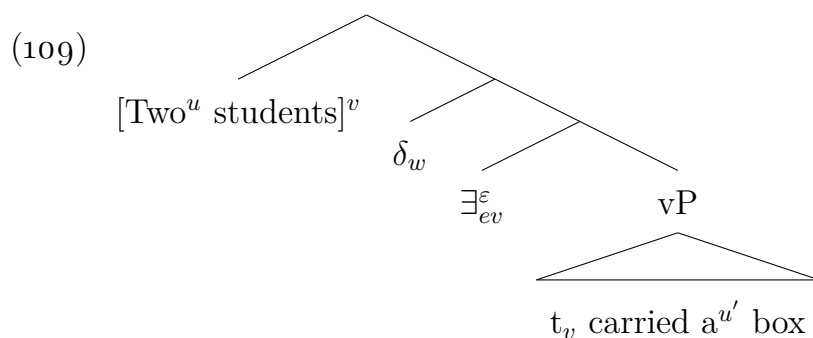
- a) $I[\varepsilon, u, u']J$, i.e. J is $\{\varepsilon, u, u'\}$ -different from I . Given the definition of $[]$ in (19), this entails that J must be singleton, and the assignment j in J differs from the assignment i in I at most with respect to the values for ε , u and u' .
- b) The value of u for j , i.e. uj , is a sum of students of cardinality two.
- c) The value of u' for j , i.e. $u'j$, is a sum of boxes of cardinality one (the uniqueness condition is trivially satisfied, since there is only one assignment in J).
- d) The value of ε for j , i.e. εj , is a carrying event.
- e) The sum of students uj is the agent of event εj , and the box $u'j$ is the theme of event εj .

These conditions will hold if there are two students, s_1 and s_2 , a box, b , and a carrying event e , such that $s_1 \oplus s_2$ is the agent of e , and b is the theme of e . This is compatible with a situation where two students carry a box together. Furthermore, assuming that *carry* is lexically cumulative, these conditions will also hold if there

are two students who separately carried the same box (cf. section 3.2.9 for a discussion of lexical cumulativity).

3.8.1 Singular Indefinites under the Weak Distributivity Operator

Now suppose that the subject is quantifier-raised out of the vP to a position above event closure, and a weak distributivity operator is inserted below its final position:



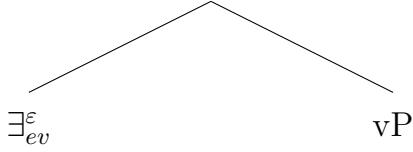
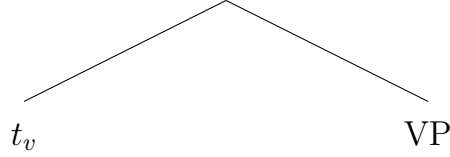
This structure corresponds to (110) with an overt weak distributivity operator:¹⁴

(110) Two^u students both carried a^{u'} box.

The compositional translation of the vP combined with the event closure operator is the following:¹⁵

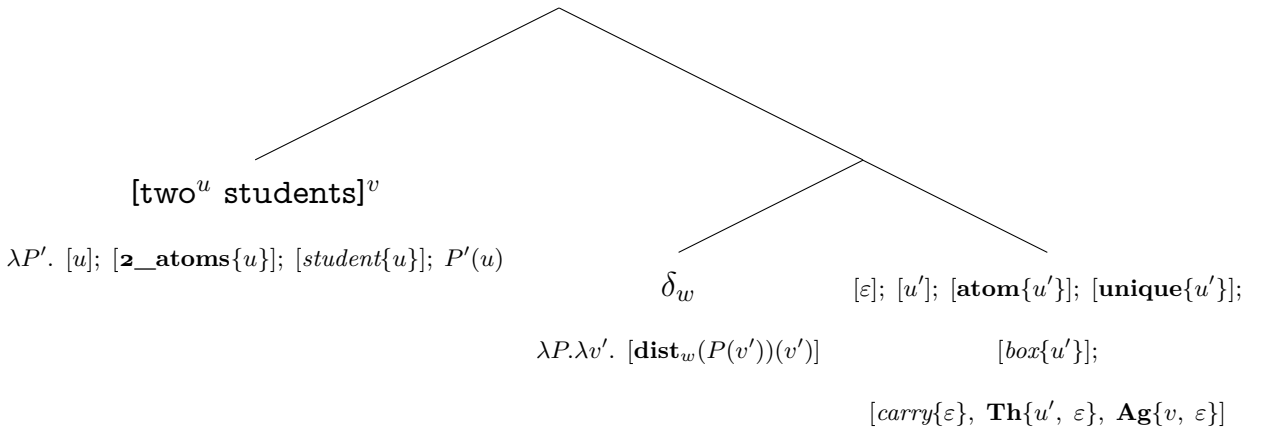
¹⁴The sentence *Two students both carried a box* can also have a strong distributive interpretation, which can be accounted for by assuming that a null strong distributivity operator is stacked with the overt weak distributivity operator. As pointed out in section 3.7.2, the combination of weak and strong distributivity operators results in a strong distributive interpretation.

¹⁵In this tree and the following, I give lifted translations of VPs and vPs when necessary, and omit their original translations.

(111) $[\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\mathbf{box}\{u'\}];$ $[\mathbf{carry}\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}]$  $\lambda V. [\varepsilon]; V(\varepsilon) \quad \lambda \zeta. [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\mathbf{box}\{u'\}];$ $[\mathbf{carry}\{\zeta\}, \mathbf{Th}\{u', \zeta\}, \mathbf{Ag}\{v, \zeta\}]$  $\lambda P'. P'(v) \quad \lambda Q. \lambda \zeta. Q(\lambda v'. [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\mathbf{box}\{u'\}];$ $[\mathbf{carry}\{\zeta\}, \mathbf{Th}\{u', \zeta\}, \mathbf{Ag}\{v', \zeta\}])$

This is then combined with the distributivity operator and the raised subject. The resulting structure is translated via the Distributive Quantifying-In rule in (97) to yield the following DRS:

(112)

 $\text{two}^u \text{ students } \delta_w \text{ carried}^\varepsilon \text{ a}^{u'} \text{ box}$ $[u]; [\mathbf{2_atoms}\{u\}]; [\mathbf{student}\{u\}];$ $[\mathbf{dist}_w([\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\mathbf{box}\{u'\}]; [\mathbf{carry}\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])(u)]$ 

Given the definition of \mathbf{dist}_w in (85a) above, the final DRS in (112) can be unpacked in the following way:

$$(113) \quad \lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}])IJ \wedge \exists H. (J\langle u \rangle H \wedge \exists H'. ([\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])HH')$$

Let us consider the truth conditions of this DRS in detail. It will be true with respect to a singleton input info state I iff there exists an info state J such that the following conditions are met:

- a) J is singleton, and the assignment j in J differs from the assignment i in I at most with respect to the value for u .
- b) The value of u for j , i.e. uj , is a sum of students of cardinality two.

(114)

Info state J , such that $I[u]J$	...	u	...
j	...	$s_1 \oplus s_2$, such that $student(s_1 \oplus s_2)$	...

- c) There exists an info state H , such that $J\langle u \rangle H$, i.e. each assignment h in H is u -different from the assignment j in J , and: 1) the value of u for each assignment in H is an atomic sub-part of the value of u for the assignment j , and 2) for each atomic sub-part of the value of u for the assignment j , H contains an assignment for which u returns this atomic sub-part. Since the value of u for j is a sum-individual with two atomic sub-parts, H must contain two assignments:

(115)

Info state H , such that $J\langle u \rangle H$	...	u	...
h_1 (such that $h_1[u]j$)	...	s_1	...
h_2 (such that $h_2[u]j$)	...	s_2	...

- d) There exists an info state H' , which differs from H at most with respect to the values for ε and u' , such that u' returns the same atomic individual for every assignment in H' , and for every assignment h' in H' , $u'h'$ is a box, $\varepsilon h'$ is a carrying event, uh' is the agent of $\varepsilon h'$, and $u'h'$ is the theme of $\varepsilon h'$. Again, given the

adopted definition of \square , H' must contain two assignments, and the values of u for the assignments in H' must be the same as those for H :

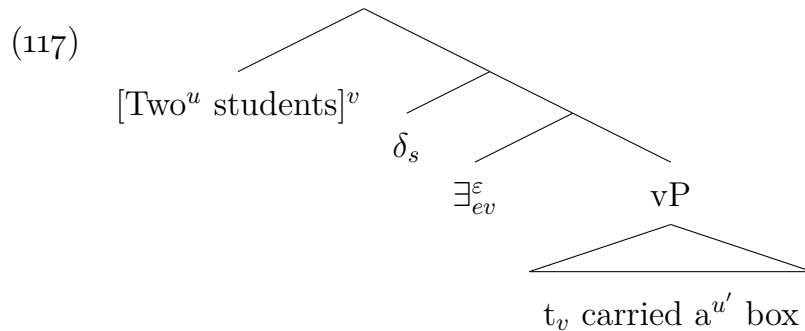
(116)

Info state H' , s.t. $H[u']H'$	...	u	ε	u'	...
h'_1 (such that $h'_1[u']h_1$)	...	s_1	e_1	b	...
h'_2 (such that $h'_2[u']h_2$)	...	s_2	e_2	b	...

These conditions can be paraphrased as follows: there exist two students, s_1 and s_2 , one box, b , and two carrying events, e_1 and e_2 , such that s_1 is the agent of e_1 , s_2 is the agent of e_2 , and b is the theme of both e_1 and e_2 . Now, given the Role Uniqueness condition in (29), it follows that e_1 and e_2 must be distinct events, i.e. in this case, the students must have performed the carrying separately.

3.8.2 Singular Indefinites under the Strong Distributivity Operator

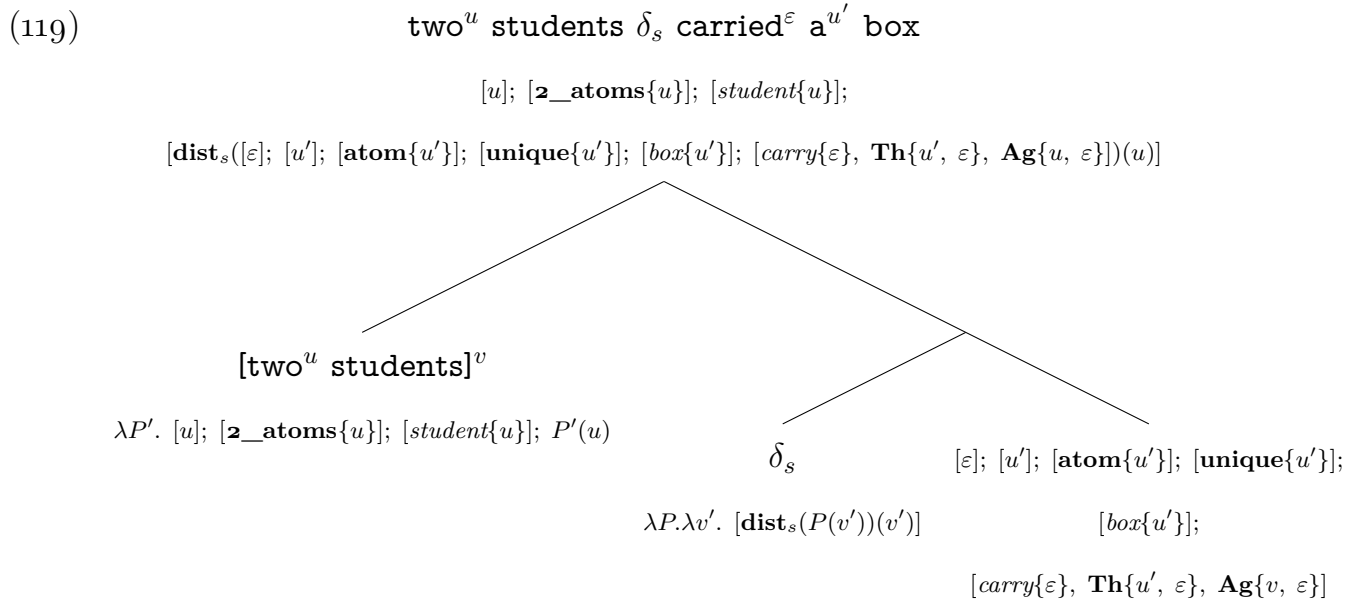
Finally, consider the translation of (117), which involves a strong distributivity operator inserted below the raised subject:



This structure corresponds to (118), with an overt strong distributivity operator:

(118) Two^u students *each* carried a^{u'} box.

We have already calculated the translation of the vP combined with the event closure operator, see (111). This structure is then combined with the strong distributivity operator and the subject DP via the Distributive Quantifying-In rule:



Again, we can unpack the DRS in (119) in the following, substituting the \mathbf{dist}_s operator for its definition in (85b):

(120) $\lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}])IJ \wedge \exists H. (J\langle u \rangle H \wedge \exists H'. (\mathbf{dist}([\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]))HH')$

This DRS is very similar to that in (113) above, except for the presence of the \mathbf{dist} operator. Consequently, the first three conditions for the truth of (120) are the same as for (113), I repeat them here for clarity.

The DRS in (120) will be true with respect to a singleton info state I iff:

- a) There exists an info state J which is singleton, and the assignment j in J differs from the assignment i in I at most with respect to the value for u .
- b) The value of u for j , i.e. uj , is a sum of students of cardinality two.

(121)

Info state J , such that $I[u]J$	...	u	...
j	...	$s_1 \oplus s_2$, such that $student(s_1 \oplus s_2)$	...

- c) There exists an info state H , such that such that $J\langle u \rangle H$:

(122)

Info state H , such that $J\langle u \rangle H$	...	u	...
h_1 (such that $h_1[u]j$)	...	s_1	...
h_2 (such that $h_2[u]j$)	...	s_2	...

d) The final condition is different from the one we had for the DRS in (113) in the previous section. Given the definition of the **dist** operator in (86) above, (120) states that there exists an info state H' , such that every assignment h in H corresponds to a subset H'' of H' , where $\{h\}[\varepsilon, u']H''$, u' returns the same atomic individual for all the assignments in H'' , and for every assignment h'' in H'' : $u'h''$ is a box, $\varepsilon h''$ is a carrying event, uh'' is the agent of $\varepsilon h''$, and $u'h''$ is the theme of $\varepsilon h''$. Given that the relation \sqsubseteq does not allow for the expansion of info states, it follows that each such H'' is singleton. Moreover, since H contains two assignments that differ in the value for u , there must be two such singleton sub-set info states in H' :

(123)

Info state H''_1	...	u	ε	u'	...
h''_1	...	s_1	e_1	b_1	...
Info state H''_2	...	u	ε	u'	...
h''_2	...	s_2	e_1	b_2	...

So in effect, the info state H in (115) is in this case split into multiple singleton info states, and the conditions encoded in the vP are applied separately to each of these info states. Crucially, the uniqueness condition for u' is evaluated separately for H''_1 and H''_2 , and is trivially satisfied, since each of these info states contains a single assignment. Consequently, the values of u' for the assignments in these info states can be different, i.e. the two students could have carried different (atomic) boxes.

Given these truth conditions, the interpretation we obtain for (117) can be paraphrased as follows: there are two distinct students s_1 and s_2 , two carrying

events e_1 and e_2 , and two possibly distinct boxes b_1 and b_2 , such that s_1 is the agent of e_1 and b_1 is the theme of e_1 , and s_2 is the agent of e_2 and b_2 is the theme of e_2 .

To conclude, singular indefinites in the scope of weak distributivity operators introduce a global uniqueness condition on the values of the dref they introduce. However, under strong distributivity operators this condition is effectively neutralised.

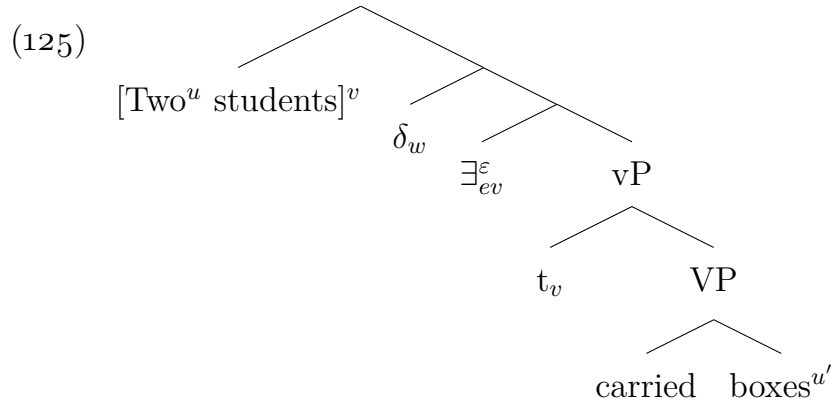
3.9 Plural Indefinites under Distributivity Operators

3.9.1 Bare Plurals under the Weak Distributivity Operator: Dependent Plurality

Let us now consider the translation of simple sentences involving two plural DPs. As an example take (124), which is identical to sentence (102) except for the fact that the singular indefinite DP in the object position has been replaced by a bare plural:

(124) Two^u students carried boxes^u.

Again, this sentence has several underlying structures, depending on which distributivity operator, if any, is inserted, and which DP, if any, undergoes quantifier-raising. Inserting no distributivity operator results in a collective or cumulative interpretation. Leaving this reading aside, I will focus on the interpretation of plural DPs in the scope of distributivity operators, beginning with the weak variant and disregarding the exhaustification operator for time being:



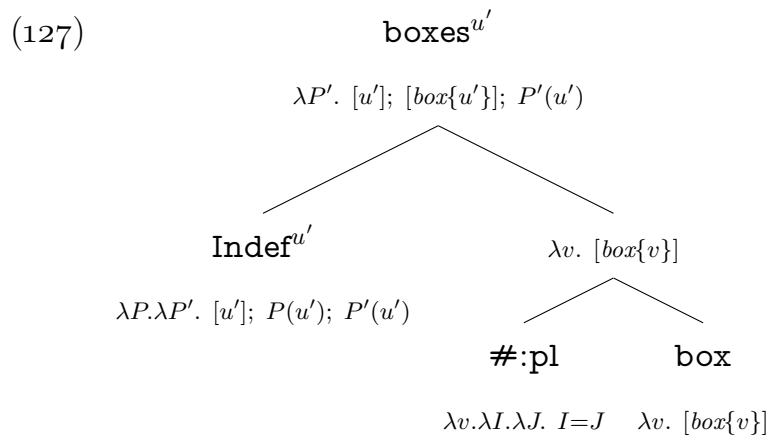
This structure corresponds to sentence (126), where the weak distributivity operator is overt:

(126) Two^u students *both* carried boxes^{u'}.

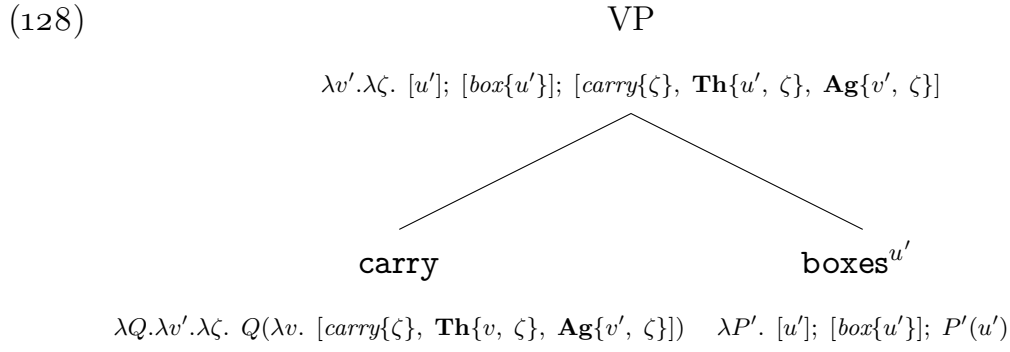
In the next two sections I will demonstrate that this structure gives rise to the dependent plural interpretation, exhibiting the properties of co-distributivity and overarching multiplicity, as discussed in Chapter 1.

3.9.1.1 Deriving Co-Distributivity

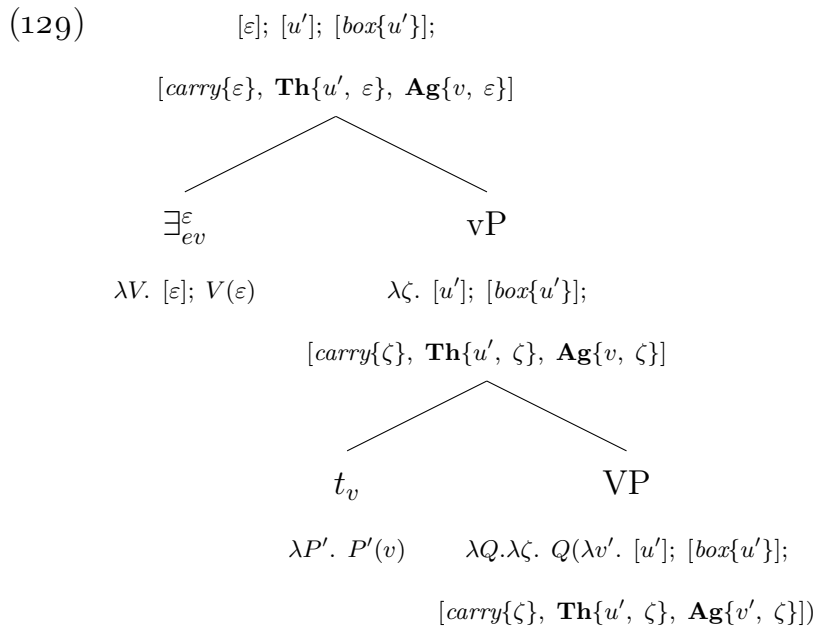
Consider the compositional translation of (125), starting with the translation of the bare plural:



This is then combined with the (lifted) translation of the verb:



Then the translation of the VP is lifted again to combine with the subject trace, and the resulting vP-translation is combined with event closure:



Finally, the combination of (129) with the weak distributivity operator and the raised subject is translated via Distributive Quantifying-In:

$$\begin{array}{c}
(130) \quad \text{two}^u \text{ students } \delta_w \text{ carried}^\varepsilon \text{ boxes}^{u'} \\
[u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}]; \\
[\mathbf{dist}_w([\varepsilon]; [u']; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])(u)] \\
\begin{array}{ccc}
& \diagdown & \diagup \\
[\text{two}^u \text{ students}]^v & & \\
\lambda P'. [u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}]; P'(u) & \delta_w & \exists_{ev} P \\
& \lambda P. \lambda v'. [\mathbf{dist}_w(P(v'))(v')] & [\varepsilon]; [u']; [box\{u'\}]; \\
& & [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}]
\end{array}
\end{array}$$

Replacing \mathbf{dist}_w with its definition, we obtain the following DRS, equivalent to the final DRS in (130):

$$(131) \quad \lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}]) I J \wedge \exists H. (J \langle u \rangle H \wedge \exists H'. ([\varepsilon]; [u']; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]) H H')$$

The DRS in (131) is similar to that in (113) above, except for the absence of atomicity and uniqueness conditions on u' . Given that the semantics of structures like (125) is central to the analysis of dependent plurals, I will again provide a detailed analysis of the truth conditions of (131).

The DRS in (131) is true with respect to a singleton input info-state I iff:

a) There exists an info-state J u -different from I , such that u returns a sum of two atomic individuals for each assignment in J . Given the definition of \square (i.e. u -difference) in (19), J must be singleton, e.g.:

$$(132)$$

Info state J , such that $I[u]J$	...	u	...
j	...	$s_1 \oplus s_2$, such that $student(s_1 \oplus s_2)$	...

J is the output info-state of the final DRS in (129), which means that this new value for u is introduced into the discourse.

b) There exists an info state H , such that $J\langle u\rangle H$, i.e. each assignment h in H is u -different from the assignment j in J , and: 1) the value of u for each assignment in H is an atomic sub-part of the value of u for the assignment j , and 2) for each atomic sub-part of the value of u for the assignment j , H contains an assignment for which u returns this atomic sub-part. Since the value of u for j is a sum-individual with two atomic sub-parts, H must contain two assignments:

(133)

Info state H , such that $J\langle u\rangle H$	...	u	...
h_1 (such that $h_1[u]j$)	...	s_1	...
h_2 (such that $h_2[u]j$)	...	s_2	...

c) There exists an info state H' , such that $H[\varepsilon, u']H'$ and for every assignment h' in H' : *box* is true of $u'h'$, *carry* is true of $\varepsilon h'$, $u'h'$ is the theme of $\varepsilon h'$, and uh' is the agent of $\varepsilon h'$. Again, given the adopted definition of \square , H' cannot contain more than two assignments:

(134)

Info state H' , s.t. $H[u']H'$	...	u	ε	u'	...
h'_1 (such that $h'_1[u']h_1$)	...	s_1	e_1	b_1	...
h'_2 (such that $h'_2[u']h_2$)	...	s_2	e_2	b_2	...

Note, that the values of u' with respect to H' (b_1 and b_2 in the above table) can be either atomic or non-atomic on the domain level, and can be either distinct or identical on the state level. In this the info state in (134) differs from that in (116) above, which characterises the truth conditions of a sentence involving a singular DP in the scope of a weak distributivity operator. As a special case, the truth

conditions of the DRS in (129) are compatible with a scenario where two students each carried one box, and the two boxes were different. This is the co-distributive, dependent plural reading.

3.9.1.2 Deriving Overarching Multiplicity

To fully capture the dependent plural interpretation we must derive the overarching Multiplicity Condition associated with dependent plurals: (124) will not be judged true if both students carried the same box. Thus, we must ensure that the sum of the boxes carried by the students is greater than one. This is accomplished with the help of the implicature calculation algorithm, discussed in section 3.6.

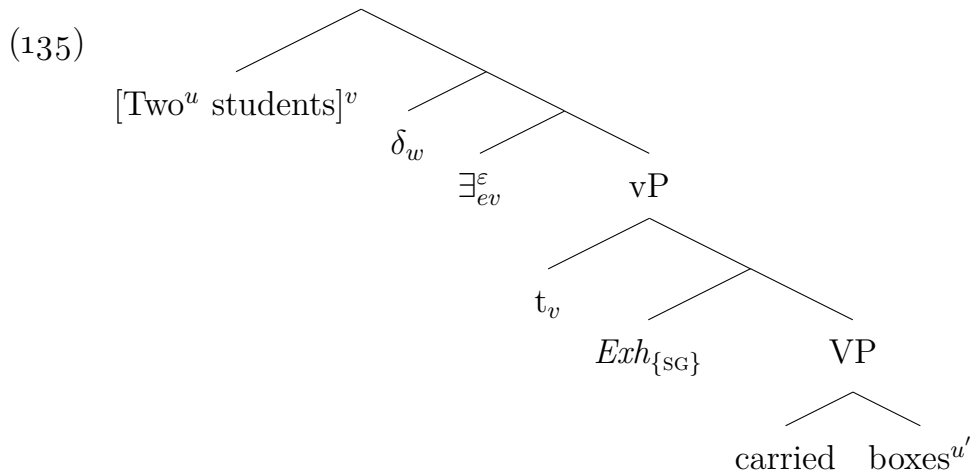
As the reader may recall, the algorithm for calculating scalar implicatures that we adopt in this thesis rests on the assumption that such calculations may be performed at various levels of the syntactic structure of a sentence. Specifically, the calculation of scalar implicatures is triggered by the insertion of a designated syntactic exhaustification operator *Exh*. Semantically, this operator adds a condition which negates all the stronger alternatives of the constituent it combines with. Furthermore, recall that following Ivlieva (2013), we assume that the multiplicity implicature associated with the plural feature is obligatory, i.e. the plural feature must be c-commanded by an *Exh* operator whose set of alternatives includes the translation of the corresponding constituent with the plural feature replaced by the singular. Finally, I adopted a locality principle for *Exh*-insertion, which applies to items associated with obligatory scalar implicatures, e.g. the plural feature, and states that the *Exh* operator must occur in the most local configuration with the respect to the scalar item, where its insertion does not weaken the overall interpretation of the sentence (cf. 62).

In structure (125) there are four potential insertion sites for *Exh*: above the VP, above the vP, above event closure, and at the root above the raised subject.¹⁶

¹⁶Formally, there is a fifth option of inserting *Exh* immediately above the distributivity operator, below the subject. However, this structure would be uninterpretable in the current system, since the exhaustification operator would block the application of the Distributive Quantifyin-In rule.

The first site is the most local with respect to the plural, and thus following the locality principle, this site must be chosen, as long as the overall interpretation of the sentence is not weakened. Since (125) does not contain any downward-entailing operators, the latter condition will be satisfied.

Inserting the *Exh* immediately above the VP results in the following structure:



The translation of the VP was calculated above in (128). I repeat it here:

$$(136) \quad [{}_{VP} \text{carried boxes}^{u'}] \rightsquigarrow \lambda v'. \lambda \zeta. [u']; [box\{u'\}]; [carry\{\zeta\}, \mathbf{Th}\{u', \zeta\}, \mathbf{Ag}\{v', \zeta\}]$$

$$:= \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u']J \wedge box\{u'\}J \wedge carry\{\zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J$$

Exh is translated as an **Exh** operator in PCDRT*. A generalised definition of **Exh** operators was given above in (63). In combination with a term of type $\mathbf{e}(\mathbf{vt})$, **Exh** is defined as follows:

$$(137) \quad \mathbf{Exh}_{ALT}(\mathbf{e}(\mathbf{vt}))(\mathbf{e}(\mathbf{vt}))(V_{\mathbf{e}(\mathbf{vt})}) := \lambda v_{\mathbf{e}}. \lambda \zeta_{\mathbf{v}}. \lambda I_{st}. \lambda J_{st}. P(\zeta)IJ \wedge$$

$$\forall V'_{\mathbf{e}(\mathbf{vt})}. (V' \in ALT \wedge V' \succ V \rightarrow \neg V'(\zeta)(v)IJ),$$

where ALT is the set of alternatives for V .

The definition in (137) requires for all stronger alternatives to be negated. The set of alternatives for (136) includes the following term, which is the translation of the corresponding VP with the plural indefinite direct object replaced by a singular indefinite (cf. 105 for a compositional translation):

$$(138) \quad \lambda v'. \lambda \zeta. [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [box\{u'\}]; [carry\{\zeta\}, \mathbf{Th}\{u', \zeta\}, \mathbf{Ag}\{v', \zeta\}] \\ := \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u']J \wedge \mathbf{atom}\{u'\}J \wedge \mathbf{unique}\{u'\}J \wedge box\{u'\}J \wedge \\ carry\{\zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J$$

To perform exhaustification, we must determine whether the alternative in (138) is stronger than (136). It is, following the definition of strength in (67): for any appropriate model M and assignments function g , any individual and event that satisfy the conditions in (138) also satisfy the conditions in (136), while the converse is not true, i.e. any event involving an individual carrying an *atomic* sum of boxes is necessarily an event involving that same individual carrying a sum of boxes, while not every event of an individual carrying a sum of boxes is an event of that individual carrying an atomic sum of boxes. Hence, the expression in (136) combined with the exhaustification operator defined in (137) is strengthened:

$$(139) \quad \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u']J \wedge box\{u'\}J \wedge carry\{\zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge \\ \neg(I[u']J \wedge \mathbf{atom}\{u'\}J \wedge \mathbf{unique}\{u'\}J \wedge box\{u'\}J \wedge carry\{\zeta\}J \wedge \\ \mathbf{Th}\{u', \zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J) \\ := \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u']J \wedge box\{u'\}J \wedge carry\{\zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \\ \mathbf{Ag}\{v', \zeta\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J)$$

This is then combined with the subject trace, the event closure operator, the weak distributivity operator and the raised subject, resulting in the following DRS:

$$(140) \quad \lambda I. \lambda J. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \\ \exists H'. (H[\varepsilon, u']H' \wedge box\{u'\}H' \wedge carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H' \wedge \\ (\neg \mathbf{atom}\{u'\}H' \vee \neg \mathbf{unique}\{u'\}H'))))$$

This DRS is very similar to the one derived in the previous section in the absence of exhaustification, except that (140) requires for the values of u' to be either non-atomic or non-unique with respect to the info state H' in (134), i.e. u' must either return a non-atomic individual for some assignment in H' or return different individuals for the assignments in H' . For convenience, I reproduce the table representing H' here:

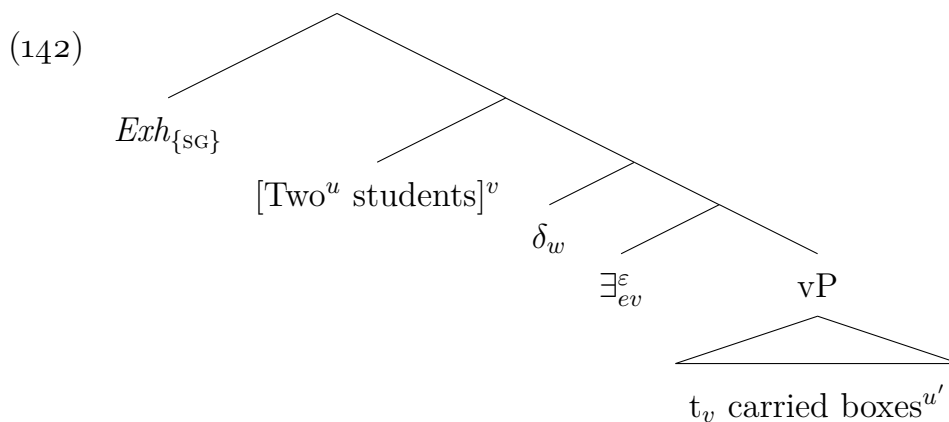
(141)

Info state H' , s.t. $H[u']H'$	...	u	ε	u'	...
h'_1 (such that $h'_1[u']h_1$)	...	s_1	e_1	b_1	...
h'_2 (such that $h'_2[u']h_2$)	...	s_2	e_2	b_2	...

Thus, the DRS in (140) will be true if there exist two atomic students s_1 and s_2 , two carrying events e_1 and e_2 , and two sums of boxes b_1 and b_2 , such that s_1 carried b_1 in e_1 , and s_2 carried b_2 in e_2 . Moreover, following the conditions in (140), it must be the case that either b_1 or b_2 is non-atomic, or $b_1 \neq b_2$. In other words, (140) will be true if there are two students such that they each carried one or more boxes, and more than one box was involved overall. This amounts to a co-distributive reading combined with a global Multiplicity Condition, i.e. a dependent plural reading.

For completeness, let us consider the translation of (125) in case, contrary to the locality principle, the exhaustification operator is inserted at a higher position. If *Exh* is inserted directly above the vP or directly above the event closure operator the result is again the DRS in (140), which corresponds to the dependent plural interpretation combined with an overarching Multiplicity Condition on the referent of the bare plural DP (for expository purposes, I omit the full calculation).

Let us, then, consider the final option. If the exhaustivity operator is inserted at the root we obtain the following structure:



The translation of the constituent that $Exh_{\{SG\}}$ combines with in (142) was already calculated in (130). I repeat it here, together with its ‘unpacked’ form:

$$\begin{aligned}
(143) \quad & [u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}]; [\mathbf{dist}_w([\varepsilon]; [u']; [box\{u'\}]); \\
& [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]](u) \\
& := \lambda I. \lambda J. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \\
& \exists H'. (H[\varepsilon, u']H' \wedge box\{u'\}H' \wedge carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H'))
\end{aligned}$$

As pointed out above, this DRS will be true if there are two students who each carried a sum of boxes.

The singular alternative to (143) is the DRS in (113), repeated here in the ‘unpacked’ form:

$$\begin{aligned}
(144) \quad & \lambda I. \lambda J. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \\
& \exists H'. (H[\varepsilon, u']H' \wedge \mathbf{atom}\{u'\}H' \wedge \mathbf{unique}\{u'\}H' \wedge box\{u'\}H' \wedge \\
& carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H'))
\end{aligned}$$

As discussed in section 3.8.1, the DRS in (144) will be true if there are two students who both carried the same box. This DRS is stronger than (143), hence it must be negated when (143) is combined with the exhaustification operator, yielding (145) as the translation of (142) :

$$\begin{aligned}
(145) \quad & \lambda I. \lambda J. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \\
& \exists H'. (H[\varepsilon, u']H' \wedge box\{u'\}H' \wedge carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H')) \\
& \wedge \neg(I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \\
& \exists H'. (H[\varepsilon, u']H' \wedge \mathbf{atom}\{u'\}H' \wedge \mathbf{unique}\{u'\}H' \wedge box\{u'\}H' \wedge \\
& carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H')))) \\
& := \lambda I. \lambda J. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \\
& \exists H'. (H[\varepsilon, u']H' \wedge box\{u'\}H' \wedge carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H')) \\
& \wedge \neg \exists H. (J\langle u \rangle H \wedge \exists H'. (H[\varepsilon, u']H' \wedge \mathbf{atom}\{u'\}H' \wedge \mathbf{unique}\{u'\}H' \wedge \\
& box\{u'\}H' \wedge carry\{\varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H'))
\end{aligned}$$

This DRS will be true if there are two students who each carried a sum of boxes, and there is no atomic box that they both carried. These truth conditions

are stronger than those of (140). For instance, in a model where student s_1 carried a box b_1 , while student s_2 carried two boxes $b_1 \oplus b_2$, the DRS in (140) will be true, while that in (145) – false.

The truth conditions of (145) are the ones that obtain in Ivlieva’s (2013) system when exhaustification is applied above event closure. As far as I know, there is no evidence that such an interpretation indeed exists for sentences like (124) and (126). In the current system, it is ruled out by the principle of Locality of *Exh*-insertion, thus predicting only a dependent plural interpretation for structures involving a bare plural DP in the scope of a weak distributivity operator.

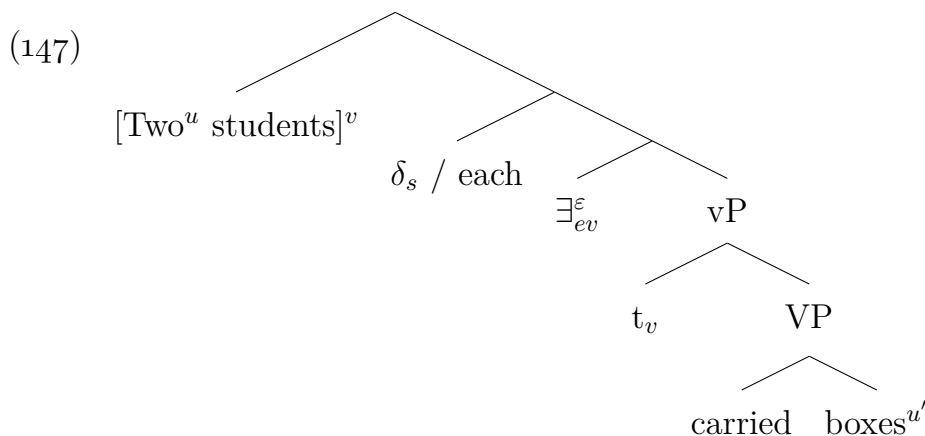
3.9.2 Bare Plurals under the Strong Distributivity Operator

Let us now consider the interpretation of bare plurals in the scope of strong distributivity operators:

(146) a. Two^{*u*} students δ_s carried boxes^{*u'*}.

b. Two^{*u*} students *each* carried boxes^{*u'*}.

The examples in (146) have the following structure (disregarding exhaustification for now), with the compositional translation in (148):



$$\begin{array}{c}
(148) \quad \text{two}^u \text{ students } \delta_s \text{ carried}^\varepsilon \text{ boxes}^{u'} \\
\quad [u]; [\mathbf{2_atoms}\{u\}]; [\text{student}\{u\}]; \\
\quad [\mathbf{dist}_s([\varepsilon]; [u']; [\text{box}\{u'\}]; [\text{carry}\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])(u)] \\
\quad \swarrow \quad \searrow \\
\quad [\text{two}^u \text{ students}]^v \quad \delta_s \quad \exists_{ev} \mathbf{P} \\
\lambda P'. [u]; [\mathbf{2_atoms}\{u\}]; [\text{student}\{u\}]; P'(u) \quad \lambda P. \lambda v'. [\mathbf{dist}_s(P(v'))(v')] \quad [\varepsilon]; [u']; [\text{box}\{u'\}]; \\
\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad [\text{carry}\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}]
\end{array}$$

Replacing the \mathbf{dist}_s operator with its definition, we obtain the following DRS, equivalent to the final DRS in (148):

$$\begin{array}{l}
(149) \quad \lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [\text{student}\{u\}]) I J \wedge \exists H. (J \langle u \rangle H \wedge \\
\quad \exists H'. (\mathbf{dist}([\varepsilon]; [u']; [\text{box}\{u'\}]; [\text{carry}\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])) H H')
\end{array}$$

The difference between the DRS in (149) and that in (131), discussed above, is that in the former the drefs ε and u' are re-introduced for each individual assignment in H' , and similarly the predicate *carry* and the thematic relations are applied separately to the values of ε , u and u' for each assignment in H' . This difference in itself does not make a truth-conditional impact on the basic (i.e. non-enriched) meaning, i.e. (149) and (131) define the same set of input-output state pairs in any (appropriate) model. However, this distinction plays a crucial role when it comes to calculating the scalar implicature associated with the plural DP *boxes* in (147).

As in the case of the weak distributivity operator discussed above, the four relevant sites for the insertion of *Exh* in (147) are above the VP, above the vP, above event closure, and above the raised subject. However, the Locality Principle forces us to choose the lowest of the available insertion sites, applying *Exh* directly to the VP. We have already calculated the translation of the VP combined with the *Exh* operator (cf. 139). I repeat it here for convenience:

$$(150) \quad \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u']J \wedge \mathbf{box}\{u'\}J \wedge \mathbf{carry}\{\zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J)$$

This predicate is then combined with the subject trace, the event closure operator, the strong distributivity operator and the raised subject DP, resulting the following enriched sentential translation:

$$(151) \quad \lambda I. \lambda J. I[u]J \wedge \mathbf{z_atoms}\{u\}J \wedge \mathbf{student}\{u\}J \wedge \exists H. (J\langle u \rangle H \wedge \exists H'. (\mathbf{dist}(\lambda I'. \lambda J'. I'[\varepsilon, u']J' \wedge \mathbf{box}\{u'\}J' \wedge \mathbf{carry}\{\varepsilon\}J' \wedge \mathbf{Th}\{u', \varepsilon\}J' \wedge \mathbf{Ag}\{u, \varepsilon\}J' \wedge (\neg \mathbf{atom}\{u'\}J' \vee \neg \mathbf{unique}\{u'\}J'))))HH')$$

Due to the presence of the **dist** operator, info state H is split into multiple (in this case, two) singleton info states, and u' is re-assigned, and its non-atomicity is checked separately for each of these singleton info states (note, that uniqueness for u' is trivially satisfied in this case). I.e. there must exist two info states H_1'' and H_2'' of the following form:

$$(152)$$

Info state H_1''	...	u	ε	u'	...
h_1''	...	s_1	e_1	b_1	...
Info state H_2''	...	u	ε	u'	...
h_2''	...	s_2	e_2	b_2	...

Here, s_1 and s_2 are atomic students, and e_1 and e_2 are carrying events, such that s_1 is the agent of e_1 and s_2 is the agent of e_2 . Moreover, b_1 and b_2 are *non-atomic* sums of boxes, such that b_1 is the theme of e_1 and b_2 is the theme of e_2 .

In other words, the DRS in (151) will be true iff there are two students who each carried more than one box. This correctly captures the truth conditions of sentence (146b).

Again, for completeness, let us consider the option of inserting the *Exh* operator in higher positions in (147). If we attach *Exh* directly above the vP or directly

above the event closure operator, we will again obtain the DRS in (151). However, inserting *Exh* above the raised subject produces a different result.

In this case exhaustification is applied to the DRS in (149), repeated in (153a). Its singular alternative is the DRS in (120), repeated in (153b):

$$(153) \quad \text{a. } \lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}])IJ \wedge \exists H. (J\langle u \rangle H \wedge \\ \exists H'. (\mathbf{dist}([\varepsilon]; [u']; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]))HH')$$

$$\text{b. } \lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}])IJ \wedge \exists H. (J\langle u \rangle H \wedge \\ \exists H'. (\mathbf{dist}([\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [box\{u'\}]; \\ [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]))HH')$$

Lest us consider the relative strength of these DRSs. Take an arbitrary appropriate model M , assignment function g and input info state I . Now take an output info state J , such that I and J satisfies (153b) in M . The conditions in (153b) state that J must differ from I at most with respect to the values of u , and u must return a sum of two students for every assignment in J . For the sake of illustration, suppose that I contains two assignments, i_1 and i_2 . Then J also contains two assignments, j_1 and j_2 , of the following form, where s_1, s_2, s_3 and s_4 represent atomic students such that $s_1 \neq s_2$ and $s_3 \neq s_4$:

(154)

Info state J	...	u	...
j_1	...	$s_1 \oplus s_2$	...
j_2	...	$s_3 \oplus s_4$	...

Furthermore, the DRS in (153b) states that there must exist an info state H , such that $J\langle u \rangle H$:

(155)

Info state H	...	u	...
h_1	...	s_1	...
h_2	...	s_2	...
h_3	...	s_3	...
h_4	...	s_4	...

Finally, given the conditions under the **dist** operator in (153b), there must exist a set of info states $\{H''_1, \dots, H''_4\}$ such that $H''_1[\varepsilon, u']h_1, \dots, H''_4[\varepsilon, u']h_4$, and for each $H''_n = \{h''_n\}$, $\varepsilon h''_n$ is a carrying event, $u'h''_n$ is an atomic box, uh''_n is the agent of $\varepsilon h''_n$, and $u'h''_n$ is the theme of $\varepsilon h''_n$:

(156)

Info state H''_1	...	u	ε	u'	...
h''_1	...	s_1	e_1	b_1	...
Info state H''_2	...	u	ε	u'	...
h''_2	...	s_2	e_2	b_2	...
Info state H''_3	...	u	ε	u'	...
h''_3	...	s_3	e_3	b_3	...
Info state H''_4	...	u	ε	u'	...
h''_4	...	s_4	e_4	b_4	...

The conditions in (153a) differ from those in (153b) only in that the values of u' , i.e. b_1, \dots, b_4 in (156), are not required to be atomic. It is thus clear that any pair of info states I and J that satisfies (153b), will necessarily satisfy (153a).

However, the converse also holds. Take, again, an arbitrary appropriate model M , assignment function g and input info state I . Take an output info state J , such that I and J satisfies (153a) in M . Assuming, again, for the sake of illustration,

that I contains two assignments, it follows that there exists a set of info states as in (156), where b_1, \dots, b_4 are sums of books, which in this case are not required to be atomic. Now, recall that *carry* is lexically distributive with respect to its theme, i.e. for any event e and individual x , if e is a carrying event and x is the theme of e , then for each atomic x' , such that $x' \leq x$, there exists an event $e' \leq e$, which is a carrying event and whose theme is x' . Recall, that in the calculation of relative strength, we only consider those models that respect the distributivity conditions associated with lexical predicates. It follows, then, that M must contain a set of carrying events e'_1, \dots, e'_4 , where $e'_1 \leq e_1, \dots, e'_4 \leq e_4$, whose agents are s_1, \dots, s_4 , respectively, and whose themes are b'_1, \dots, b'_4 , respectively, where b'_1, \dots, b'_4 are atomic sums of books. Finally, Axiom 4 in (27d) ensures that there exists a set of info states $\{K_1, \dots, K_4\}$ of the following form:

(157)

Info state K_1	||	...	u	ε	u'	...
k_1	||	...	s_1	e'_1	b'_1	...
Info state K_2	||	...	u	ε	u'	...
k_2	||	...	s_2	e'_2	b'_2	...
Info state K_3	||	...	u	ε	u'	...
k_1	||	...	s_3	e'_3	b'_3	...
Info state K_4	||	...	u	ε	u'	...
k_2	||	...	s_4	e'_4	b'_4	...

The existence of info states $\{K_1, \dots, K_4\}$ entails that the arbitrary info states I and J , which by assumption satisfy (153b) in an arbitrary appropriate model M , must also satisfy (153b) in M .

We can thus conclude that neither of the alternatives in (153) is stronger than the other. This means that combining (153a) with the exhaustification operator

does not lead to strengthening, and the DRS in (153a) is derived as the final translation for (146) in case *Exh* is inserted at the root. This DRS will be true if there are two students, who each carried one or more boxes. These truth conditions are too weak: sentence (146b) entails that each student carried more than one box. As pointed out above, in our system the option of performing exhaustification at the root is blocked by the principle of Locality of *Exh*-Insertion, and hence the weak reading corresponding to the DRS in (153a) is correctly ruled out.

To conclude, we have seen that bare plural DPs in the scope of weak distributivity operators are interpreted as dependent plurals, with an overarching Multiplicity Condition derived as a scalar implicature. On the other hand, when a bare plural DP occurs under a strong distributivity operator, the multiplicity requirement is applied distributively, relative to each atomic individual in the distributed sum.

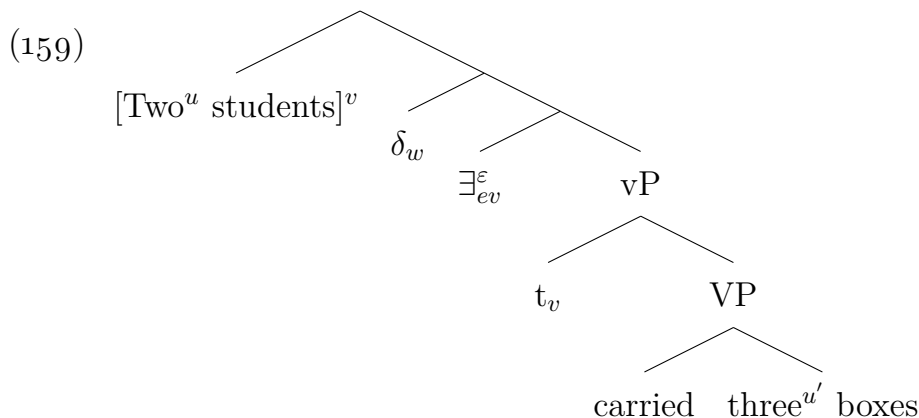
3.9.3 Numerals and Cardinal Modifiers under Distributivity Operators

Let us now consider the interpretation of plural DPs containing numerals and cardinal modifiers such as *several* in the scope of weak and strong distributivity operators.

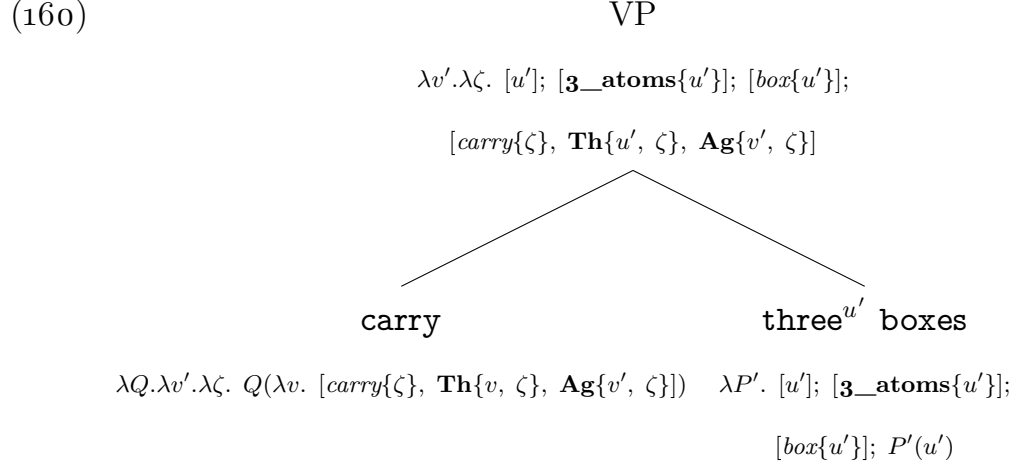
Take the following example:

(158) Two^{*u*} students *all* / δ_w carried ^{ε} three^{*u'*} boxes.

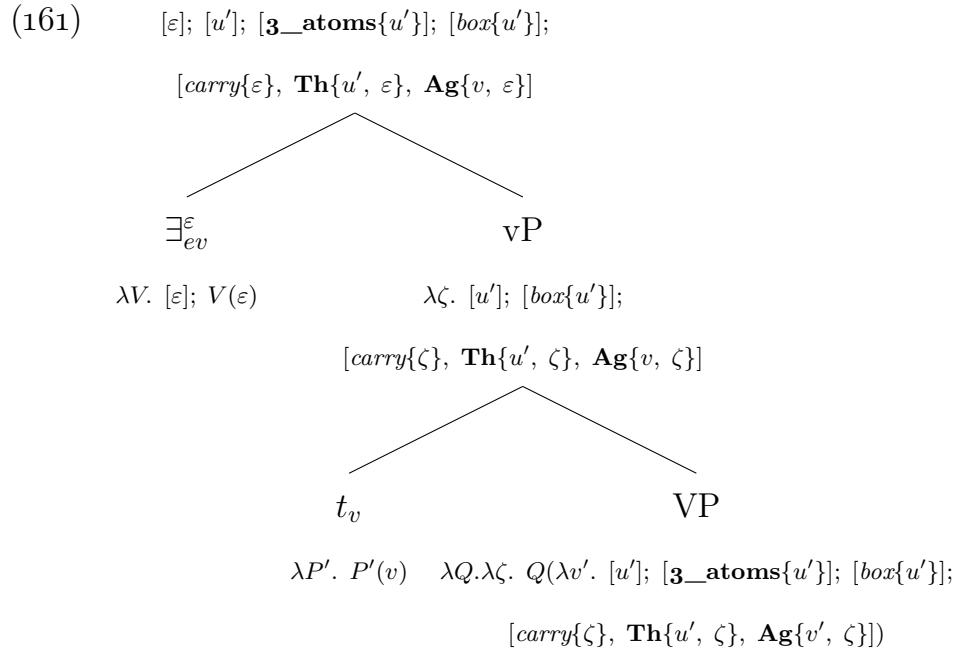
This sentence is assigned the following underlying structure:



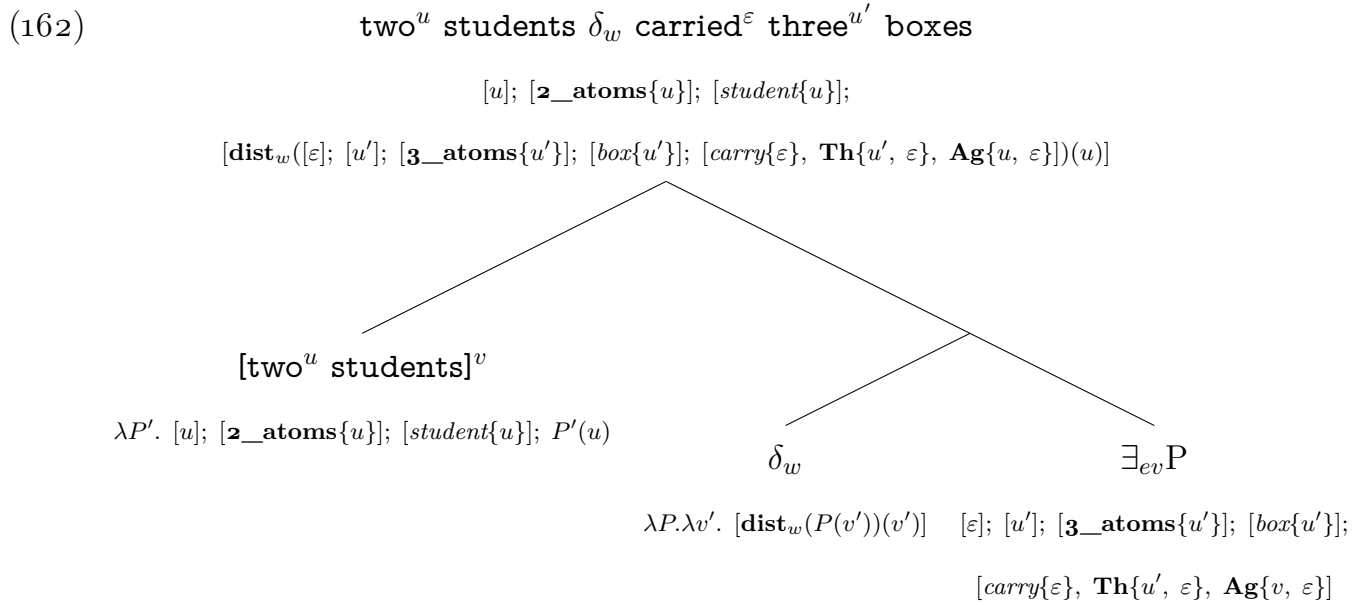
Let us calculate the compositional translation of this structure, starting with the VP:



The VP is then combined with the subject trace and the event closure operator:



Finally, the weak distributivity operator and the raised subject are introduced, and the resulting structure is translated via the Distributive Quantifying-In rule:



If we replace \mathbf{dist}_w with its definition, we obtain the following DRS, equivalent to the final DRS in (162):

(163) $\lambda I.\lambda J.([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}])IJ \wedge \exists H. (J\langle u \rangle H \wedge$

$\exists H'. ([\varepsilon]; [u']; [\mathbf{3_atoms}\{u'\}]; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])HH')$

As in the case of (131) discussed in detail above, this DRS will be true if there exists an info state H' of the following form, where s_1 and s_2 represent atomic student-individuals:

(164)

Info state H'	...	u	ε	u'	...
h'_1	...	s_1	e_1	b_1	...
h'_2	...	s_2	e_2	b_2	...

Following the conditions in (163), b_1 and b_2 are sums of boxes, and e_1 and e_2 are carrying events, such that the agent of e_1 is s_1 , the agent of e_2 is s_2 , the theme of e_1 is b_1 and the theme of e_2 is b_2 . Crucially, the DRS in (163) includes an additional condition $\mathbf{3_atoms}\{u'\}$ which must be true of H' . Recall, that quantity conditions are interpreted distributively, i.e. with respect to each assignment in the info state:

$$(165) \quad \mathbf{3_atoms}\{u\} := \lambda I_{st}. \forall i \in I. \mathbf{3_atoms}(ui),$$

$$\text{where } \mathbf{3_atoms}(x_e) := |\{y_e : y \leq x \wedge \mathbf{atom}(y)\}| = 3.$$

This means, that the dref u' must return a sum of individuals of cardinality three for every assignment in H' , i.e. in (164) the cardinality of both b_1 and b_2 must be three.

This in turn entails that for (158) to be judged true two students must have carried three boxes each.

The same truth conditions obtain if the numerical DP is placed under a strong distributivity operator:

$$(166) \quad \text{Two}^u \text{ students } \textit{each} / \delta_s \text{ carried}^\varepsilon \text{ three}^{u'} \text{ boxes.}$$

$$(167) \quad \lambda I. \lambda J. ([u]; [\mathbf{2_atoms}\{u\}]; [student\{u\}])IJ \wedge \exists H. (J\langle u \rangle H \wedge \exists H'. (\mathbf{dist}([\varepsilon]; [u']; [\mathbf{3_atoms}\{u'\}]; [box\{u'\}]; [carry\{\varepsilon\}, \mathbf{Th}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])))HH')$$

In this case, due to the presence of the **dist** operator H' must be split into multiple singleton info states, and the conditions associated with u' and ε must be checked separately for each of these info states. But since all these conditions are already state-level distributive (i.e. they are checked for each assignment in an info state), this does not lead to any change in the truth conditions as compared to (163).

To conclude, the presence of both weak and strong distributivity operators triggers a distributive interpretation of DPs with numerals and cardinal modifiers in their scope.

3.10 Dependent Definites and Possessives

Thus far we have considered the interpretation of singular and plural indefinite DPs in PCDRT*, and have established that dependent plural interpretations obtain when bare plural indefinites occur in the scope of weak distributivity operators.

However the phenomenon of dependent plurality is not restricted to constructions involving indefinite dependents. As discussed in Chapter 1, definite and possessive DPs can also function as dependent plurals. In this section I present an analysis of dependent definites and possessives in the proposed framework.

3.10.1 Non-Anaphoric Definite Article: Maximality as a Domain-level Requirement

I follow Brasoveanu (2007, 2008) in distinguishing between two types of the definite article, anaphoric and non-anaphoric. The former, defined above in section 3.4, is conceptually simpler and involves reference to a previously established dref. The latter, on the other hand, introduces a new dref whose values are constrained by the application of the maximality operator.

Consider the following example:

(168) Three students^{*u*} all named ^{ε} the^{*u'*} paintings they_{*u*} liked ^{ε'} .

Suppose three students were taken to an art museum, and then asked about their impressions. In this context the most salient reading of (168) is one where each student produced a list containing the *maximal set* of paintings that she liked.¹⁷ This reading is compatible with a situation where each student liked, and named, only a single painting, as long as more than one painting was named overall. In other words, the definite DP *the paintings that they liked* functions as a dependent plural. Now, we have analysed dependent plurals in terms of weak distributivity: the atomic sub-sums of the licenser (the subject DP in 168) are distributed as values of a dref, *u*, across the assignments in a plural info state, and the dref introduced by the dependent, *u'*, is required to be globally non-atomic (i.e. domain-level non-atomic or non-unique) with respect to that info state. Given the reading of (168) described above, it follows that the maximality operator involved in the semantics of the definite article that introduces *u'* must apply distributively

¹⁷Another reading, irrelevant for us here, is where each student named all the painting that at least one of the students liked, i.e. all the students named the same set of paintings.

to each of the values of u' for the assignments in a plural info state, i.e. maximality must act as a domain-level requirement. Somewhat more formally, the DRS which we want to derive as the translation of (168) should be true if there exists an info state H containing three assignments such that for each h in H : a) uh is an atomic student, and $\oplus uH$ is a sum of three students, b) εh is a naming event, c) $u'h$ is the maximal sum of paintings that uh liked, and c) uh is the agent of εh and $u'h$ is the theme of εh (i.e. uh named $u'h$). E.g.:

(169)

Info state H	...	u	ε	u'	...
h_1	...	s_1	e_1	$p_1 \oplus p_2$	...
h_2	...	s_2	e_2	$p_3 \oplus p_4$	...
h_3	...	s_3	e_3	p_5	...

Here s_1 , s_2 , and s_3 are different atomic student-individuals, and p_1 , p_2 , p_3 , p_4 and p_5 represent different atomic paintings. This info state will satisfy the truth conditions of (168) in a context where s_1 liked and named only paintings p_1 and p_2 , student s_2 liked and named only paintings p_3 and p_4 , and student s_3 liked and named only painting p_5 . The challenge, then, is to provide a definition for the maximality operator in such a way, that it produces a DRS with these truth conditions.

Let us now consider the definition of the maximality operator and the non-anaphoric definite article proposed in Brasoveanu's (2008):¹⁸

$$(170) \quad \mathbf{max}^u(D) := \lambda I_{st} \cdot \lambda J_{st} \cdot ([u]; D)IJ \wedge \forall K_{st} (([u]; D)IK \rightarrow uK \subseteq uJ)$$

(171) *Non-Anaphoric Definite Article*

$$\mathbf{the}^u \rightsquigarrow \lambda P_{\text{et}} \cdot \lambda P'_{\text{et}} \cdot \mathbf{max}^u(P(u)); P'(u)$$

¹⁸More precisely, (171) corresponds to Brasoveanu's (2008) translation of the plural version of the article, since Brasoveanu (2008) incorporates the semantics of number into the translation of determiners.

Under the definition in (170), the maximality operator is indexed with a dref, e.g. u , and combines with a DRS, e.g. D , returning another DRS. The latter DRS re-assigns the values for u and ensures that the *set of values* for u across the assignments in the output info state J is maximal with respect to D , i.e. the set of values for the dref with respect to the plural info state must contain all the values such that D is satisfied. One may refer to this as state-level maximality.

The non-anaphoric definite article then ensures that the dref it introduces is maximal in the above sense with respect to the restrictor predicate, and that it satisfies the nuclear scope predicate.

In the system developed here these definitions will not deliver the required result. To see why, consider the following simple example:

(172) A^u student named $^\varepsilon$ the $^{u'}$ paintings she $_u$ liked $^{\varepsilon'}$.

Given the translation of the definite article in (171) and the maximality operator in (170), this sentence will yield the following DRS, disregarding exhaustification:

(173) $[u, \varepsilon]; [\mathbf{atomic}\{u\}]; [\mathbf{unique}\{u\}]; [student\{u\}];$
 $\mathbf{max}^{u'}([\varepsilon']; [painting\{u'\}]; [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}]);$
 $[name\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}]$
 $:= \lambda I. \lambda J. \exists H. I[u, \varepsilon]H \wedge \mathbf{atomic}\{u\}H \wedge \mathbf{unique}\{u\}H \wedge student\{u\}H \wedge$
 $H[u', \varepsilon']J \wedge painting\{u'\}J \wedge like\{\varepsilon'\}J \wedge \mathbf{Exp}\{u, \varepsilon'\}J \wedge \mathbf{Th}\{u', \varepsilon'\}J \wedge$
 $\forall K. (H[u', \varepsilon']K \wedge painting\{u'\}K \wedge like\{\varepsilon'\}K \wedge \mathbf{Exp}\{u, \varepsilon'\}K \wedge$
 $\mathbf{Th}\{u', \varepsilon'\}K \rightarrow u'K \subseteq u'J) \wedge name\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J$

Now, recall that under our assumptions the truth of a DRS must be evaluated with respect to a singleton input info state (section 3.2.6), and the re-assignment relation \sqsubseteq does not allow for an increase in the cardinality of an info state (cf. 40). This entails that the DRS in (173) will be true only if there exists a *singleton* info state J that satisfies the listed conditions. Consequently $u'J$, the set of values of u' for the assignments in J , will necessarily also be singleton. This in turn implies that the condition $u'K \subseteq u'J$ can only be satisfied in case $u'K = u'J$.

Given the lexical distributivity of the predicates *picture* and *like*, it follows that the maximality requirement will be satisfied only if there is a unique painting that the student liked. Thus, under our definitions of truth and dref re-assignment, and Brasoveanu's (2008) definition of maximality, (172) is predicted to be true only in case there is a student who liked a single painting, and named it. This is clearly not the correct interpretation for (172). Instead, (172) requires for there to be a student who liked more than one painting, and named all the paintings that she liked.

This problem extends to more complex examples involving dependent definites, as in (168). Under the above assumptions, this sentence is predicted to be true if there are three students each of whom liked only a single painting, and named it. This interpretation is too strong, since (168) is clearly compatible with a scenario where one or more of the students liked and named more than one painting, as long as each student named all the paintings that she liked.

In light of this, I will re-define the maximality operator in the following way:¹⁹

$$(175) \quad \mathbf{max}^u(D) := \lambda I_{st} \cdot \lambda J_{st} \cdot \exists f_{ss} \cdot \exists K_{st} \cdot (\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = K \wedge \\ \forall i \in I. (i[u]f(i)) \wedge DKJ \wedge \\ \forall f'_{ss} \cdot \forall K'_{ss} \cdot (\mathbf{Dom}(f') \subseteq I \wedge \mathbf{Ran}(f') = K' \wedge \forall i \in \mathbf{Dom}(f'). (i[u]f'(i)) \wedge \\ \exists J'_{st} \cdot (DK'J') \rightarrow \forall i \in \mathbf{Dom}(f'). (uf'(i) \leq uf(i))), \\ \text{where } f \text{ and } f' \text{ are a partial functions from } \mathcal{D}_s \text{ to } \mathcal{D}_s.$$

This definition makes use of the definition of new dref introduction in (19). It

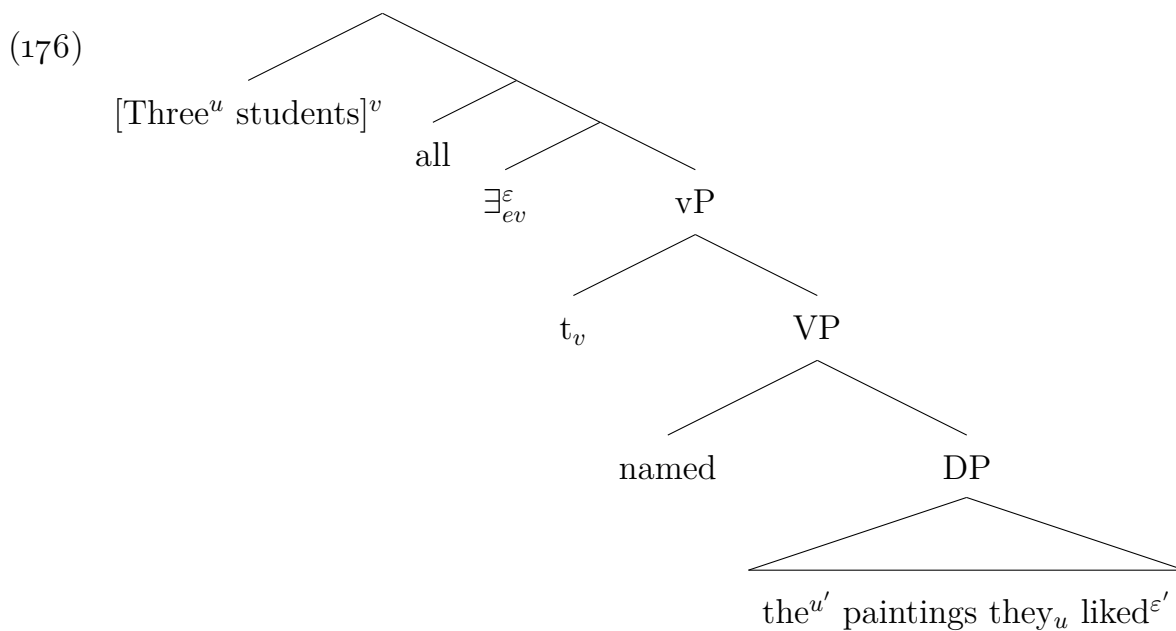
¹⁹Note that replacing the relation between sets of values of a dref with a parallel relation between sums of those values in the definition of the maximality operator in (170) also leads to problems:

$$(174) \quad \mathbf{max}^u(D) := \lambda I_{st} \cdot \lambda J_{st} \cdot ([u]; D)IJ \wedge \forall K_{st} \cdot ([u]; D)IK \rightarrow \oplus uK \leq \oplus uJ$$

Consider again the 'students in a museum' scenario and sentence (168). Now, suppose that student s_1 liked painting p_1 , student s_2 liked paintings p_2 and p_3 , and student s_3 liked paintings p_2 and p_4 . Under the definition in (174) sentence (168) is predicted to be judged true if e.g. student s_1 named painting p_1 , student s_2 named paintings p_2 and p_3 , but student s_3 named only painting p_4 , but not p_2 , which by assumption she also liked. This is so because the sum of all the values for u' will be the same whether s_3 named p_2 or not, since it was already named by student s_2 . Intuitively however, given that student s_3 failed to name all the painting she liked, (168) should not be judged true in this situation.

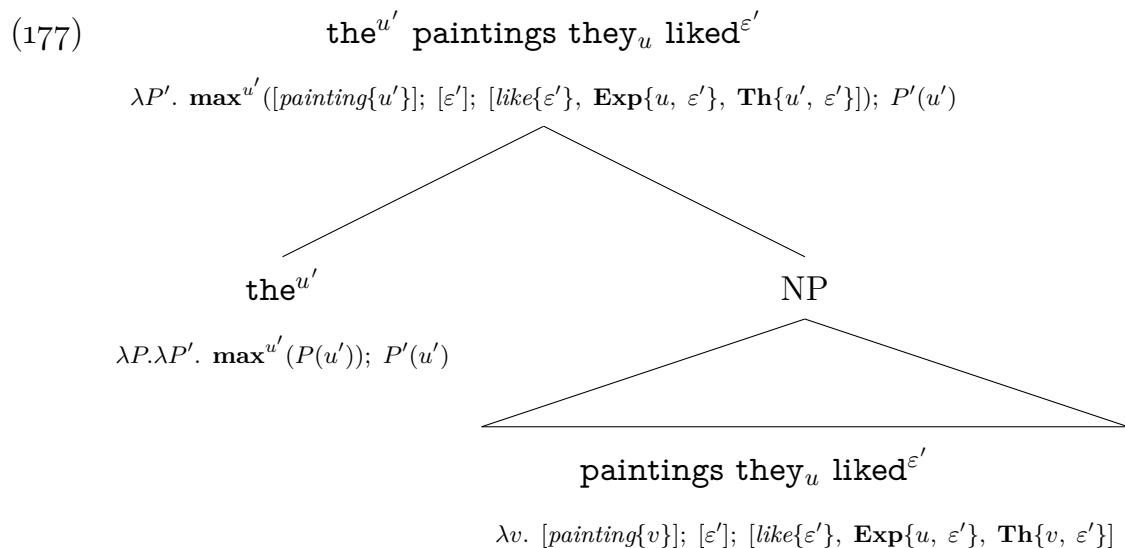
follows from the first part of the definition in (175) that there exists an info state K such that $I[u]K$ and DKJ , i.e. the \mathbf{max}^u operator introduces a new dref u in K , and then applies its argument DRS to K and the output info state. Moreover, it is required that if an info state K' is such that $I'[u]K'$ for some $I' \subseteq I$ and there is a J' such that $DK'J'$, then for each assignment i in I , the value of u with respect to the assignment that corresponds to i in K' is a non-proper sub-sum of the value of u with respect to the assignment that corresponds to i in K . Defined in this way, \mathbf{max} ensures that the value of the dref it introduces is maximal for each assignment in K . The non-anaphoric definite article can then be given the same translation as in (171).

Given this definition of the maximality operator, let us calculate the translation of (168), setting aside the issue of exhaustification for the moment. The syntactic structure I assume for (168) is the following:

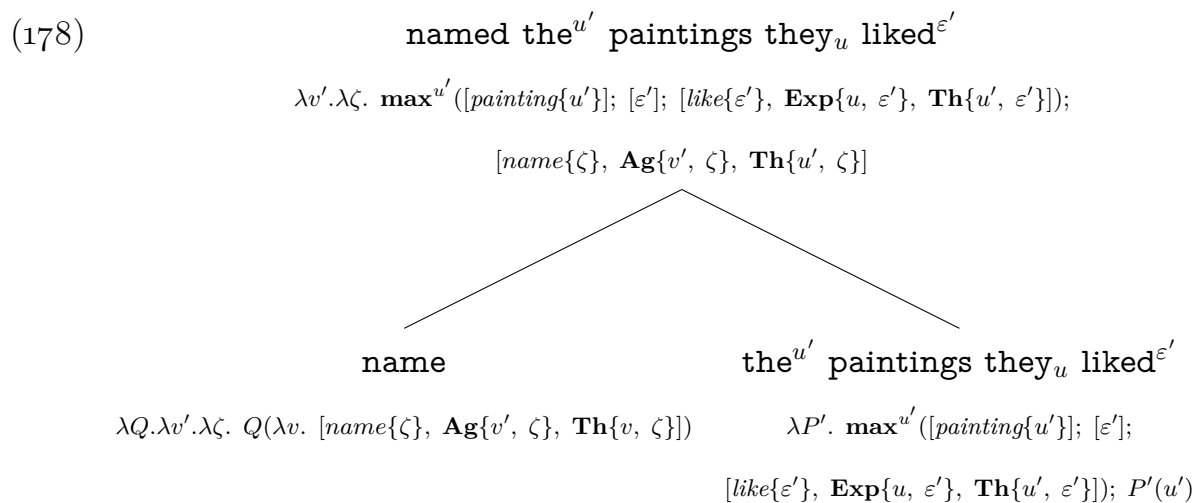


The following tree illustrates the compositional translation of the plural definite DP:²⁰

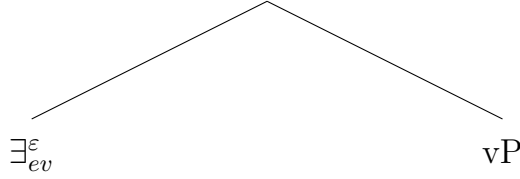
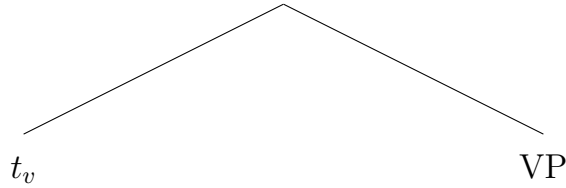
²⁰At this stage, I will not discuss the question of how exhaustification applies to the plural feature on the pronoun, and simply take the pronoun to be number-neutral. For a more detailed discussion of this issue see section 3.12.3.



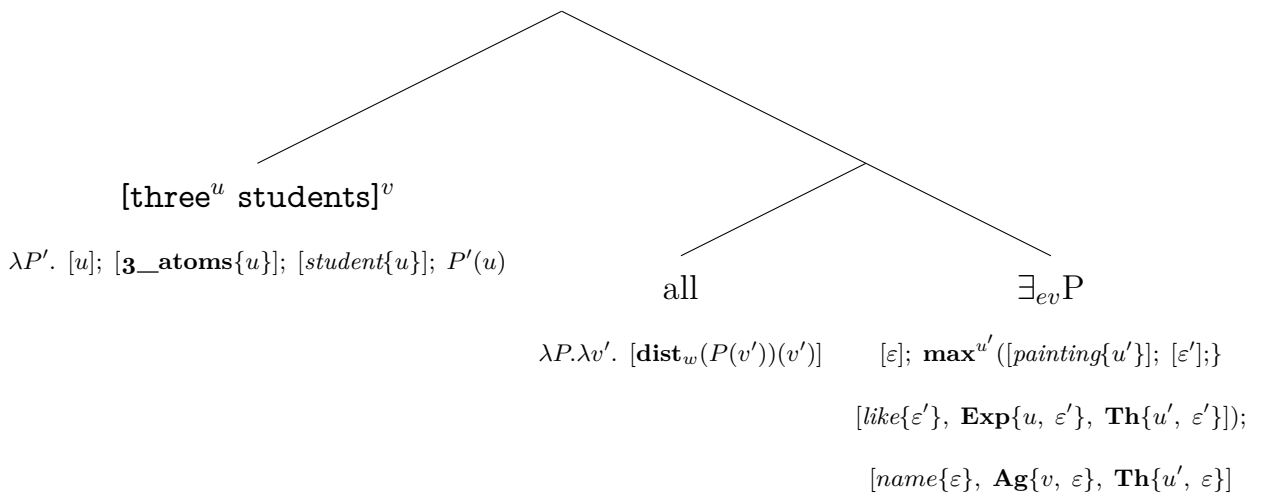
This term is then combined with the translation of the transitive verb *name* to yield the following VP translation:



The VP translation is then lifted and combined with the subject trace and the event closure operator, yielding the following DRS:

(179) $[\varepsilon]; \mathbf{max}^{u'}([\mathit{painting}\{u'\}]; [\varepsilon']; [\mathit{like}\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}]);$ $[name\{\varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}]$  $\lambda V. [\varepsilon]; V(\varepsilon) \quad \lambda \zeta. \mathbf{max}^{u'}([\mathit{painting}\{u'\}]; [\varepsilon']; [\mathit{like}\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}]);$ $[name\{\zeta\}, \mathbf{Ag}\{v, \zeta\}, \mathbf{Th}\{u', \zeta\}]$  $\lambda P'. P'(v) \quad \lambda Q. \lambda \zeta. Q(\lambda v'. \mathbf{max}^{u'}([\mathit{painting}\{u'\}]; [\varepsilon']; [\mathit{like}\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}]);$ $[name\{\zeta\}, \mathbf{Ag}\{v', \zeta\}, \mathbf{Th}\{u', \zeta\}]$

The combination of this DRS with the weak distributive operator *all* and the raised subject is then translated via the Distributive Quantifying-In rule:

(180) **three^u students all named^ε the^{u'} paintings they_u liked^{ε'}** $[u]; [\mathbf{3_atoms}\{u\}]; [\mathit{student}\{u\}];$ $[\mathbf{dist}_w([\varepsilon]; \mathbf{max}^{u'}([\mathit{painting}\{u'\}]; [\varepsilon']; [\mathit{like}\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])];$ $[name\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}](u)]$ 

Let us take the final DRS in (180) and unpack it by successively replacing the \mathbf{dist}_w and \mathbf{max} operators with their definitions, given in section 3.7.1 and in (175)

respectively:

$$\begin{aligned}
(181) \quad & [u]; [\mathbf{3_atoms}\{u\}]; [student\{u\}]; \\
& [\mathbf{dist}_w([\varepsilon]; \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}], \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\})); \\
& [name\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}]](u) \\
& := \lambda I. \lambda J. I[u]J \wedge \mathbf{3_atoms}\{u\}J \wedge student\{u\}J \wedge \\
& \exists H. (J\langle u \rangle H \wedge \exists H'. ([\varepsilon]; \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}], \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\})); \\
& [name\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}])HH') \\
& := \lambda I. \lambda J. I[u]J \wedge \mathbf{3_atoms}\{u\}J \wedge student\{u\}J \wedge \\
& \exists H. (J\langle u \rangle H \wedge \exists H'. \exists K. (H[\varepsilon]K \wedge \exists f_{ss}. \exists L_{st}. (\mathbf{Dom}(f) = K \wedge \mathbf{Ran}(f) = \\
& L \wedge \forall k \in K. (k[u']f(k)) \wedge L[\varepsilon']H' \wedge painting\{u'\}H' \wedge like\{\varepsilon'\}H' \wedge \\
& \mathbf{Exp}\{u, \varepsilon'\}H' \wedge \mathbf{Th}\{u', \varepsilon'\}H' \\
& \wedge \forall f'_{ss}. \forall L'_{st}. (\mathbf{Dom}(f') \subseteq K \wedge \mathbf{Ran}(f') = L' \wedge \forall k \in \mathbf{Dom}(f'). (k[u']f'(k)) \wedge \\
& \exists H''_{st}. (L'[\varepsilon']H'' \wedge painting\{u'\}H'' \wedge like\{\varepsilon'\}H'' \wedge \mathbf{Exp}\{u, \varepsilon'\}H'' \wedge \\
& \mathbf{Th}\{u', \varepsilon'\}H'') \rightarrow \forall k \in \mathbf{Dom}(f'). (u'f'(k) \leq u'f(k)))) \wedge \\
& name\{\varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H'))
\end{aligned}$$

We can now examine the truth conditions of this DRS making use of the familiar table format for representing info states. The DRS in (181) will be true with respect to a singleton input info-state I iff there exists an info-state J such that:

a) J is u -different from I and u returns a sum of three students for each assignment in J . Given our adopted definition of dref re-assignment, J must also be singleton, e.g.:

(182)

Info state J , such that $I[u]J$	...	u	...
j	...	$s_1 \oplus s_2 \oplus s_3$	...

b) There exists an info state H , such that $J\langle u \rangle H$. Since the value of u for j is a sum-individual with three atomic sub-parts, H must contain three assignments:

(183)

Info state H , such that $J\langle u \rangle H$	...	u	...
h_1 , such that $h_1[u]j$	...	s_1	...
h_2 , such that $h_2[u]j$	...	s_2	...
h_3 , such that $h_3[u]j$	...	s_3	...

c) There exists an info state H' which differs from H at most with respect to the values for ε , ε' and u' , such that for every assignment h' in H' :

- $u'h'$ is a sum of paintings;
- $\varepsilon'h'$ is a liking event whose experiencer is uh' and whose theme is $u'h'$;
- $\varepsilon h'$ is a naming event whose agent is uh' and whose theme is $u'h'$;
- for any x such that x is a sum of paintings and there is a liking event e whose experiencer is uh' and whose theme is x , x is part of or equal to $u'h'$ (i.e. $u'h'$ is the maximal sum of paintings that uh' liked).

Again, given the adopted definition of \square , H' cannot contain more than three assignments:

(184)

Info state H' , s.t. $H[u']H'$	...	u	ε	u'	ε'	...
h'_1 (such that $h'_1[u']h_1$)	...	s_1	e_1	p_1	e'_1	...
h'_2 (such that $h'_2[u']h_2$)	...	s_2	e_2	p_2	e'_2	...
h'_3 (such that $h'_3[u']h_3$)	...	s_3	e_3	p_3	e'_3	...

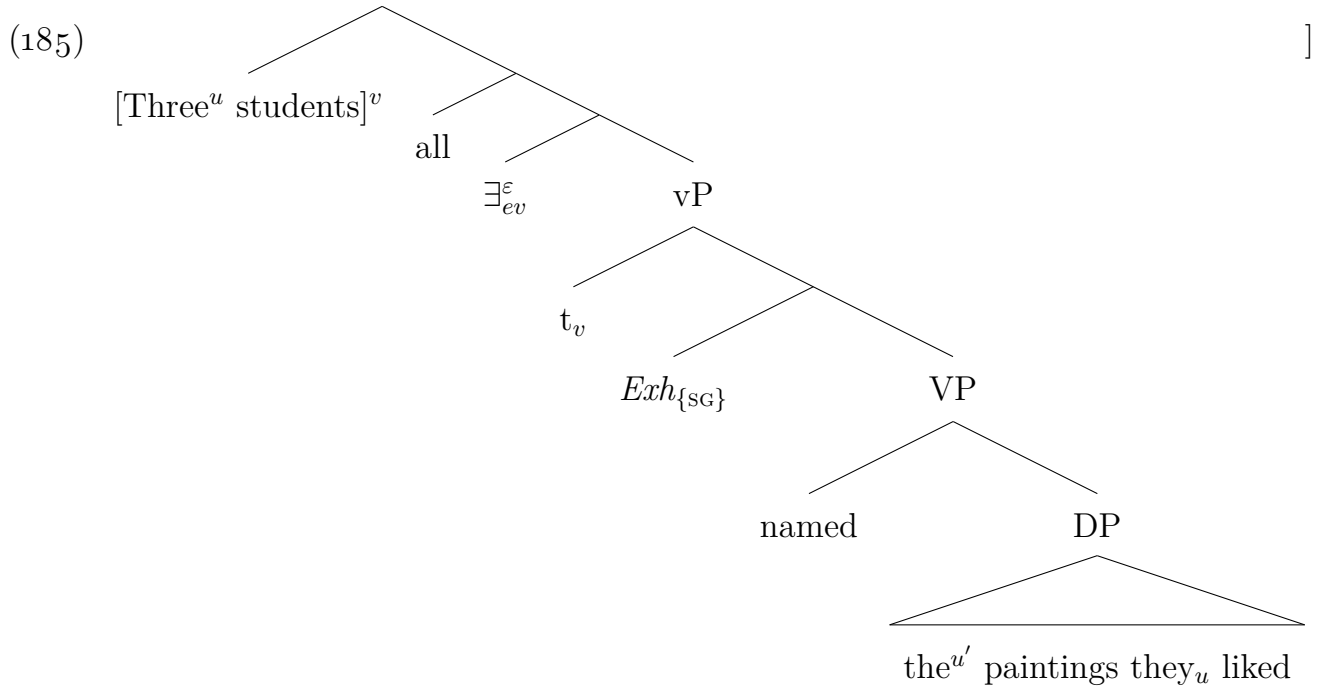
The info state represented in (184) will satisfy the above conditions if p_1 is the maximal sum of painting that s_1 liked, and s_1 named p_1 ; p_2 is the maximal sum of painting that s_2 liked, and s_2 named p_2 ; and p_3 is the maximal sum of painting that s_3 liked, and s_3 named p_3 .

Thus, save for the maximality requirement imposed on the values of the *dref* introduced by the definite DP, the truth conditions for the DRS in (181) are directly parallel those that we derived in section 4.3.1 for constructions involving indefinite dependent plurals. They can be paraphrased as follows: there are three students such that each student named one or more paintings that she liked, and each students named all the paintings that she liked. These truth conditions correctly capture the required interpretation of sentence (168) except for one thing: they falsely predict that (168) will be judged true in a situation where a single painting was named overall. As with dependent plural indefinites, we need to complement the derived truth conditions with an overarching multiplicity requirement. I turn to this issue in the next section.

3.10.2 Definite DPs and the Multiplicity Implicature

In accounting for the multiplicity requirement associated with definite dependent plurals I will follow the same strategy as with dependent indefinites, namely I will derive the Multiplicitiy Condition as a scalar implicature which arises in competition with the singular counterpart of the dependent plural. Indeed, we won't need any additional assumptions to derive the multiplicitiy implicature for plural definites as compared with indefinite DPs.

Recall that following Ivlieva (2013), I assume that scalar implicatures are derived via the insertion of an exhaustivity operator *Exh* at some level in the clausal structure. There are four potential points of insertion in (176): immediately above the VP, immediately above the vP, immediately above the event closure operator, and at the root, above the raised subject. Following the Locality Principle in (62), the first option must be chosen. It is illustrated in (185):



The syntactic *Exh* operator is translated as one of a family of **Exh** operators as defined above in (63). To interpret (185) we need an **Exh** operator of type $(\mathbf{e}(\mathbf{vt}))(\mathbf{e}(\mathbf{vt}))$. This operator was already defined in (137) above, and I repeat the definition in (186):

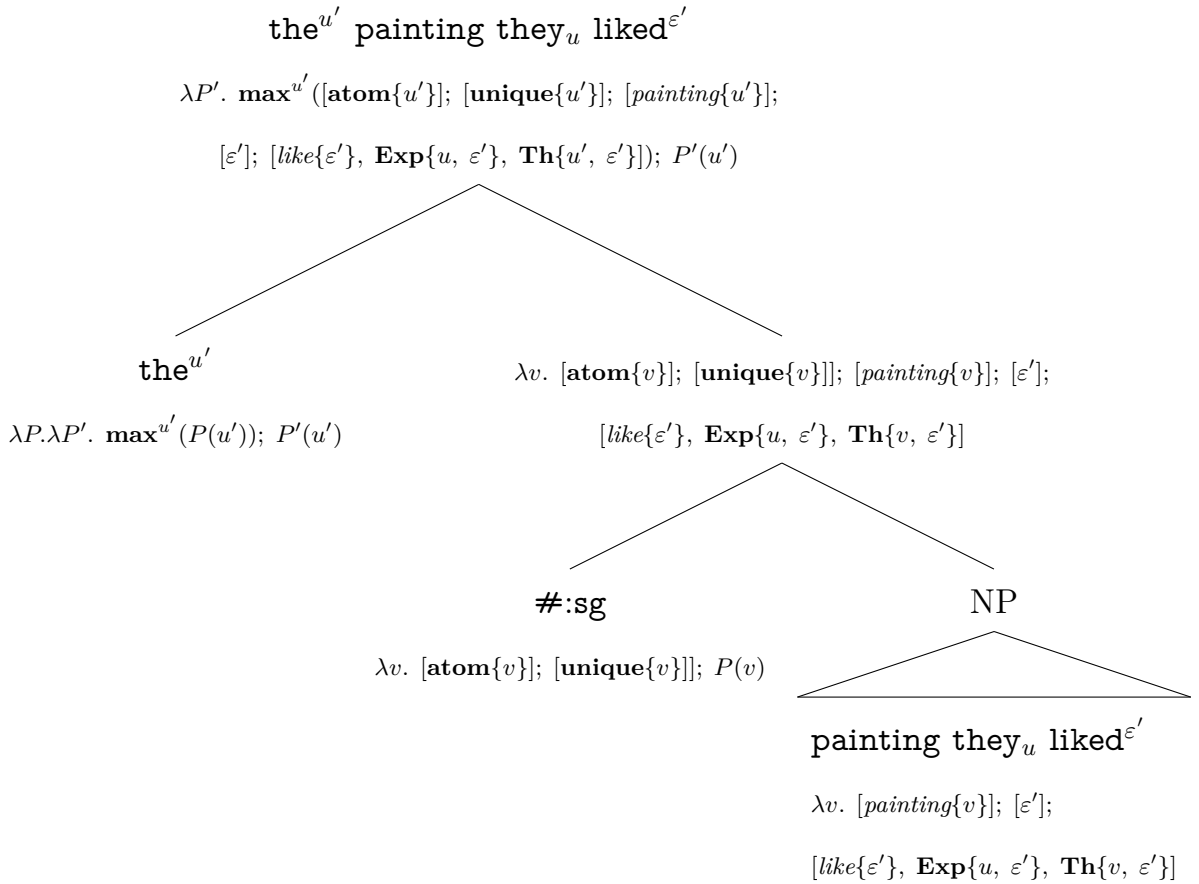
$$(186) \quad \mathbf{Exh}_{\text{ALT}} (\mathbf{e}(\mathbf{vt}))(\mathbf{e}(\mathbf{vt})) (V_{\mathbf{e}(\mathbf{vt})}) := \lambda v_{\mathbf{e}}. \lambda \zeta_{\mathbf{v}}. \lambda I_{st}. \lambda J_{st}. P(\zeta) I J \wedge$$

$$\forall V'_{\mathbf{e}(\mathbf{vt})}. (V' \in \text{ALT} \wedge V' \succ V \rightarrow \neg V'(\zeta)(v) I J),$$

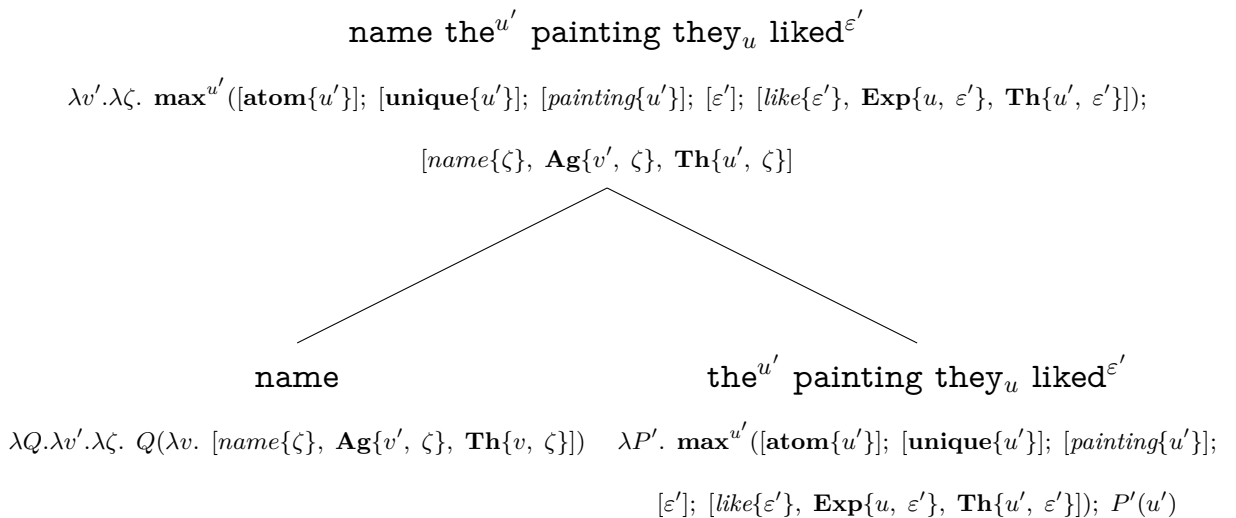
where ALT is the set of alternatives for V .

In order to apply this operator to the translation of the VP in (185) we need to first derive the translation of its alternative, i.e. the VP *named the^u painting they_u liked*, with a singular definite DP as the direct object. For convenience, I first illustrate the compositional translation of the singular definite DP, and then of its combination with the verb:

(187)



(188)



We must now check whether (188) is stronger than (178). We do this based on the definition of the \succ relation in (67), which I repeat here for convenience:

(189) *Generalised Strength*

For any conjoinable type α , such that $\alpha = (\tau_1, (\tau_2(\dots \tau_n \mathbf{t}) \dots))$,

$Q'_\alpha \succ Q_\alpha$ iff:

a) For any appropriate model M and assignment function g , and any a_1 of type τ_1 , ..., a_n of type τ_n , and I_{st} :

if there exists a J'_{st} such that $\llbracket Q'(a_1) \dots (a_n) IJ' \rrbracket^{M,g} = 1$, then there exists a J_{st} , such that $J =_{\{a_1, \dots, a_n\}} J'$ and $\llbracket Q(a_1) \dots (a_n) IJ \rrbracket^{M,g} = 1$.

b) There is an appropriate model M , assignment function g , a_1 of type τ_1 , ..., a_n of type τ_n , I_{st} and J_{st} , such that $\llbracket Q(a_1) \dots (a_n) IJ \rrbracket^{M,g} = 1$ and there does not exist a J'_{st} , such that $J =_{\{a_1, \dots, a_n\}} J'$ and $\llbracket Q'(a_1) \dots (a_n) IJ' \rrbracket^{M,g} = 1$.

Let us represent the expression in (178) as P , and that in (188) as P' . Then:

(190) $P'_{(se(sv((st)(st))))} \succ P_{(se(sv((st)(st))))}$ iff:

a) For any appropriate model M , assignment function g , dref v_{se} , event dref ζ_{sv} and info state I_{st} :

if there exists an info state J'_{st} such that $\llbracket P'(v)(\zeta) IJ' \rrbracket^{M,g} = 1$, then there exists an info state J_{st} such that $J =_{\{v, \zeta\}} J'$ and $\llbracket P(v)(\zeta) IJ \rrbracket^{M,g} = 1$;

b) There is an appropriate model M , assignment function g , dref v_{se} , event dref ζ_{sv} and info states I_{st} and J_{st} such that:

$\llbracket P(v)(\zeta) IJ \rrbracket^{M,g} = 1$ and there is no info state J'_{st} such that $J =_{\{v, \zeta\}} J'$ and $\llbracket P'(v)(\zeta) IJ' \rrbracket^{M,g} = 1$.

In (191) and (192) I repeat the expressions derived in (178) and (188), respectively, together with their unpacked versions, where the **max** operator is replaced with its definition in (175):

$$\begin{aligned}
(191) \quad P &:= \lambda v'. \lambda \zeta. \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}]); \\
&[name\{\zeta\}, \mathbf{Ag}\{v', \zeta\}, \mathbf{Th}\{u', \zeta\}] \\
&:= \lambda v'. \lambda \zeta. \lambda I. \lambda J. \exists f_{ss}. \exists L_{st}. (\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = L \wedge \forall i \in I. (i[u']f(i)) \wedge \\
&L[\varepsilon']J \wedge painting\{u'\}J \wedge like\{\varepsilon'\}J \wedge \mathbf{Exp}\{u, \varepsilon'\}J \wedge \mathbf{Th}\{u', \varepsilon'\}J \wedge \\
&\forall f'_{ss}. \forall L'_{ss}. (\mathbf{Dom}(f') \subseteq I \wedge \mathbf{Ran}(f') = L' \wedge \forall i \in \mathbf{Dom}(f'). (i[u']f'(i)) \wedge \\
&\exists J'_{st}. (L'[\varepsilon']J' \wedge painting\{u'\}J' \wedge like\{\varepsilon'\}J' \wedge \mathbf{Exp}\{u, \varepsilon'\}J' \wedge \mathbf{Th}\{u', \varepsilon'\}J') \rightarrow \\
&\forall i \in \mathbf{Dom}(f'). (u'f'(i) \leq u'f(i))) \wedge name\{\zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge \\
&\mathbf{Th}\{u', \zeta\}J))
\end{aligned}$$

$$\begin{aligned}
(192) \quad P' &:= \lambda v'. \lambda \zeta. \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [painting\{u'\}]; [\varepsilon']; \\
&[like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}]); \\
&[name\{\zeta\}, \mathbf{Ag}\{v', \zeta\}, \mathbf{Th}\{u', \zeta\}] \\
&:= \lambda v'. \lambda \zeta. \lambda I. \lambda J. \exists f_{ss}. \exists L_{st}. (\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = L \wedge \forall i \in I. (i[u']f(i)) \wedge \\
&L[\varepsilon']J \wedge \mathbf{atom}\{u'\}J \wedge \mathbf{unique}\{u'\}J \wedge painting\{u'\}J \wedge like\{\varepsilon'\}J \wedge \\
&\mathbf{Exp}\{u, \varepsilon'\}J \wedge \mathbf{Th}\{u', \varepsilon'\}J \wedge \\
&\forall f'_{ss}. \forall L'_{ss}. (\mathbf{Dom}(f') \subseteq I \wedge \mathbf{Ran}(f') = L' \wedge \forall i \in \mathbf{Dom}(f'). (i[u']f'(i)) \wedge \\
&\exists J'_{st}. (L'[\varepsilon']J' \wedge \mathbf{atom}\{u'\}J' \wedge \mathbf{unique}\{u'\}J' \wedge painting\{u'\}J' \wedge \\
&like\{\varepsilon'\}J' \wedge \mathbf{Exp}\{u, \varepsilon'\}J' \wedge \mathbf{Th}\{u', \varepsilon'\}J') \rightarrow \forall i \in \mathbf{Dom}(f'). (u'f'(i) \leq \\
&u'f(i))) \wedge name\{\zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J))
\end{aligned}$$

We must now determine whether the conditions in (189) are satisfied for the predicates in (191) and (192).

Take a model M , dref u'' , event dref ε and info state I , such that there exists an info state J' where $\llbracket P'(u'')(\varepsilon)IJ' \rrbracket^{M,g} = 1$. Given the conditions in (192), this entails that there is an atomic sum of paintings p , such that for each $i \in I$, ui liked p and $u''i$ named p . Moreover, the maximality condition ensures that for each $i \in I$, p is the only *atomic sum of paintings* that ui liked. Given that *like* is lexically distributive with respect to its theme and *painting* is lexically distributive with respect to its sole argument, and we are only considering models where the lexical distributivity of predicates is respected, it follows that for every $i \in I$, p is the only

sum of paintings that *ui* liked. This means that the conditions in (191) are also satisfied for u'' , ε , I and J' in M , i.e. $\llbracket P(u'')(\varepsilon)IJ' \rrbracket^{M,g} = 1$. The first condition in (189) is thus met.

Now take a model M , dref u , event dref ε , and info state $I = \{i_1, i_2\}$, such that ui_1 liked only an atomic sum of paintings p_1 in M , and named p_1 in M , and ui_2 liked only an atomic sum of paintings p_2 in M , and named p_2 in M , and $p_1 \neq p_2$. Then, there is an output info state J such that $\llbracket P(u)(\varepsilon)IJ \rrbracket^{M,g} = 1$. However, there is no info state J' such that $\llbracket P'(u)(\varepsilon)IJ' \rrbracket^{M,g} = 1$, since by assumption it is not the case that there is a atomic sum of paintings that both ui_1 and ui_2 liked and named. Since M does not violate any restrictions on appropriate models, it follows that the second condition in (189) is also met.

I conclude that the predicate in (192) is indeed stronger than the predicate in (191). Note that this conclusion crucially relies on the assumption that for the purpose of strength comparison we only consider models that respect the lexical distributivity of predicates. If instead the set of appropriate models included also those where lexical distributivity is not respected, the first condition in (189) would not be met, and (192) would not come out as stronger than (191). Then the combination of (192) with the exhaustification operator would not lead to strengthening, and we would thus incorrectly predict a number neutral interpretation for the plural definite in (168).

In our system, however, combining (192) with the *Exh* operator leads to the negation of the stronger alternative, yielding (193):

$$\begin{aligned}
(193) \quad & \lambda v'. \lambda \zeta. \lambda I. \lambda J. \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])IJ \\
& name\{\zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \\
& (\neg \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [painting\{u'\}]; [\varepsilon']; \\
& [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])IJ \vee \neg name\{\zeta\}J \vee \neg \mathbf{Ag}\{v', \zeta\}J \vee \\
& \neg \mathbf{Th}\{u', \zeta\}J) \\
& := \lambda v'. \lambda \zeta. \lambda I. \lambda J. \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])IJ \\
& name\{\zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge \\
& \neg \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [painting\{u'\}]; [\varepsilon']; \\
& [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])IJ
\end{aligned}$$

Given this enriched predicate, the final translation for (185) will be the following:

$$\begin{aligned}
(194) \quad & \lambda I. \lambda J. I[u]J \wedge \mathbf{3_atoms}\{u\}J \wedge student\{u\}J \wedge \\
& \exists H. (J\langle u \rangle H \wedge \exists H'. \exists H''. (H[\varepsilon]H'' \wedge \\
& \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])H''H' \wedge \\
& name\{\varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H' \wedge \\
& \neg \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [painting\{u'\}]; [\varepsilon']; \\
& [like\{\varepsilon'\}, \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])H''H'))
\end{aligned}$$

Compare this DRS to the un-enriched one in (181). Like the DRS in (181) discussed in detail above, the one in (194) will be true if there is a sum of three students, each of whom named the maximal sum of paintings that she liked. However, (194) contains the additional condition which states that it must not be the case that for each student the maximal sum of paintings that she liked is atomic, and this sum is the same for all the students. It follows that more than one painting must be involved overall (e.g., for table 184, this entails that either p_1 , p_2 or p_3 are non-atomic, or p_1 , p_2 and p_3 are not all the same individual). We have thus derived the Multiplicity Condition for the definite dependent plural in (168).

Given that inserting the *Exh* operator at the VP level strengthens the overall meaning, the principle of Locality of *Exh*-insertion blocks the possibility of attach-

ing *Exh* higher in the tree. However, in the case of definite dependent plurals this restriction does not play a significant role. If the exhaustivity operator is allowed to apply e.g. at the root, we obtain the following strengthened DRS for sentence (168) (to shorten the exposition, I will omit the full calculation here):

$$\begin{aligned}
 (195) \quad & \lambda I. \lambda J. I[u]J \wedge \mathbf{3_atoms}\{u\}J \wedge \text{student}\{u\}J \wedge \\
 & \exists H. (J\langle u \rangle H \wedge \exists H'. \exists H''. (H[\varepsilon]H'' \wedge \\
 & \mathbf{max}^{u'}([painting\{u'\}]; [\varepsilon']; [like\{\varepsilon'\}], \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])H''H' \wedge \\
 & \text{name}\{\varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H')) \wedge \\
 & \neg \exists H. (J\langle u \rangle H \wedge \exists H'. \exists H''. (H[\varepsilon]H'' \wedge \\
 & \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [painting\{u'\}]; [\varepsilon']; \\
 & [like\{\varepsilon'\}], \mathbf{Exp}\{u, \varepsilon'\}, \mathbf{Th}\{u', \varepsilon'\}])H''H' \wedge \\
 & \text{name}\{\varepsilon\}H' \wedge \mathbf{Ag}\{u, \varepsilon\}H' \wedge \mathbf{Th}\{u', \varepsilon\}H'))
 \end{aligned}$$

This DRS will be true if there are three students, such that each student s named the maximal sum of paintings s liked, and it is not the case that there is an atomic painting p such that for each student s , p is the only atomic painting that s liked, and s named p . Given the lexical distributivity of the predicates *painting* and *like*, this is again equivalent to the condition that each of the three students named all the paintings that she liked, and more than one painting was named overall.

Summing up, I have demonstrated how the overarching multiplicity condition is derived for sentences like (168), involving definite dependent plural DPs. In the next section I briefly outline an analysis of possessive DPs in the proposed system.

3.10.3 Possessive DPs

Following Brasoveanu (2008) (see also Heim and Kratzer 1998), I will adopt the simplifying assumption that possessive DPs such as *John's books* are covert non-anaphoric definites. The possessive relation between the referent of the possessor

DP and the referent introduced by the determiner 's is then added as part of the restrictor:

$$(196) \quad 's^u \rightsquigarrow \lambda P_{et}. \lambda Q_{(et)t}. \lambda P'_{et}. \mathbf{max}^u(Q([\lambda v. Poss\{v, u\}]); P(u)); P'(u)$$

The DP *John's books* is then translated as follows:

$$(197) \quad \begin{array}{c} \mathbf{John}^{u'} 's^u \mathbf{books} \\ \lambda P'. \mathbf{max}^u([\mathbf{u}' \mid \mathbf{u}' = \mathbf{John}]; [Poss\{\mathbf{u}', \mathbf{u}\}]; [book\{\mathbf{u}\}]); P'(u) \\ \swarrow \quad \searrow \\ \mathbf{John}^{u'} \quad \lambda Q. \lambda P'. \mathbf{max}^u(Q(\lambda v. [Poss\{v, u\}]); [book\{u\}]); P'(u) \\ \swarrow \quad \searrow \\ \lambda P. [\mathbf{u}' \mid \mathbf{u}' = \mathbf{John}]; P(u') \quad 's^u \quad \mathbf{books} \\ \lambda P. \lambda Q. \lambda P'. \mathbf{max}^u(Q([\lambda v. Poss\{v, u\}]); P(u)); P'(u) \quad \lambda v. [book\{v\}] \end{array}$$

Furthermore, I will take possessive pronouns such as *their* to be the surface realisation of the underlying combination 'pronoun + 's':

$$(198) \quad \begin{array}{c} \mathbf{their}_{u'}^u \mathbf{books} \\ \lambda P'. \mathbf{max}^u([Poss\{\mathbf{u}', \mathbf{u}\}]; [book\{\mathbf{u}\}]); P'(u) \\ \swarrow \quad \searrow \\ \mathbf{they}_{u'} \quad \lambda Q. \lambda P'. \mathbf{max}^u(Q(\lambda v. [Poss\{v, u\}]); [book\{u\}]); P'(u) \\ \swarrow \quad \searrow \\ \lambda P. P(u') \quad 's^u \quad \mathbf{books} \\ \lambda P. \lambda Q. \lambda P'. \mathbf{max}^u(Q([\lambda v. Poss\{v, u\}]); P(u)); P'(u) \quad \lambda v. [book\{v\}] \end{array}$$

Given the parallelism between the translations of definite and possessive DPs, dependent possessives in examples like (199) will be analysed analogously to dependent definites discussed above.

$$(199) \quad \text{Three students}^u \text{ all handed in their}_{u'}^u \text{ papers.}$$

3.11 Cumulative Readings

3.11.1 Lexical Cumulativity

In this section I will briefly examine the way cumulative readings can be captured in the proposed system. Consider first the example in (200):

(200) Three^{*u*} students read^{*ε*} five^{*u'*} books.

This sentence has a reading on which there are three students, each of whom read one or more books, and they read five books in total. For instance, (200) will be true in a context where student s_1 read three books, and students s_2 and s_3 read one book each. I will assume that this interpretation arises in the absence of distributivity operators, due to the properties of the lexical relations involved.

The translation of (200), if no distributivity operators are inserted, is the following:

(201) $[u]; [\mathbf{3_atoms}\{u\}]; [student\{u\}]; [\varepsilon]; [u']; [\mathbf{5_atoms}\{u'\}]; [book\{u'\}];$
 $[read\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u', \varepsilon\}]$

This DRS will be true with respect to a singleton input info state $I = \{i\}$ if there exists a singleton info state $J = \{j\}$, such that $i[u, u']j$, uj is a sum of three students, $u'j$ is a sum of five books, and εj is a reading event whose agent is uj and whose theme $u'j$. Recall, that I take most lexical relations, including *read*, as well as thematic relation such as **Ag** and **Th** to be cumulative on the domain level, cf. section 3.2.9 above. I repeat the relevant definitions here for convenience:

(202) *Lexical Cumulativity*

$$\forall x, y (R(x) \wedge R(y) \rightarrow R(x \oplus y))$$

$$\forall x_1, x_2, y_1, y_2. (R(x_1, y_1) \wedge R(x_2, y_2) \rightarrow R(x_1 \oplus x_2, y_1 \oplus y_2))$$

Assuming that *read*, **Ag** and **Th** are lexically cumulative in the above sense, we have an account of the cumulative reading of (200).

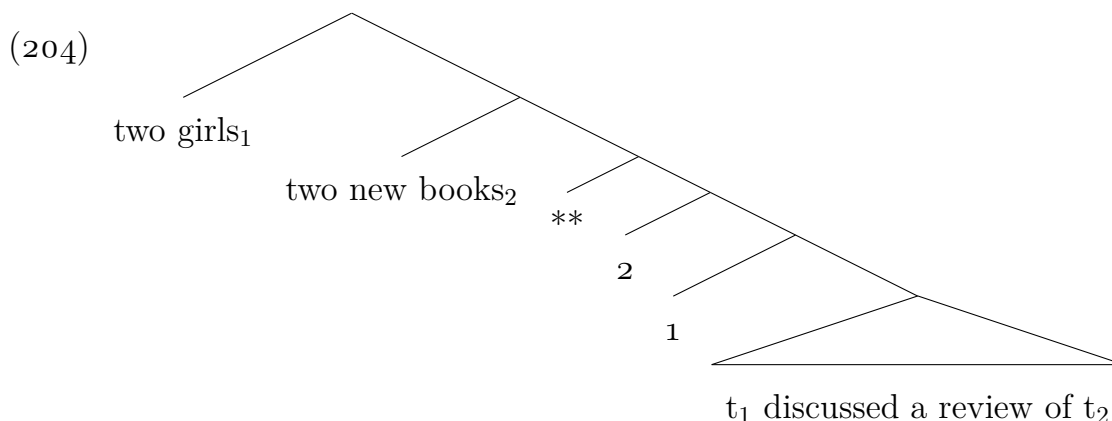
3.11.2 Phrasal Cumulativity

Beck (2000a) and Beck and Sauerland (2001) have argued that lexical cumulativity is not sufficient to account for the full range of cumulative readings. For instance, the following example, adapted from Beck (2000a), has an interpretation on which one girl discussed a review of one new book, and another girl discussed a review of another new book:

(203) Two girls discussed a review of two new books.

Here the two plural DPs are not co-arguments of the same verb, and moreover the DP *two new books* occurs within a singular DP which is interpreted distributively. In this case, there seems to be no way to capture the co-distributive relation between the plural DPs in terms of lexical cumulativity.

Beck (2000a) and Beck and Sauerland (2001) solve this problem by introducing a phrasal cumulativity operator $**$. Sentence (203) on the cumulative reading is then assigned the following logical form, which involves quantifier-raising of both plural DPs above the $**$ -operator:



Beck and Sauerland (2001) define the phrasal cumulativity operator as follows, assuming that DPs quantify over sets of individuals:

(205) $[**R(X)(Y)] = 1$ iff $\forall x \in X. \exists y \in Y. R(x)(y)$ and $\forall y \in Y. \exists x \in X. R(x)(y)$

Here I would like to show how the same idea can be re-cast based on the notions

of weak and strong distributivity that were introduced in this chapter. First, let us generalise the $\langle \rangle$ relation, previously defined for a single dref (cf. 83):

$$(206) \quad \langle u_1, \dots, u_n \rangle := \lambda I_{st}. \lambda J_{st}. \exists f. (I = \mathbf{Dom}(f) \wedge J = \cup \mathbf{Ran}(f) \wedge \\ \forall i_s. \forall H_{st}. (f(i) = H \rightarrow \forall h_s \in H. (i[u_1, \dots, u_n]h \wedge \mathbf{atom}(u_1 h) \wedge \dots \wedge \\ \mathbf{atom}(u_n h)) \wedge \oplus_{u_1} H = u_1 i \wedge \dots \wedge \oplus_{u_n} H = u_n i)),$$

where f is a partial function from the domain of assignments \mathcal{D}_s to the set of info states $\wp(\mathcal{D}_s)$.

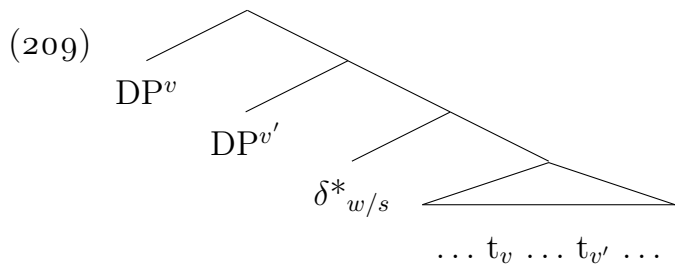
We can now define binary versions of the distributivity operators:

$$(207) \quad \text{a. } \mathbf{dist}_w^*(D)(u)(u') := \lambda I_{st}. \exists J_{st}. (\langle u, u' \rangle; D)IJ \\ \text{b. } \mathbf{dist}_s^*(D)(u)(u') := \lambda I_{st}. \exists J_{st}. (\langle u, u' \rangle; \mathbf{dist}(D))IJ$$

As in the case of standard distributivity operators, binary distributivity operators are encoded in the syntax as phonologically null heads δ_w^* and δ_s^* , which I will refer to as phrasal cumulativity operators, with the following translations:

$$(208) \quad \text{a. } \delta_w^* \rightsquigarrow \\ \lambda P_{\mathbf{e}(\mathbf{et})}. \lambda Q_{(\mathbf{et})\mathbf{t}}. Q(\lambda v'. [\mathbf{dist}_w^*(P(v')(v))(v')(v)]) \\ := \lambda P_{\mathbf{e}(\mathbf{et})}. \lambda Q_{(\mathbf{et})\mathbf{t}}. \lambda v_{\mathbf{e}}. \lambda I_{st}. \lambda J_{st}. Q(\lambda v'. I = J \wedge \exists H_{st}. [J\langle v, v' \rangle H \wedge \\ \exists H'_{st}. (P(v')(v))HH']) \\ \text{b. } \delta_s^* \rightsquigarrow \\ \lambda P_{\mathbf{e}(\mathbf{et})}. \lambda Q_{(\mathbf{et})\mathbf{t}}. Q(\lambda v'. [\mathbf{dist}_s^*(P(v')(v))(v')(v)]) \\ := \lambda P_{\mathbf{e}(\mathbf{et})}. \lambda Q_{(\mathbf{et})\mathbf{t}}. \lambda v_{\mathbf{e}}. \lambda I_{st}. \lambda J_{st}. Q(\lambda v'. I = J \wedge \exists H_{st}. [J\langle v, v' \rangle H \wedge \\ \exists H'_{st}. (\mathbf{dist}(P(v')(v))HH')])$$

Syntactically, δ_w^* and δ_s^* are heads that allow multiple (specifically, two) specifiers. A phrasal cumulative interpretation arises when two plural DPs move into the specifier positions of δ_w^* or δ_s^* , i.e. when the following configuration obtains:



Such structures are then translated via the following rule:

Two-Place Distributive Quantifying-In

If A is a constituent of the following form:

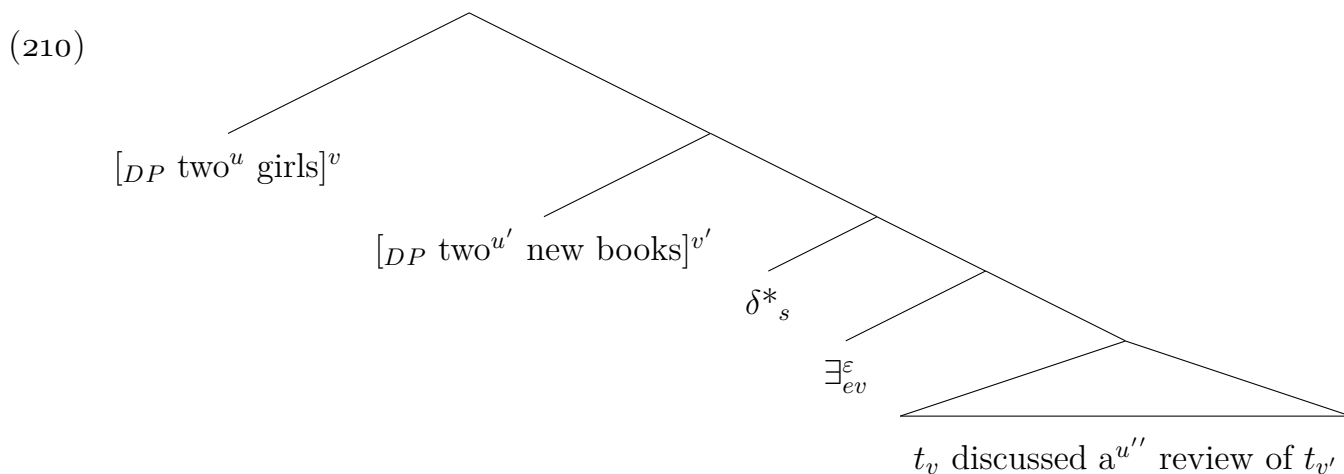
$$[A DP^v [DP^{v'} [\delta^*_{w/s} [B \dots]]]],$$

such that $DP^v \rightsquigarrow \alpha$, $DP^{v'} \rightsquigarrow \beta$, $\delta^*_{w/s} \rightsquigarrow \delta$, and $B \rightsquigarrow \gamma$, then:

$$A \rightsquigarrow \alpha(\delta(\lambda v'. \lambda v. \gamma)(\beta)),$$

provided that this is a well-formed term.

Consider again example (203). This sentence can be analysed as having the following underlying syntactic structure:



Given the translations of its sub-constituents in (211), the structure in (210) is translated via the *Two-Place Distributive Quantifying-In* rule as the DRS in (212):²¹

²¹In these translations I am treating *review* as a two-place predicate.

- (211) a. $\text{two}^u \text{ girls} \rightsquigarrow \lambda P. [u]; [\mathbf{2_atoms}\{u\}]; [\text{girl}\{u\}]; P(u)$
 b. $\text{two}^{u'} \text{ new books} \rightsquigarrow \lambda P. [u']; [\mathbf{2_atoms}\{u'\}]; [\text{new}\{u'\}]; [\text{book}\{u'\}]; P(u')$
 c. $\exists_{ev}^\varepsilon \mathbf{t}_v \text{ discussed a}^{u''} \text{ review of } \mathbf{t}_{v'} \rightsquigarrow$
 $[\varepsilon]; [u'']; [\mathbf{atom}\{u''\}]; [\mathbf{unique}\{u''\}]; [\text{review}\{u'', v'\}];$
 $[\text{discuss}\{\varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}]$
- (212) $\lambda I_{st}. \lambda J_{st}. I[u, u']J \wedge \mathbf{2_atoms}\{u\}J \wedge \text{girl}\{u\}J \wedge \mathbf{2_atoms}\{u'\}J \wedge$
 $\text{new}\{u'\}J \wedge \text{book}\{u'\}J \wedge \exists H_{st}. (J\langle u, u' \rangle H \wedge$
 $\exists H'_{st}. (\mathbf{dist}([\varepsilon]; [u'']; [\mathbf{atom}\{u''\}]; [\mathbf{unique}\{u''\}]; [\text{review}\{u'', u'\}];$
 $[\text{discuss}\{\varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}])HH')$

This DRS will be true with respect to a singleton input info state I iff there exists a singleton output info state $J = \{j\}$ such that j differs from i at most with respect to the values of u and u' , and the following conditions hold:

- a) uj is a sum of two girls, and $u'j$ is a sum of two new books:

(213)

Info state J	...	u	u'	...
j	...	$g_1 \oplus g_2$	$b_1 \oplus b_2$	...

b) There exists an info state H such that $J\langle u, u' \rangle H$. Given the definition of $\langle \rangle$ in (206), H must be such that for each $h \in H$: h differs from j at most with respect to the values of u and u' , uh and $u'h$ are atomic individuals, and the sum of values of u for all the assignments in H equals uj , and the sum of values of u' for all the assignments in H equals $u'j$. E.g.:

(214)

Info state H	...	u	u'	...
h_1	...	g_1	b_2	...
h_2	...	g_2	b_1	...

c) Finally, following the definition the **dist** operator, there must exist an info state H' which is the union of info states H_1'', \dots, H_n'' , such that each $h \in H$ corresponds to a singleton info state $H'' = \{h''\}$ in $\{H_1'', \dots, H_n''\}$, such that h'' differs from h at most with respect to the values of ε and u'' , $u''h''$ is an atomic review of $u'h''$, and $\varepsilon h''$ is a discussing event whose agent is uh'' and whose theme is $u''h''$. For example, for H in (214), there must exist two info states of the following form, where r_1 is a review of b_2 , e_1 is a discussing event whose agent is g_1 and whose theme is r_1 , and r_2 is a review of b_1 and e_2 is a discussing event whose agent is g_2 and whose theme is r_2 :

(215)

Info state H_1''	...	u	u'	ε	u''	...
h_1''	...	g_1	b_2	e_1	r_1	...
Info state H_2''	...	u	u'	ε	u''	...
h_2''	...	g_2	b_1	e_2	r_2	...

It is evident that these truth-conditions correspond to the phrasal cumulative reading of (203).

3.12 Plural Pronouns and Distributivity

In the previous sections we have considered the interpretation of indefinite plurals and non-anaphoric definite plurals in the scope of distributivity operators. In this section I would like to address a number of issue issues that arise when we apply the proposed system to pronouns, and more generally, to anaphoric nominal expression.

3.12.1 Pronoun Reference Ambiguity under Distributivity Operators

Let us start by examining a particular ambiguity that regularly arises when plural pronouns occur in the scope of distributivity operators. Consider the following example from Kamp and Reyle (1993):

(216) The^u lawyers hired^ε a^{u'} secretary they liked^{ε'}.

This sentence can have a distributive interpretation, where each lawyer hired a possibly different secretary. As Kamp and Reyle (1993) point out, the interpretation of the pronoun *they* under this kind of reading is ambiguous in the following way: it can refer to each individual lawyer or to the whole group of lawyers referred to by the subject.²² That is, (216) can have two distinct distributive interpretations. On the one hand, (216) can mean that each lawyer x in the group of lawyers X hired a secretary that x liked. Let's call this the distributive interpretation of the pronoun. Alternatively, (216) can mean that each lawyer x in the group of lawyers X hired a secretary that the lawyers X liked. I will refer to this as the group interpretation of the pronoun. It turns out, that this ambiguity cannot be captured under our current assumptions. Let us see why.

In the current framework, the distributive interpretation of examples like (216) is derived by positing a phonologically null distributivity operator below the subject. In the case of (216), this must be a strong distributivity operator, given that the DP *a secretary* is singular:

(217) The^u lawyers δ_s hired^ε a^{u'} secretary they_u liked^{ε'}.

Suppose the subject in (217) refers to a sum of two lawyers, $l_1 \oplus l_2$. Then, given the translation of the strong distributivity operator in (89), (217) will be true if there exist two singleton info states of the following form, where s_1 and s_2 are

²²There is of course a third option where the pronoun refers to some third-party individual provided by the context. This reading is not relevant for the current discussion, and I disregard it.

atomic individuals who are secretaries, e_1 and e_2 are hiring events, such that l_1 is the agent of e_1 , s_1 is the theme of e_1 , l_2 is the agent of e_2 , and s_2 is the theme of e_2 , and e'_1 and e'_2 are liking events, such that s_1 is the theme of e'_1 and s_2 is the theme of e'_2 :

(218)

Info state H''_1	...	u	u'	ε	ε'	...
h''_1	...	l_1	s_1	e_1	e'_1	...
Info state H''_2	...	u	u'	ε	ε'	...
h''_2	...	l_2	s_2	e_2	e'_2	...

Now consider the interpretation of the pronoun *they* in (217). Since we want its reference to be tied to that of the subject, we must assume that it carries the same index, i.e. u . This would derive the distributive interpretation of the pronoun, since *they* would be interpreted with respect to each of the info states in (218), for which u returns the individual lawyers. There seems however, to be no straightforward way to derive the group reference of the pronoun: in the scope of the distributivity operator the original ‘group’ reference of u to the sum of two lawyers is no longer accessible.

This problem can be solved by assuming, in the spirit of Kamp and Reyle 1993, that distributivity operators do not directly ‘split’ the reference of the DP they combine with. Instead, they introduce a new dref which returns the same value for the original info state as the dref they take as argument, and then split this newly introduced dref:

(219) *Distributivity operators (revised version)*

a. δ_w^u , $all^u \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.[u \mid u = v]; [\mathbf{dist}_w(P(u))(u)]$

$:= \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge (u = v)J \wedge \exists H_{st}.[J\langle u \rangle H \wedge \exists H'_{st}.(P(u))HH']$

b. δ_s^u , $each^u \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.[u \mid u = v]; [\mathbf{dist}_s(P(u))(u)]$

$:= \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge (u = v)J \wedge \exists H_{st}.[J\langle u \rangle H \wedge \exists H'_{st}(\mathbf{dist}(P(u)))HH']$

The equality relation between drefs used here (e.g. $u = v$) is an abbreviation for the following:

(220) $u = u' := \lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (ui = u'i)$

Given the revised translations in (219), the ‘group’ reference of the DP that a distributivity operator combines with remains accessible in the scope of that operator. Thus, the distributive and group interpretations of a plural pronoun in the scope of a distributivity operator can be distinguished by co-indexing the pronoun either directly with the antecedent DP (for a group interpretation) or with the distributivity operator (for a distributive interpretation), e.g.:

(221) a. The^{*u*} lawyers $\delta_s^{u''}$ hired ^{ε} a^{*u'*} secretary they_{*u*} liked ^{ε'} .

b. The^{*u*} lawyers $\delta_s^{u''}$ hired ^{ε} a^{*u'*} secretary they_{*u''*} liked ^{ε'} .

In the following, I will continue to use the simpler translations of distributivity operators in (89) when the issue of pronominal interpretation is not directly relevant for the discussion, keeping in mind however, that their actual translations should be more in lines with (219).²³

²³The proposed system, incorporating the *Distributive Quantifying-In* rule introduced in section 3.7.3 and the revised translations of the distributivity operators in (219), can be generalised in an interesting way to account, in a CDRT-style framework, for the contrast between strict and sloppy readings of pronouns under ellipsis, and generally between what has been standardly analysed in static semantic frameworks as a difference between ‘binding’ and ‘co-reference’ (cf. e.g. the discussion in Heim and Kratzer 1998:Ch.9, and references therein). Let us stipulate that all syntactic movement occurs into specifier positions of a class of designated functional heads, call them *binders*. This class includes distributivity operators, but also a non-distributive, ‘neutral’,

3.12.2 Pronoun-Antecedent Agreement

As it stands now, the proposed theory of distributivity faces a significant empirical problem: it predicts that in the scope of strong distributivity operators singular pronouns will be able to pick out drefs introduced by plural antecedents. To see why this is a problem, consider the following example:

(225) Three girls each bought a car that she liked

In this sentence, each girl is associated with a possibly different car. This reading is enforced by the presence of a strong distributivity operator *each*.

Now consider the following indexing:

(226) *Three^{*u*} girls each^{*u*2} bought ^{ε 1} a^{*u*3} car that she_{*u*2} liked ^{ε 2}.

We have assumed that indices are chosen freely in the syntax. Moreover, nothing in the semantics as it stands at the moment prevents the singular pronoun to be co-indexed with the distributivity operator in this configuration. Indeed, since the VP in (226) is combined with a strong distributivity operator, it will be interpreted binder head, call it β , with the following interpretation, parallel to (219):

(222) $\beta^u \rightsquigarrow \lambda P_{\text{et}}.\lambda v_e.[u \mid u = v]; P(u)$

Then, the translation of all Quantifying-In structures can be reduced to the *Distributive Quantifying-In* rule given in section 3.7.3. Now, consider a standard example of VP-ellipsis, involving a pronoun in the elided VP:

(223) John^{*u*} likes his mother, and Bill^{*u'*} does too <like his mother>.

This sentence has three distinct readings: John likes John's mother and Bill likes John's mother (the strict interpretation of the pronoun), John likes John's mother and Bill likes Bill's mother (the sloppy interpretation), or John likes the mother of some third-party individual *x* and Bill likes the mother of *x*. Given the above assumptions, we can capture the syntactic parallelism condition on ellipsis by requiring for all pronouns in the elided structure to either carry the same index as the corresponding pronouns in the antecedent structure, or be co-indexed with the corresponding binders. The three readings for (223) listed above, then correspond to the following structures, all satisfying this condition:

(224) a. John^{*u*} β^w likes his^{*u*} mother, and Bill^{*u'*} does too < β^w like his^{*u*} mother>.
 b. John^{*u*} β^w likes his^{*w*} mother, and Bill^{*u'*} does too < β^w like his^{*w'*} mother>.
 c. John^{*u*} β^w likes his^{*u''*} mother, and Bill^{*u'*} does too < β^w like his^{*u''*} mother>.

I will leave the investigation of further semantic and syntactic implications of this approach for future research.

separately with respect to three singleton info states, such that for each of them u_2 returns one of the three girls. Thus, u_2 will be atomic and unique with respect to each of these info states, and the conditions imposed by the singular feature on the pronoun will be satisfied.

Thus, our system predicts the indexing in (226) to be available, which is clearly incorrect: sentence (226) cannot be interpreted as stating that each girl bought a car that she herself liked.

Compare (226) to example (227), which involves a singular quantifier as the subject. Recall, that singular quantifiers induce strong distributivity, and (227) is fine on the bound variable interpretation of the pronoun:

(227) Each^{*u*} girl bought a car that she_{*u*} liked.

So how do we rule out the configuration in (226), while allowing for (227)? Intuitively, the problem with (226) is that the number feature on the pronoun does not match the number feature on the antecedent DP. Thus, the problem could be solved by introducing a formal matching condition, that would ensure that pronouns and their antecedent DPs carry the same number feature.

There is independent evidence that formal matching conditions of this kind are necessary. Kamp and Reyle (1993) have argued in favour of a condition which matches the gender feature of a pronoun with that of its antecedent. For instance, they observe that the reference of the pronouns *it* and *him* is unambiguous in the following example due to gender agreement of the pronouns with the antecedent DPs (cf. also the observations to the same effect in Krifka 1996):

(228) Jones owns Ulysses. It fascinates him.

A stronger argument in support of a purely formal condition on pronoun-antecedent agreement can be given based on data from languages that possess a more elaborate system of grammatical gender, e.g. Russian.²⁴ Consider the

²⁴One could in principle attribute the restricted choice of antecedents for the pronouns in (228) to a semantic condition on pronoun referents. On such a theory, *it* would be required to refer to non-human individuals, while *he* conversely would have to refer to humans. This would be

following examples:

- (229) a. Na ulice stoit mašina. Ona/*on signalit.
 on street stand car.F pro.F/*pro.M signals
 ‘A car is standing in the street. It is signalling.’
- b. Na ulice stoit avtomobil. On/*ona signalit.
 on street stand car.M pro.M/*pro.F signals
 ‘A car is standing in the street. It is signalling.’

As the translation indicates, both of these sentence can be used to describe the same state of affairs, i.e. the DPs *mašina* and *avtomobil* can be used to refer to the same object. The difference between these nouns in the given context is purely formal: *mašina* is feminine, while *avtomobil* is masculine. However, as the examples demonstrate, this difference must be reflected in the choice of pronouns which have these DPs as their antecedents: only a feminine pronoun can be used if the antecedent is the feminine *mašina*, and only a masculine pronoun can be used if the antecedent the masculine *avtomobil*.

In this case the restriction on pronoun gender cannot be attributed to a restriction on the individuals that the pronoun refers to, because both pronouns can refer to the same individual. The choice of gender on the pronoun is determined solely by the grammatical gender of the antecedent DP.

I propose that a similar formal matching condition exists for the number feature. I will implement this condition by introducing a fixed non-logical constant \mathbf{Num}_{sg} of type $(se)st$, which classifies pairs of assignments and drefs into two sets: singular and plural. This function is then added to the translations of the number features:²⁵

- (230) a. $\# : sg \rightsquigarrow \lambda v_e. \lambda I_{st}. \lambda J_{st}. \mathbf{atom}\{v\}J \wedge \mathbf{unique}\{v\}J \wedge \forall j \in J. (\mathbf{Num}_{sg}(v)(j))$
- b. $\# : pl \rightsquigarrow \lambda v_e. \lambda I_{st}. \lambda J_{st}. I = J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(v)(j))$

sufficient to explain the pattern in (228). Thus, this example cannot be taken as conclusive evidence for a purely *formal* condition on pronoun-antecedent agreement.

²⁵The matching condition on gender can be implemented in a similar way, by introducing a set of disjoint functions of type $(se)st$ encoding the grammatical gender features. Here, I disregard conditions on gender agreement.

I will use the following predicates to abbreviate these new conditions:

$$(231) \quad \text{a. } \mathbf{Sg}\{u\} := \lambda J_{st}. \forall j \in J. (\mathbf{Num}_{sg}(u)(j))$$

$$\text{b. } \mathbf{Pl}\{u\} := \lambda J_{st}. \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j))$$

Then, the translations of the number features can be stated in an abbreviated form:

$$(232) \quad \text{a. } \# : \text{sg} \rightsquigarrow \lambda v_e. [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]; [\mathbf{Sg}\{v\}]$$

$$\text{b. } \# : \text{pl} \rightsquigarrow \lambda v_e. [\mathbf{Pl}\{v\}]$$

For the system to function correctly, we must ensure that the values for \mathbf{Num}_{sg} that were previously fixed are preserved when the info state is modified. This can be done by adding the relevant conditions to the definitions of the $[]$ and $\langle \rangle$ relations:

$$(233) \quad \text{a. } [u] := \lambda g_s. \lambda h_s. \forall v_{se}. (v \neq u \rightarrow (vg = vh \wedge \mathbf{Num}_{sg}(v)(g) = \mathbf{Num}_{sg}(v)(h)))$$

$$\text{b. } \langle u \rangle := \lambda I_{st}. \lambda J_{st}. \exists f. (I = \mathbf{Dom}(f) \wedge J = \cup \mathbf{Ran}(f) \wedge \forall i_s. \forall H_{st}. (f(i) = H \rightarrow \forall h_s \in H. (i[u]h \wedge \mathbf{atom}(uh) \wedge \mathbf{Num}_{sg}(u)(i) = \mathbf{Num}_{sg}(u)(h)) \wedge \oplus uH = ui)),$$

where f is a partial function from \mathcal{D}_s to \mathcal{D}_s .

Next, I will modify Axiom 4 in (27d) to ensure that we always have enough assignments not only with respect to the values of a dref, but also with respect to the value of the \mathbf{Num}_{sg} relation:

$$(234) \quad \text{Axiom 4 (revised)}$$

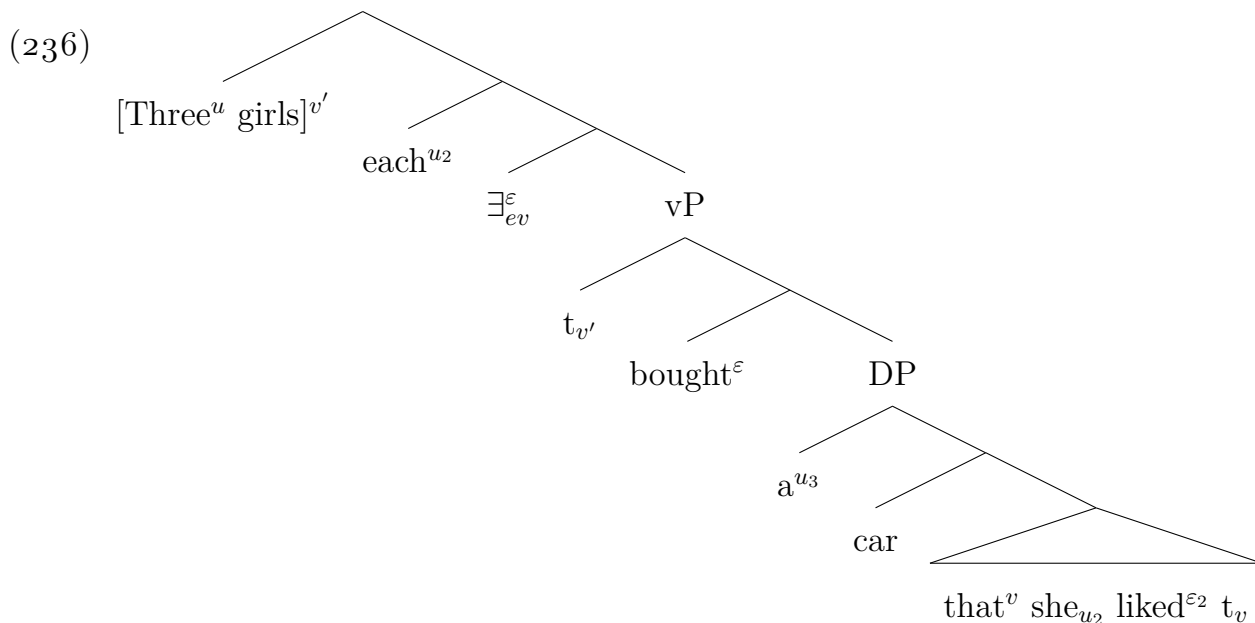
$$\forall i_s. \forall v_{se}. \forall x_e. (\mathbf{udref}(v) \rightarrow \exists j_s. (i[v]j \wedge vj = x \wedge \mathbf{Num}_{sg}(v)(j)) \wedge \exists j_s. (i[v]j \wedge vj = x \wedge \neg \mathbf{Num}_{sg}(v)(j)))$$

Finally, I will add the condition of \mathbf{Num}_{sg} -equivalence to the $=$ -relation between drefs:

$$(235) \quad u = u' := \lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (ui = u'i \wedge \mathbf{Num}_{sg}(u)(i) = \mathbf{Num}_{sg}(u')(i))$$

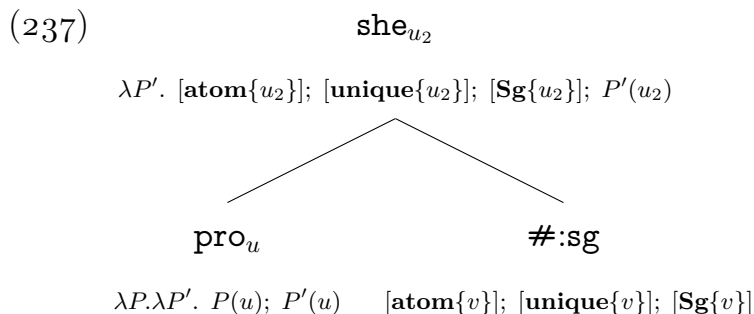
This makes sure that the value of \mathbf{Num}_{sg} is correctly passed on by the syntactic distributivity operators in (219).

Given these modifications, the bound variable reading of the pronoun in (226) will be blocked. To see why, consider the compositional translation of sentence (226). I assume the following syntactic structure for (226):

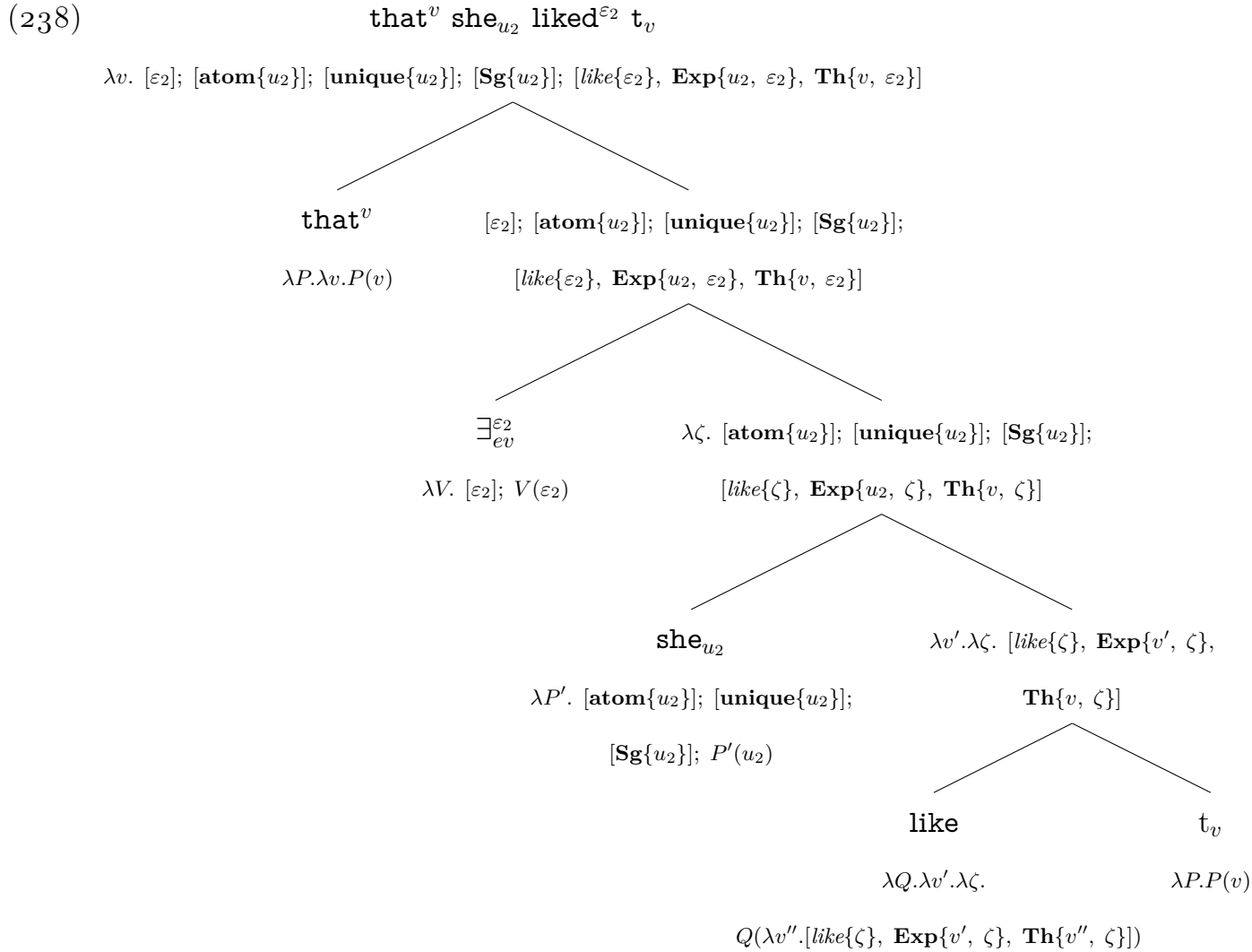


Recall that in our system bound variable reading of pronouns under distributivity operators arise if the pronouns are co-indexed with the distributivity operators (cf. the previous section). Thus, in (236) the distributivity operator and the pronoun carry the same index (u_2). I will now show how this indexing configuration is ruled out under the proposed account of pronoun-antecedent agreement.

Let us start with the translation of the the singular pronoun:



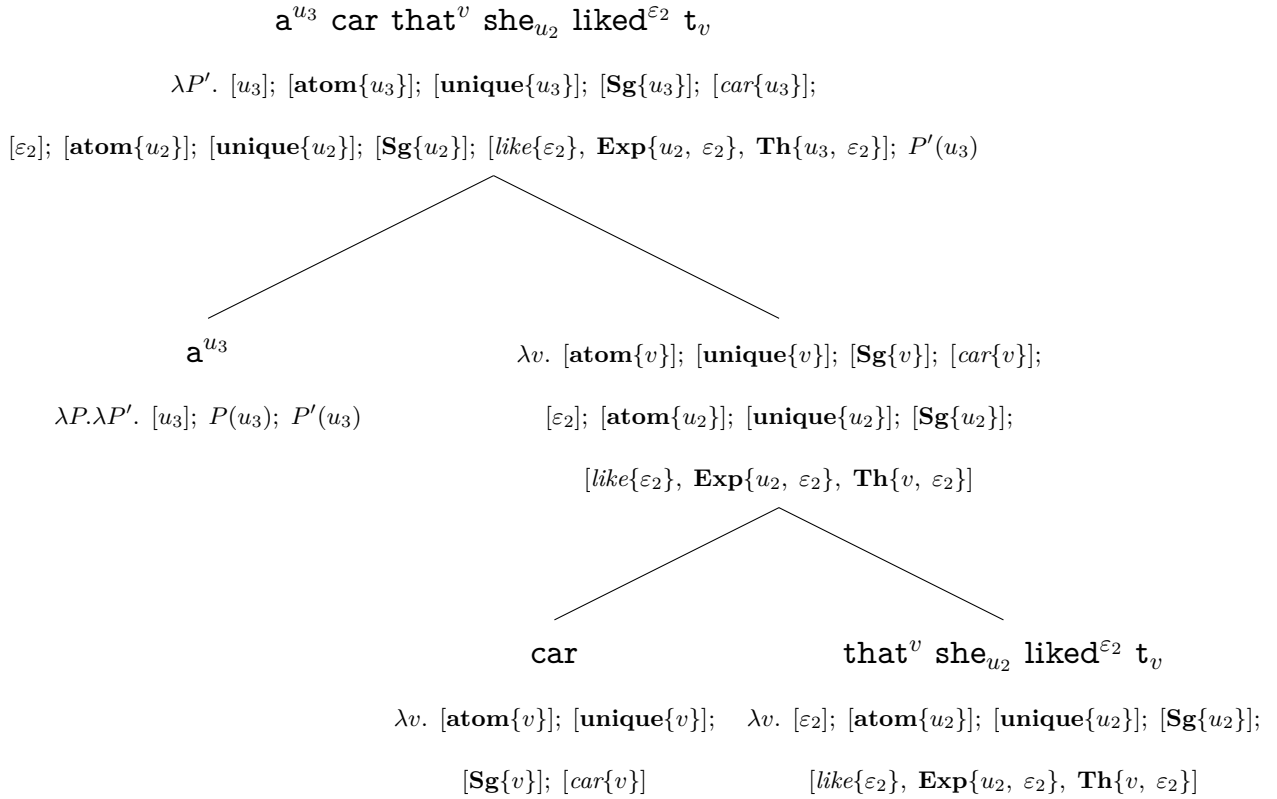
The translation of the relative clause is then the following:²⁶



Now we can calculate the translation of the whole direct object DP in (236):

²⁶I analyse the relative pronoun as semantically vacuous: it combines with a predicate and returns the same predicate. The main function of the relative pronoun is to trigger the Quantifying-In Rule, which establishes binding of the trace by a lambda-operator.

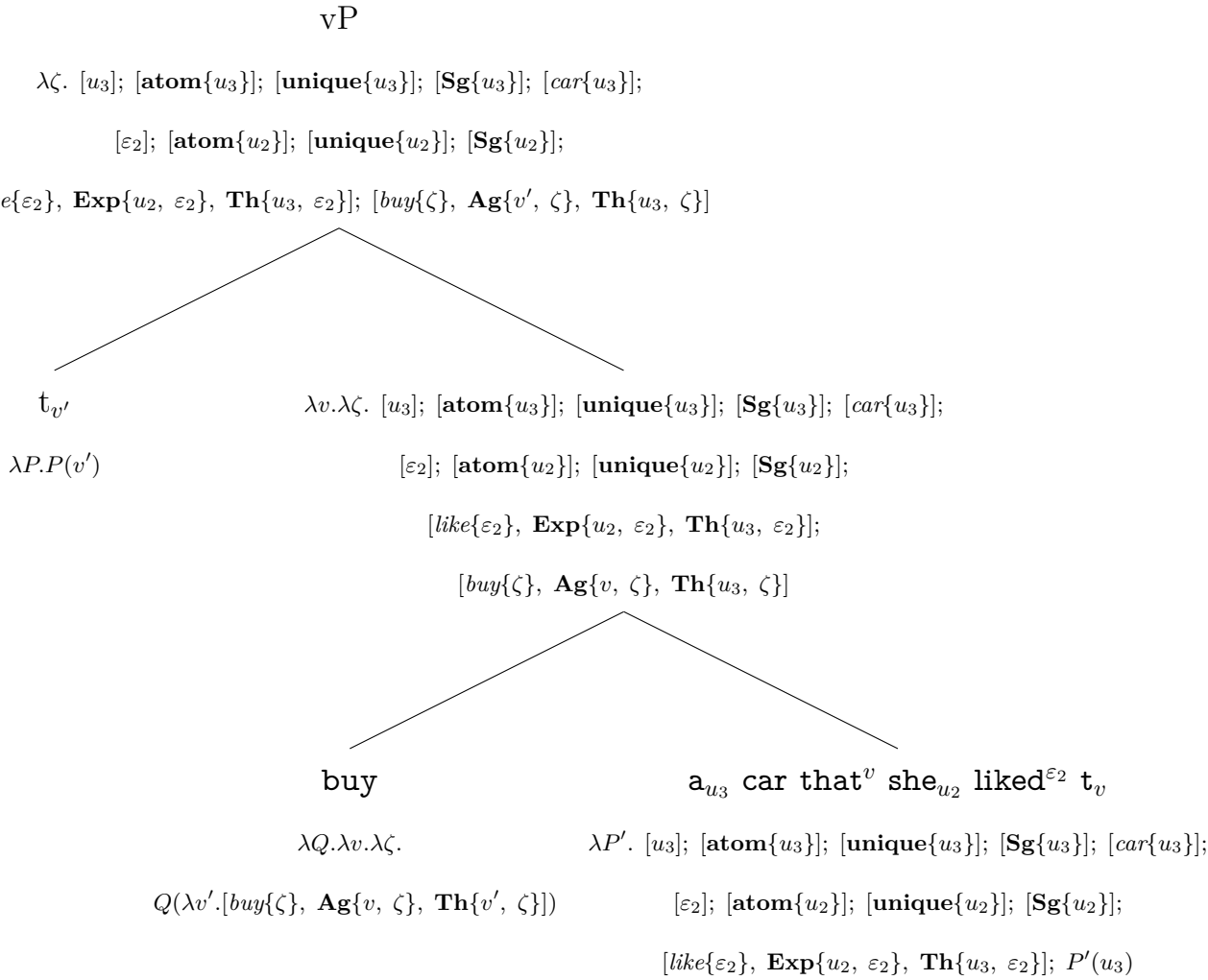
(239)



By assumption, the subject in (226) must raise outside of the vP to a position above the distributivity operator, leaving a trace in its base position. The translation of the vP is then the following:²⁷

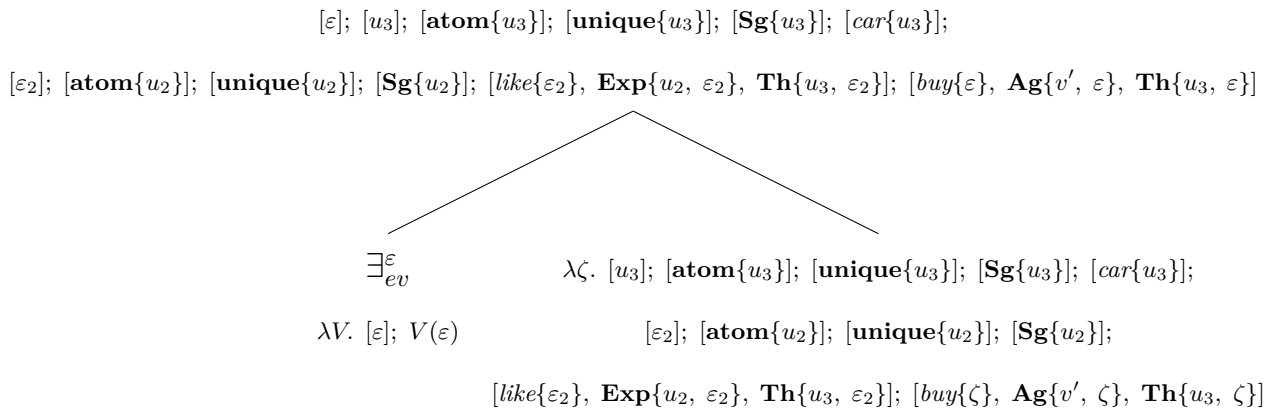
²⁷Note, that translation of the VP must be lifted to combine with the subject trace. I omit the lifted variant of the translation for reasons of space.

(240)



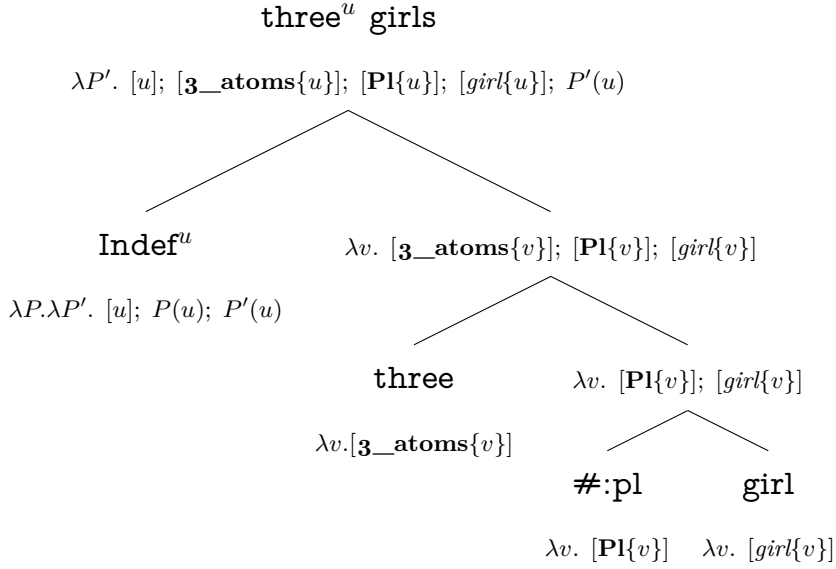
The vP then combines with the event closure operator:

(241)



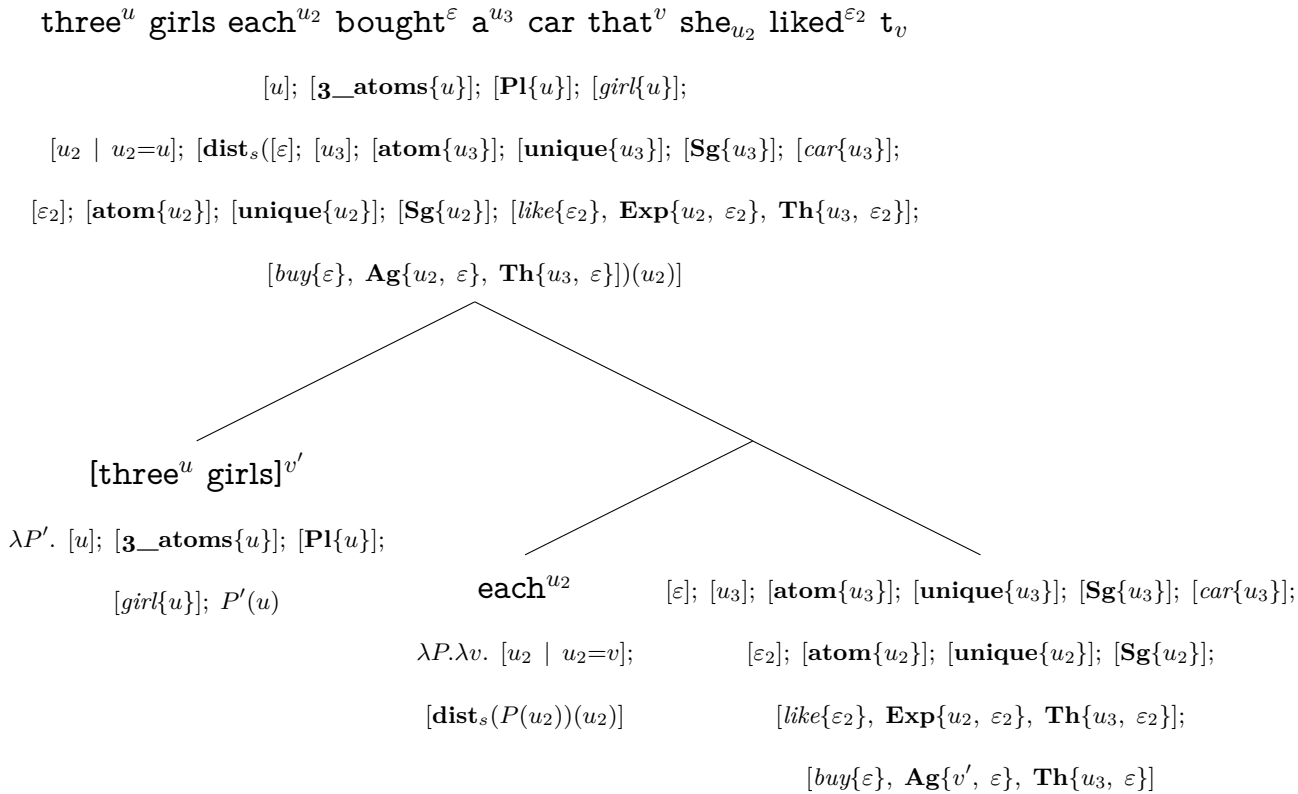
Next, the translation in (241) combines with the strong distributivity operator and the raised subject. The subject has the translation in (242):

(242)



Finally, the DRS in (241) combines with the strong distributivity operator and the raised subject in (242) via the Distributive Quantifying-In rule, yielding the following DRS as the translation of sentence (226):

(243)



Let us analyse the truth conditions of the DRS in (243) in the familiar way. This DRS will be true with respect to a singleton info state $I = \{i\}$, if there exists

a singleton output info state $J = \{j\}$, such that:

a) j differs from i at most with respect to the values of u and u_2 .

b) $u_j = u_2j$, it is a sum of three girls, and $\neg\mathbf{Num}_{sg}(u)(j)$ and $\neg\mathbf{Num}_{sg}(u_2)(j)$

(cf. the definition in 226):

(244)

Info state J	...	u	u_2	...
j (such that $i[u, u_2]j$)	...	$g_1 \oplus g_2 \oplus g_3$	$g_1 \oplus g_2 \oplus g_3$	...

c) There exists a set of three singleton info states $H_1 = \{h_1\}$, $H_2 = \{h_2\}$, and $H_3 = \{h_3\}$, such that $u_2h_1 \oplus u_2h_2 \oplus u_2h_3 = u_2j$, and the following conditions holds for each $h \in \{h_1, h_2, h_3\}$:

c1) h differs from j at most with respect to the values of u_2 , u_3 , ε and ε_2 .

c2) given the translation of the distributivity operator in (219b) and the revised definition of the $\langle \rangle$ -relation in (233b), it follows that $\mathbf{Num}_{sg}(u_2)(h) = \mathbf{Num}_{sg}(u_2)(j)$.

c3) u_3h is an atomic car, and $\mathbf{Num}_{sg}(u_3)(h)$.

c4) u_2h is a atomic individual and $\mathbf{Num}_{sg}(u_2)(h)$.

c5) εh is a buying event, whose agent is u_2h and whose theme is u_3h .

c6) ε_2h is a liking event, whose experiencer is u_2h and whose theme is u_3h .

(245)

Info state H_1	...	u	u_2	u_3	ε	ε_2	...
h_1	...	$g_1 \oplus g_2 \oplus g_3$	g_1	c_1	e_1^{buy}	e_1^{like}	...
Info state H_2	...	u	u_2	u_3	ε	ε_2	...
h_2	...	$g_1 \oplus g_2 \oplus g_3$	g_2	c_2	e_2^{buy}	e_2^{like}	...
Info state H_3	...	u	u_2	u_3	ε	ε_2	...
h_3	...	$g_1 \oplus g_2 \oplus g_3$	g_3	c_3	e_3^{buy}	e_3^{like}	...

Here, g_1 , g_2 , and g_3 are atomic girls, c_1 , c_2 , and c_3 are atomic cars, e_1^{buy} , e_2^{buy} , and e_3^{buy} are buying events, and e_1^{like} , e_2^{like} , and e_3^{like} are liking events. The following relations hold: for each $n \in \{1, 2, 3\}$, g_n is the agent of e_n^{buy} and experiencer of e_n^{like} , and c_n is the theme of e_n^{buy} and e_n^{like} . In other words g_1 liked and bought car c_1 , g_2 liked and bought car c_2 , and g_3 liked and bought car c_3 .

If we ignore the values of \mathbf{Num}_{sg} and the conditions placed on those values, the above truth conditions amount to saying that there are three girls, each of whom bought a car that she liked. However, the conditions imposed on the values of \mathbf{Num}_{sg} in (243) give rise to a contradiction. On the one hand, $\neg\mathbf{Num}_{sg}(u_2)(j)$ must hold, due to the plural feature on the subject and the condition $u = u_2$. On the other hand, the singular feature on the embedded pronoun requires for $\mathbf{Num}_{sg}(u_2)(h)$ to hold for every $h \in \{h_1, h_2, h_3\}$. Finally, the definition of the $\langle \rangle$ -relation in (233b) states that the value of $\mathbf{Num}_{sg}(u_2)(h)$ must be the same as $\mathbf{Num}_{sg}(u_2)(j)$ for each $h \in \{h_1, h_2, h_3\}$. This is impossible, and hence the DRS in (243) cannot be true in any context.

Thus, I have demonstrated how mismatches between the number features of pronouns and their antecedents, as in (226), can be ruled out by making use of a designated relation \mathbf{Num}_{sg} between drefs and assignments. However, the proposed modification of the semantics of number features gives rise to a complication, due to the fact the translation of the singular is no longer strictly stronger than that of the plural. Consequently, in order to maintain our analysis of the multiplicity implicature associated with plural DPs, we must modify the way the exhaustification operator is defined.

Recall our definitions of strength and exhaustification, which I repeat in (246) and (247):

(246) *Generalised Strength*

For any conjoinable type α , such that $\alpha = (\tau_1, (\tau_2(\dots \tau_n \mathbf{t}) \dots))$,

$Q'_\alpha \succ Q_\alpha$ iff:

a) For any appropriate model M and assignment function g , and any a_1 of type τ_1 , ..., a_n of type τ_n , and I_{st} :

if there exists a J'_{st} such that $\llbracket Q'(a_1) \dots (a_n) IJ' \rrbracket^{M,g} = 1$, then there exists a J_{st} , such that $J =_{\{a_1, \dots, a_n\}} J'$ and $\llbracket Q(a_1) \dots (a_n) IJ \rrbracket^{M,g} = 1$.

b) There is an appropriate model M , assignment function g , a_1 of type τ_1 , ..., a_n of type τ_n , I_{st} and J_{st} , such that $\llbracket Q(a_1) \dots (a_n) IJ \rrbracket^{M,g} = 1$ and there does not exist a J'_{st} , such that $J =_{\{a_1, \dots, a_n\}} J'$ and $\llbracket Q'(a_1) \dots (a_n) IJ' \rrbracket^{M,g} = 1$.

(247) *Generalised Exhaustification*

For any conjoinable type α , such that $\alpha = (\tau_1, (\tau_2(\dots \tau_n \mathbf{t}) \dots))$,

$\mathbf{Exh}_{\text{ALT} \langle \alpha, \alpha \rangle} := \lambda Q_\alpha. \lambda k_{\tau_1}^1. \lambda k_{\tau_2}^2 \dots \lambda k_{\tau_n}^n. \lambda I_{st}. \lambda J_{st}. Q(k^1) \dots (k^n) IJ \wedge \forall Q'_\alpha. (Q' \in \text{ALT} \wedge Q' \succ Q \rightarrow \neg Q'(k^1) \dots (k^n) IJ)$,

where ALT is the set of alternatives to Q , and $Q' \succ Q$ means that Q' is stronger than Q .

Given the revised translations of the number features in (230) we can no longer resort to the the definition of exhaustification in (247). As an example, consider sentences (248a) and (248b):

(248) a. Dogs^{*u*} are barking.

b. A^{*u*} dog is barking.

Sentence (248a) involves a bare plural, and hence requires an exhaustification operator. Following the Locality Principle, **Exh** is attached directly to the vP, below event closure. The translation of (248a) before event closure is given in (249a). Its alternative is the translation of the vP in (248b), given in (249b):

- (249) a. $\lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J$
- b. $\lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \mathbf{atom}\{u\}J \wedge \mathbf{unique}\{u\}J \wedge \forall j \in J. (\mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J$

Given the definition of strength in (246), the DRS in (249b) is stronger than (249a). Take a model M , assignment function g , event dref ε , and info states I and J , such that the interpretation of (249b) applied to ε , I and J is true in M . This means that there is an event of one dog barking in M . Now, take an info state J' which differs from J only in that $\forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j))$. It follows that the condition $J' =_{\{\varepsilon\}} J$ is satisfied. The revised version of Axiom 4 in (234) ensures that such J' exists. Then, the interpretation of (249a) applied to ε , I and J' is true in M , since (249a) does not place any additional restriction on the output info state, as compared to (249b), except for the value of \mathbf{Num}_{sg} for u . Thus we can conclude that the first condition in (246) is met.

We can show that the second condition in (246) is satisfied in the standard way. Take a model M , assignment function g , event dref ε , and info states I and J , such that the interpretation of (249a) applied to ε , I and J is true in M . Assume further that ε returns the same barking event involving a non-atomic sum of dogs as agent for every assignment in J . Then, there is no J' such that $J' =_{\{\varepsilon\}} J$, and the interpretation of (249b) applied to ε , I and J' is true in M : by assumption the event returned by ε involves a non-atomic agent, while the conditions in (249b) require the agent to be atomic.

We can conclude that the alternative in (249b) is indeed stronger than (249a). Then, applying the **Exh** operator as defined in (247) to the predicate in (249a) yields the following:

- (250) $\lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J$
 $\wedge \neg(I[u]J \wedge \mathbf{atom}\{u\}J \wedge \mathbf{unique}\{u\}J \wedge \forall j \in J. (\mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J)$

We can use the standard inference rules of propositional logic to simplify this complex expression, yielding the predicate in (251), which is equivalent to (250):

$$(251) \quad \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J \wedge (\neg \mathbf{atom}\{u\}J \vee \neg \mathbf{unique}\{u\}J \vee \neg \forall j \in J. (\mathbf{Num}_{sg}(u)(j)))$$

After event closure applies, we end up with the following DRS as translation of sentence (248a):

$$(252) \quad \lambda I_{st}.\lambda J_{st}. I[u, \varepsilon]J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge (\neg \mathbf{atom}\{u\}J \vee \neg \mathbf{unique}\{u\}J \vee \neg \forall j \in J. (\mathbf{Num}_{sg}(u)(j)))$$

And here we encounter a problem. The DRS in (253) does not produce the required strengthened interpretation. The reason is that $\forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j))$ entails $\neg \forall j \in J. (\mathbf{Num}_{sg}(u)(j))$, which means that the DRS in (252) is in fact equivalent to the corresponding un-enriched DRS.

To overcome this problem, I will re-formulate the definition of **Exh** operators in the following way:

$$(253) \quad \textit{Generalised Exhaustification (revised)}$$

For any conjoinable type α , such that $\alpha = (\tau_1, (\tau_2(\dots \tau_n \mathbf{t}) \dots))$,

$$\mathbf{Exh}_{\text{ALT} \langle \alpha, \alpha \rangle} := \lambda Q_\alpha. \lambda k_{\tau_1}^1. \lambda k_{\tau_2}^2 \dots \lambda k_{\tau_n}^n. \lambda I_{st}. \lambda J_{st}. Q(k^1) \dots (k^n) I J \wedge \forall Q'_\alpha. (Q' \in \text{ALT} \wedge Q' \succ Q \rightarrow \neg \exists J'_{st}. (J =_{\{k^1, \dots, k^n\}} J' \wedge Q'(k^1) \dots (k^n) I J')),$$

where ALT is the set of alternatives to Q and $Q' \succ Q$ means that Q' is stronger than Q .

Now, when we apply **Exh** to (249a) we get the following enriched predicate:

$$(254) \quad \text{a. } \lambda\zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\zeta\}J \wedge \mathbf{Ag}\{u, \zeta\}J \\ \wedge (\neg \exists J'. J =_{\{\zeta\}} J' \wedge I[u]J' \wedge \mathbf{atom}\{u\}J' \wedge \mathbf{unique}\{u\}J' \wedge \forall j \in J'. (\mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J' \wedge \mathit{bark}\{\zeta\}J' \wedge \mathbf{Ag}\{u, \zeta\}J')$$

After existential closure we arrive at the following DRS:

$$(255) \text{ a. } \lambda I_{st}.\lambda J_{st}. I[u, \varepsilon]J \wedge \forall j \in J. (\neg \mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J \wedge \mathit{bark}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \\ \wedge (\neg \exists J'. J =_{\{\zeta\}} J' \wedge I[u, \varepsilon]J' \wedge \mathbf{atom}\{u\}J' \wedge \mathbf{unique}\{u\}J' \wedge \forall j \in J'. (\mathbf{Num}_{sg}(u)(j)) \wedge \mathit{dog}\{u\}J' \wedge \mathit{bark}\{\varepsilon\}J' \wedge \mathbf{Ag}\{u, \varepsilon\}J')$$

This DRS will be true with respect to a singleton input info state I if there exists an output info state $J = \{j\}$, such that uj is a sum of dogs, εj is a barking event, uj is the agent of εj , and $\neg \mathbf{Num}_{sg}(u)(j)$ holds. This means that there must exist a barking event whose agent is a sum of dogs. Furthermore, there must be no info state $J' = \{j'\}$, such that $\varepsilon j = \varepsilon j'$ (i.e. $\varepsilon j'$ returns the same barking event), uj' is an atomic sum dogs, uj' is the agent of the barking event, and $\mathbf{Num}_{sg}(u)(j')$ holds. Given the axiom in (234), we can disregard the $\mathbf{Num}_{sg}(u)(j')$ condition. So this amounts to saying that the barking event returned by εj must not have an atomic sum of dogs as its agent. In other words, the DRS in (255) will be true if there exists a barking event whose agent is a non-atomic sum of dogs.

To sum up, in this section I argued for a formal condition which ensures that number features on pronouns match the number features on their antecedents. I have demonstrated how such a condition can be implemented while preserving the mechanism of implicature calculation. In the next section I will show how the extended system developed here can also successfully account for the interpretative properties of plural pronouns occurring under strong distributivity operators.

3.12.3 Plural Pronouns and the Multiplicity Implicature

In Chapter 1 we observed an interesting contrast in the way plural indefinites and plural pronouns are interpreted in distributive constructions. Recall the following examples from Kamp and Reyle 1993:

- (256) a. The women bought a car which had automatic transmissions.
b. The women bought a car which they liked.

Both of these sentences can have a distributive interpretation on which different women bought different cars. However, there is a difference with respect to the interpretation of the plural DPs within the relative clauses. The plural indefinite *automatic transmissions* in (256a) must be interpreted as denoting a non-singleton set of transmission with respect to each car, i.e. (256a) can only have a pragmatically odd interpretation on which each woman bought a car with multiple automatic transmission. On the other hand, the plural pronoun *they* in (256b) does not have to refer to a non-singleton set of individuals with respect to each car. Instead, its reference can co-vary with the women and the cars, i.e. (256b) can mean that each woman bought a car that she liked. This contrast becomes even clearer when we consider examples like (257), where the distributive interpretation is enforced by a floating quantifier:

- (257) a. They each bought a car which had automatic transmissions.
 b. They each bought a car which they liked.

This contrast in the way pronouns and non-pronominal DPs are interpreted in distributive contexts requires an explanation. The reason that the plural DP *automatic transmissions* must be interpreted as denoting a non-singleton set (or more precisely, a non-atomic sum) of individuals with respect to each woman and each car in (256a) and (257a) will be discussed in detail in section 5.2. Briefly, for the singular complex DP *a car which had automatic transmissions* to be interpreted distributively with respect to the subject it must be placed under a strong distributivity operator, which is overt in (257a). That is, for (257a) to be true there must exist a set of singleton info-states of the following form:

(258)

Info state H_1	...	u	u'	u''	ε	...
h_1	...	x_1	c_1	t_1	e_1^{buy}	...
...						
Info state H_n	...	u	u'	u''	ε	...
h_n	...	x_n	c_n	t_n	e_n^{buy}	...

Here, $x_1 \dots x_n$ are atomic individuals, such that $x_1 \oplus \dots \oplus x_n$ is the sum of individuals referred to by the subject pronoun; $c_1 \dots c_n$ are atomic cars; and $e_1^{buy} \dots e_n^{buy}$ are buying events such that x_i is the agent of e_i^{buy} and c_i is the theme of e_i^{buy} . In other words, x_1 bought c_1 , ..., x_n bought c_n .

Furthermore, $t_1 \dots t_n$ are sums of automatic transmission, such that c_1 has t_1 , ..., c_n has t_n . Since the DP *automatic transmissions* is also interpreted in the scope of the strong distributivity operator, its multiplicity implicature must be applied to each info state in $\{H_1, \dots, H_n\}$, which entails that each $t \in \{t_1, \dots, t_n\}$ is a non-atomic sum of transmissions.

The question now is why the multiplicity implicature is not derived for the plural pronouns in (256b) and (257b) in the same way. Consider the following set of info states that must exist for (257b) to be true:

(259)

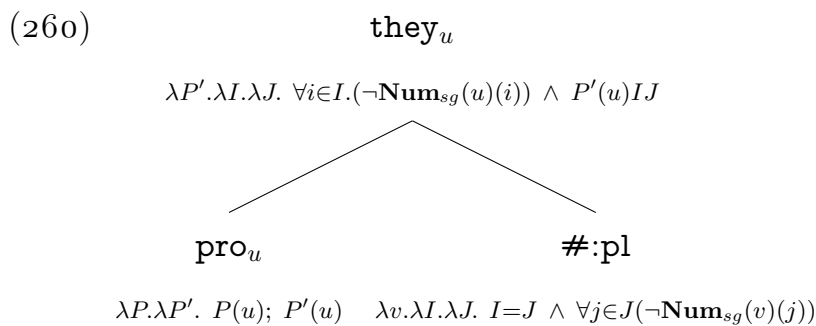
Info state H_1	...	u	u'	ε	ε_2	...
h_1	...	x_1	c_1	e_1^{buy}	e_1^{like}	...
...						
Info state H_n	...	u	u'	ε	ε_2	...
h_n	...	x_n	c_n	e_n^{buy}	e_n^{like}	...

Here again, $x_1 \dots x_n$ are atomic individuals, such that $x_1 \oplus \dots \oplus x_n$ is the sum of individuals referred to by the subject pronoun, and $c_1 \dots c_n$ are atomic

cars, and $e_1^{buy} \dots e_n^{buy}$ are buying events such that x_i is the agent of e_i^{buy} and c_i is the theme of e_i^{buy} . I.e. x_1 bought c_1, \dots, x_n bought c_n .

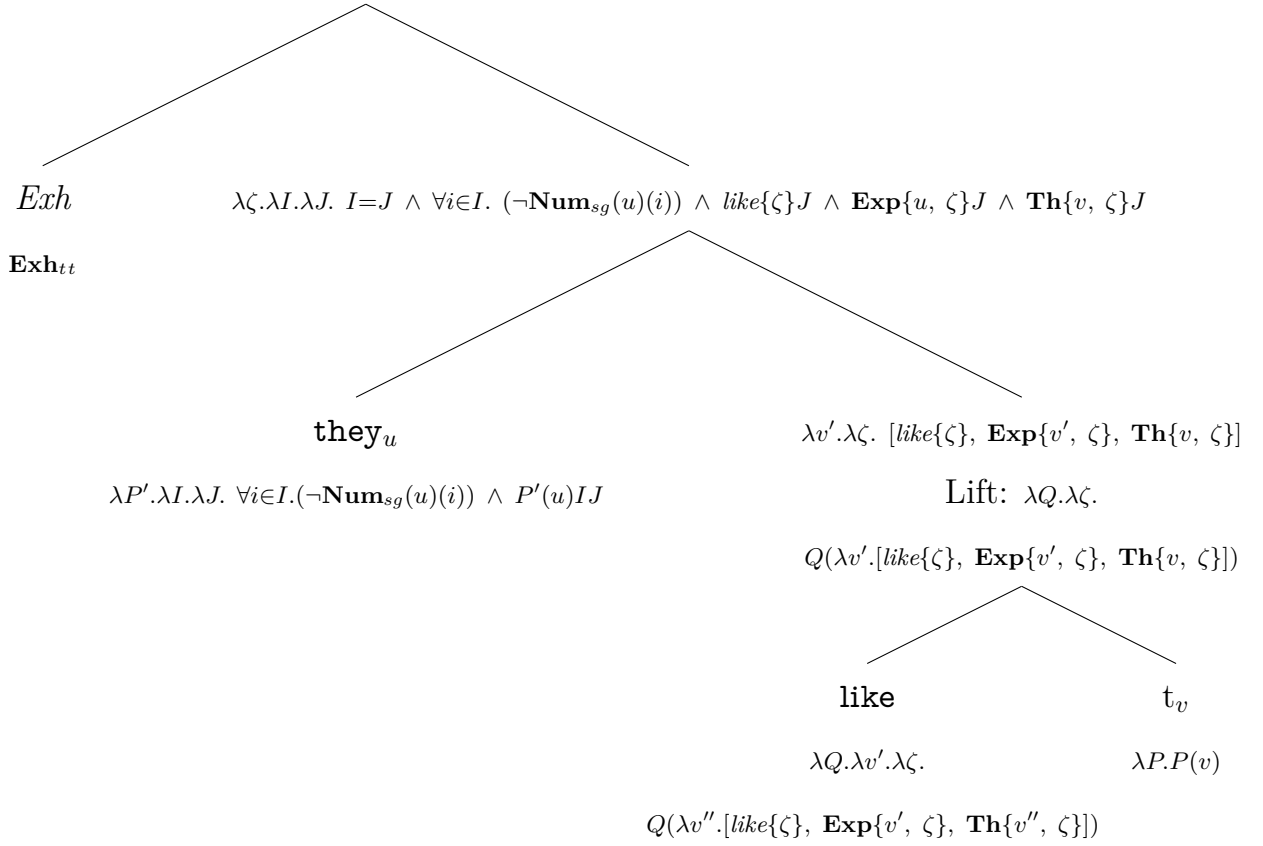
Moreover, $e_1^{like} \dots e_n^{like}$ are liking events such that c_i is the theme of e_i^{like} and x_i is the experiencer of e_i^{like} , since the lower pronoun in (257b) is co-indexed with the subject. Now, if the multiplicity implicature applied to the lower pronoun in (257b) in the same way as it applies to the plural indefinite in (257a), we would expect it to surface as a requirement for each $x \in \{x_1, \dots, x_n\}$ to be a non-atomic individual, leading to a contradiction with the semantics of the distributivity operator. However, no such contradiction is detectable in examples like (257b).

In this section I want to demonstrate that the contrast in the way plural pronouns and non-anaphoric DPs are interpreted is already captured by the semantic system developed in this chapter. Let us examine how the mechanism of implicature calculation applies to plural pronouns. Take the embedded pronoun in sentence (257b). It carries a plural feature, and hence must be c-commanded by an *Exh*-operator:



The most local site for *Exh*-insertion is above the pronoun within the relative clause. Thus, we have the following structure:

(261)



Consider the event predicate that combines with the *Exh*-operator in (261), repeated in (262a). Its alternative is the predicate in (262b), which is the translation of the corresponding structure with a singular pronoun:

- (262) a. $\lambda\zeta.\lambda I.\lambda J. I = J \wedge \forall i \in I. (\neg \mathbf{Num}_{sg}(u)(i)) \wedge \mathit{like}\{\zeta\}J \wedge \mathbf{Exp}\{u, \zeta\}J \wedge \mathbf{Th}\{v, \zeta\}J$
- b. $\lambda\zeta.\lambda I_{st}.\lambda J_{st}. I = J \wedge \mathbf{atom}\{u\}I \wedge \mathbf{unique}\{u\}I \wedge \forall i \in I. (\mathbf{Num}_{sg}(u)(i)) \wedge \mathit{like}\{\zeta\}J \wedge \mathbf{Exp}\{u, \zeta\}J \wedge \mathbf{Th}\{v, \zeta\}J$

We must determine whether the event predicate in (262b), call it P' , is stronger than that in (262a), call it P . It turns out that, given the definition of strength in (246), it is not. Take a model M , an assignment function g , an event dref ε , and a singleton info state I , where $I = \{i\}$, such that $\llbracket \mathbf{Num}_{sg}(u)(i) \rrbracket^{M,g} = 1$, $\llbracket ui \rrbracket^{M,g}$ is an atomic individual, and $\llbracket \varepsilon i \rrbracket^{M,g}$ is a liking event whose experiencer is $\llbracket ui \rrbracket^{M,g}$ and whose theme is $\llbracket vi \rrbracket^{M,g}$. Then, $\llbracket P'(\varepsilon)II \rrbracket^{M,g} = 1$. However, $\llbracket P(\varepsilon)II \rrbracket^{M,g} = 0$, given that by assumption $\llbracket \mathbf{Num}_{sg}(u)(i) \rrbracket^{M,g}$ is true, while the predicate in (262a) requires for it to be false. Furthermore, since the output info state must be equal to the

input info state in (262a), it follows that there is no J , such that $\llbracket P(\varepsilon)IJ \rrbracket^{M,g} = 1$. Thus, the first condition in (246) is not met, and we may conclude that (262b) is not stronger than (262a).

Since the alternative is not stronger, exhaustification proceeds without enrichment, and we obtain (262a) as the translation of the full structure in (261). The predicate in (262a) does not impose a non-atomicity/non-uniqueness condition on u , and hence no contradiction arises when the relative clause is later embedded under a strong distributivity operator, as in (257b).

Indeed, in the proposed system, quite generally, the multiplicity implicature is blocked for plural pronouns, as well as for anaphoric definites. This may seem like a surprising result, since it is traditionally assumed that plural pronouns refer to non-atomic individuals. In the current system, however, the non-atomicity semantics associated with plural pronouns in garden-variety contexts like (263) is not attributed to the plural feature on the pronoun, per se. Instead, the non-atomicity semantics is contributed by the antecedent DP, while the pronoun is forced to agree in its number feature with the antecedent.

(263) Three women fell asleep. Then they woke up.

As we have seen above, this approach produces welcome results when it comes to the interpretation of pronouns in the scope of strong distributivity operators.

To conclude, in this section I examined a contrast in the way pronouns and non-anaphoric DPs are interpreted in the scope of strong distributivity operators. I showed how the system developed in this chapter is able to account for this discrepancy. Two aspects of the system work together to deliver this result: first, the traditional distinction between anaphoric and non-anaphoric DPs, implemented as the absence vs presence of new dref introduction. And second, the formal matching condition, which ensures number agreement between pronouns and their antecedents.

3.13 Conclusion

In this chapter I have presented the core tenets of my proposal. I used a dynamic semantic framework which models contexts as sets of assignments, or plural info states, to capture the relevant distinctions in the domain of multiplicity. First, grammatical number features were analysed as involving state-level uniqueness/non-uniqueness conditions, i.e. as restricting the values of a dref across the assignments in a plural info state. Numerals (and other cardinal expressions), on the other hand, impose domain-level cardinality conditions, i.e. restrict the cardinality of the each value returned by a dref in a plural info state.

Second, I introduced the distinction between weak and strong distributivity operators: the former are modeled as inducing distribution across the assignments within a single info state, while the latter involve distribution across multiple info states. This distinction was then used in the analysis of weak and strong syntactic distributivity operators, e.g. floating *all* and *each*.

Thus, the proposed system distinguishes between three distinct types, or levels, of multiplicity: domain-level plurality, which involves a dref returning a non-atomic sum-individual as its value for a certain assignment in an info state, weak distributivity, or state-level plurality, where a dref returns different values for the assignments in a plural info state, and strong distributivity, where a dref returns different values for multiple info states. I demonstrated how this approach, coupled with a formalised algorithm for the calculation of the multiplicity implicature, allows us to capture the basic properties of dependent plural constructions discussed in Chapters 1: co-distributivity and overarching multiplicity. I showed how the analysis can be applied to both indefinite and definite dependent plurals. Moreover, I demonstrated how this system is able to handle the semantic contrast between plural DPs occurring in the scope of weak (e.g. floating *all*) and strong (e.g. floating *each*) distributivity operators. I further demonstrated how the proposed system can be extended to deal with constructions involving both lexical and phrasal cumulativity. Finally, I provided an account of the distinct semantic properties of

plurals pronouns occurring in the scope of distributivity operators.

In the next chapter I turn to the analysis of various classes of quantificational items, and argue that the core contrasts we observe in this domain can be adequately captured in terms of the distinction between weak and strong distributivity, proposed here.

Chapter 4

The Semantics of Quantificational Items

4.1 Introduction

In this chapter I will focus on the semantic properties of various types of quantificational items, and on the semantic interaction between these items and plurals. Most of the chapter will be devoted to the discussion of quantificational determiners. I will argue that the distinction between weak and strong distributivity introduced in Chapter 3 can be fruitfully invoked to account for the contrasts between two major groups of quantificational determiners, both with respect to the licensing of dependent plurals and to the compatibility with one major class of collective predicates. I also address some of the generalisations regarding quantificational determiners and dependent plurals established in Chapter 1, namely the Licensing and Neutrality Generalisations, and demonstrate how major aspects of these generalisations follow from the proposed semantic account. I will then move on to consider other classes of quantificational items, namely pluractional adverbials, which as we have seen in Chapter 1 can function as licensors for dependent plurals, and modals, which cannot.

4.2 Quantificational Determiners (QDs)

This section will be focused on the semantics of quantificational determiners (QDs). The basic proposal that I would like to make with respect to this class items is that the contrasting properties exhibited by singular and plural QDs can be accounted for by appealing to the distinction between strong and weak distributivity. I will argue that this approach correctly captures the interaction between quantificational DPs and various types of singular and plural DPs in their scope, and allows for an account of the Licensing and Neutrality Generalisations discussed in Chapter 1, as well as further generalisations in the domain of collective predication.

4.2.1 Translation of Plural and Singular QDs

I will follow Brasoveanu (2008), and define the translation of quantificational determiners via a general schema which links semantics of dynamic quantifiers in PCDRT* to their standard static counterparts. In its essence, my treatment of quantificational determiners will be close to that of Krifka (1996), the major innovation being a contrasting analysis of singular and plural QDs.

Both singular and plural quantificational determiners will take two predicates of type **et** as arguments, and return a DRS of the following simplified form, where the predicate P is derived from the restrictor predicate of the quantifier, and predicate P' is derived from its nuclear scope predicate:

$$(1) \quad \mathbf{max}^u(P(u); P'(u)); \mathbf{max}^{u'}(P(u')); [\mathbf{DET}\{u', u\}]$$

This DRS makes reference to the **max** operator defined above in section 3.10.1 in the previous chapter. The definition is repeated here for convenience:

- (2) $\mathbf{max}^u(D) := \lambda I_{st}.\lambda J_{st}.\exists f_{ss}.\exists K_{st}.\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = K \wedge \forall i \in I.(i[u]f(i)) \wedge DKJ$
 $\wedge \forall f'_{ss}.\forall K'_{ss}.\mathbf{Dom}(f') \subseteq I \wedge \mathbf{Ran}(f') = K' \wedge \forall i \in \mathbf{Dom}(f').(i[u]f'(i)) \wedge$
 $\exists J'_{st}.(DK'J') \rightarrow \forall i \in \mathbf{Dom}(f').(uf'(i) \leq uf(i))$),
 where f is a partial function from \mathcal{D}_s to \mathcal{D}_s , $\mathbf{Dom}(f) := \{i_s : \exists j_s. (f(i) = j)\}$
 and $\mathbf{Ran}(f) := \{j_s : \exists i_s. (f(i) = j)\}$.

The DRS in (1) does several things. First, via the **max** operator, it introduces a new dref, u , which stores the maximum possible values that satisfy the (dynamic) conjunction of P and P' . Next, it introduces another dref, u' , which stores the maximum values for P alone. Appeal to these two drefs is motivated by the existence of two types of reference to presuppositional quantificational DPs, discussed in detail by Nouwen (2003): reference to the refset and to the maxset (cf. also related observations in Krifka 1996). These can be illustrated with the help of the following examples from Nouwen 2003:

- (3) a. Few senators admire Kennedy; and they are very junior.
 b. Few senators admire Kennedy. Most of them prefer Carter.

Example (3a) illustrates reference to the refset: the plural pronoun in the second clause refers to the set of senators who admire Kennedy, i.e. the maximal individual that satisfies both the the restrictor and the nuclear scope predicate of the quantifier *few* in the first clause. Example (3a), on the other hand, is an instance of reference to the maxset: the plural pronoun in the second sentence picks up the whole set of senators as its reference, i.e. the maximal individual that satisfies the restrictor predicate of the quantifier *few*.

Next, the translation in (1) imposes a condition on the relation between the two drefs which invokes the static quantifier (designated as **DET**) corresponding to the dynamic quantifier which is being translated. For instance, the dynamic translation for *most* will involve the static quantifier **MOST**, the translation for *few* will involve the static quantifier **FEW**, etc. Importantly, like other lexical relations, the static

quantifiers themselves are interpreted distributively with respect to the info state they apply to, e.g.:¹

- (5) a. **MOST**(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (|ui| > |u'i| - |ui|)$
 b. **ALL**(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (|ui| = |u'i|)$
 c. **EVERY**(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (|ui| = |u'i|)$
 d. **FEW**(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (|ui| < n)$,

where n is a contextually determined threshold for what counts as few.²

Note, that following Brasoveanu (2007, 2008), I take the static quantifier to relate sets (or, rather, sums) of individuals, rather than sets of assignments. This allows us to avoid the proportion problem discussed at length in Brasoveanu 2007.

The difference between plural and singular quantificational determiners is captured by the way P and P' are defined for the the schema in (1). Specifically, in the case of plural quantifiers such as *all* and *most*, P and P' are obtained by applying the weak distributivity operator \mathbf{dist}_w to the restrictor and the nuclear scope set of the quantifier. This is expressed formally in (6):

$$(6) \quad \mathbf{det_pl}^{u, u'} \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. \mathbf{max}^u([\mathbf{dist}_w(P(u); P'(u))(u)]); \mathbf{max}^{u'}([\mathbf{dist}_w(P(u'))(u')]);$$

$$[\mathbf{DET}\{u', u\}]$$

¹The definitions in (5) obviously differ from the standardly assumed interpretations of static quantifiers. More standard definitions would be the following:

- (4) a. **MOST**(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (|u'i \cap ui| > |u'i/|ui|)$
 b. **ALL**(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (u'i \leq ui)$

However, since the drefs u and u' are restricted by the the DRS in (1) in such a way that for any assignment in the output info state, ui will be a sub-part of $u'i$, it suffices to compare the cardinalities of ui and $u'i$ to capture the required relations.

²It has been proposed that QDs such as *few* and *many* are ambiguous between a cardinal reading, represented in (5d), and a proportional reading, cf. Partee (1989). The latter can be captured by assuming that these QDs can be translated via proportiaonl static quantifiers of the following form:

- (5) **FEW**_{prop}(u', u) := $\lambda I_{st}. I \neq \emptyset \wedge \forall i \in I. (|ui|/|u'i| < n')$,
 where n' is a contextually determined threshold.

This potential ambiguity has no bearing on the current proposal.

For singular quantifiers such as *each* and *every*, P and P' correspond to the restrictor and nuclear scope predicates taken under the strong distributivity operator \mathbf{dist}_s :

$$(7) \quad \mathbf{det_sg}^{u,u'} \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. \mathbf{max}^u([\mathbf{dist}_s(P(u); P'(u))(u)]); \mathbf{max}^{u'}([\mathbf{dist}_s(P(u'))(u')]);$$

$$[\mathbf{DET}\{u', u\}]$$

The definitions of \mathbf{dist}_w and \mathbf{dist}_s were given in (85) (cf. section 3.7.1).

Two notes are in order. First, many quantifiers, e.g. *all*, *most*, *each*, can syntactically combine with PPs headed by the preposition *of*, rather than NPs:

$$(8) \quad \text{All / most / each of the students carried boxes.}$$

In fact, this is the only way to combine QDs with pronouns as restrictors:

$$(9) \quad \text{All of them / *all they carried boxes.}$$

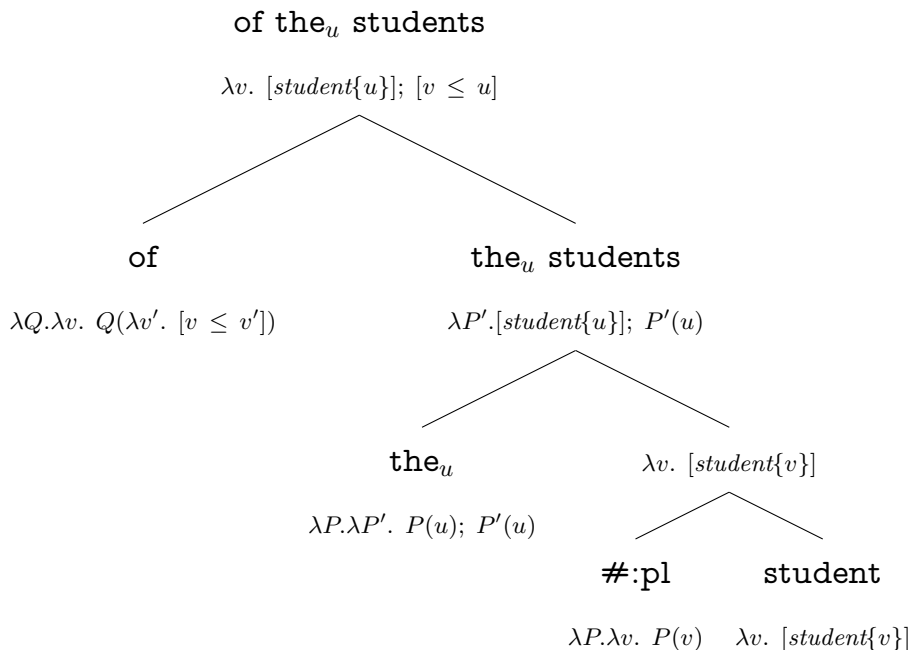
Recall, that in PCDRT* definite DPs and pronouns are translated as terms of type $(\mathbf{et})\mathbf{t}$. I will assume that the function of the preposition *of* is to turn DPs of type $(\mathbf{et})\mathbf{t}$ into predicates of type \mathbf{et} in the following way (this translation is conceptually related to the *BE* type shifter of Partee 1987):

$$(10) \quad \mathbf{of} \rightsquigarrow \lambda Q_{(\mathbf{et})\mathbf{t}}. \lambda v_{\mathbf{e}}. Q(\lambda v'. [v \leq v']),$$

where $u \leq u' := \lambda I. I \neq \emptyset \wedge \forall i \in I (ui \leq u'i)$.

This translation is essentially a dynamic way of saying that *of* extracts the sub-individuals of the individual referred to by the DP. This is illustrated in the following simple example involving a definite DP with an anaphoric definite article:

(11)



A few quantifiers, e.g. *all*, can also combine directly with a definite DP (e.g. *all the students*). I will take such structures to involve a null version of the preposition *of*, with the translation in (10). Finally, I will assume that the patterns of complementation that QDs allow are constrained by rules of syntactic selection.

The second issue has to do with negative determiners, such as *no* and *neither*. Since the empty set is not included in the domain of individuals, there is, by virtue of their semantics, no maximal dref satisfying both the restrictor and the nuclear scope predicates of such determiners. I will therefore treat them as negative existential quantifiers. Given that *no* can combine with either singular or plural restrictor NPs, I will assume that it is ambiguous between the following two translations, incorporating a weak and a strong distributivity operator respectively:

- (12) a. $\mathbf{no}_{pl} \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. [\sim [u \mid \mathbf{dist}_w(P(u); P'(u))(u)]]$
- b. $\mathbf{no}_{sg} \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. [\sim [u \mid \mathbf{dist}_s(P(u); P'(u))(u)]]$

Thus, plural quantificational determiners incorporate the semantics of weak distributivity, while singular QDs involve strong distributivity. In the following sections I first illustrate how the proposed semantics for QDs produces the required interpretation for some simple sentences, and then move on to the discussion of the

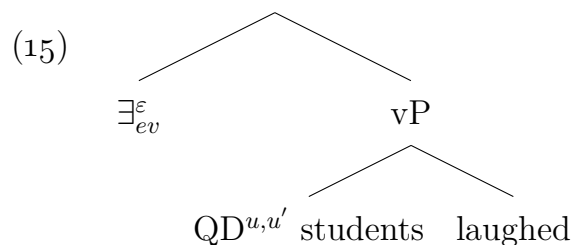
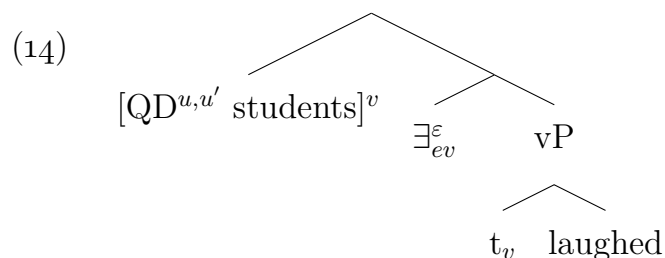
Licensing and Neutrality Generalisations, formulated in Chapter 1, and collective predication.

4.2.2 QDs in Simple Sentences

As means of illustration, let us calculate the translation of the following examples involving quantificational subjects:

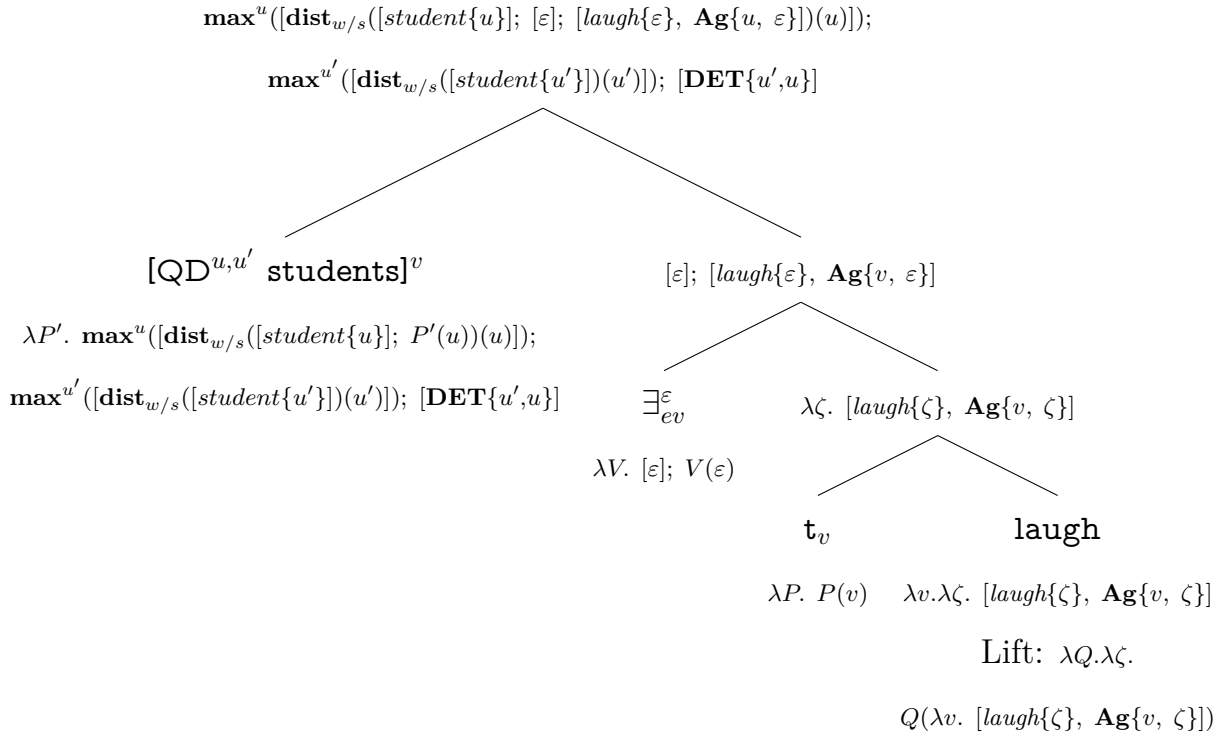
- (13) a. All^{*u, u'*} of the / Most^{*u, u'*} / Few^{*u, u'*} students laughed ^{ε} .
 b. Every^{*u, u'*} / Each^{*u, u'*} student laughed ^{ε} .

These sentence can be assigned the following generalised syntactic structures, depending on whether the quantified subject raises to a position above the event closure operator or remains *in situ* inside the vP:



Let us first calculate the translation of (14), again in the general form:

(16)



In the translations in (16), **DET** represents the static quantifier associated with the QD, while **dist**_{w/s} represents the distributivity operator, which can be either weak or strong depending on which QD is chosen. Generally, the final DRS in (16) will be true with respect to a singleton input info state $I = \{i\}$ if there exists a singleton output info state $J = \{j\}$, such that:

a) j differs from i at most with respect to the values for u and u' .

b) The value of u for j , i.e. uj , is the maximal sum of individuals such that the following conditions are satisfied:

1) If the distributivity operator is weak, there exists an info state H of the following form:

(17)

Info state H	...	u	ε	...
h_1	...	s_1	e_1	...
h_2	...	s_2	e_2	...
...
h_n	...	s_n	e_n	...

Here, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . I.e. the atomic individuals in uj are distributed as values for u across the assignments in H . Next, e_1, e_2, \dots, e_n are laughing events, whose agents are s_1, s_2, \dots, s_n , respectively.

2) If the distributivity operator is strong, there exists a set of singleton info states H_1, \dots, H_n of the following form:

(18)

Info state H_1	\dots	u	ε	\dots
h_1	\dots	s_1	e_1	\dots
\dots				
Info state H_2	\dots	u	ε	\dots
h_2	\dots	s_2	e_2	\dots
\dots				
Info state H_n	\dots	u	ε	\dots
h_n	\dots	s_n	e_n	\dots

Here, again, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . I.e. in this case the atomic individuals in uj are distributed as values for u across the assignments in the info states H_1, \dots, H_n . The values for $\varepsilon, e_1, e_2, \dots, e_n$, are again laughing events, whose agents are s_1, s_2, \dots, s_n , respectively.

In this case, the difference between weak and the strong distributivity operators does not impact the truth conditions. Either way, uj must store the maximal sum of students such that each of those students laughed.

c) Similarly, the value of u' for j , i.e. $u'j$, stores the maximal individual, such that each of its atomic sub-individuals is a student.

d) Finally, the static quantifier **DET** must hold of uj and $u'j$.

If we insert *most* as the QD in (16), the resulting DRS will be the following:

$$(19) \quad \mathbf{max}^u([\mathbf{dist}_w([student\{u\}]; [\varepsilon]; [laugh\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])](u)); \\ \mathbf{max}^{u'}([\mathbf{dist}_w([student\{u'\}])](u')); [\mathbf{MOST}\{u', u\}]$$

This DRS will be true if the maximal sum of students who each laughed has a cardinality greater than half the cardinality of the maximal sum of students.

Similarly, if we substitute QD for *every* in (16) we will obtain the following DRS:

$$(20) \quad \mathbf{max}^u([\mathbf{dist}_s([student\{u\}]; [\varepsilon]; [laugh\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])](u)); \\ \mathbf{max}^{u'}([\mathbf{dist}_s([student\{u'\}])](u')); [\mathbf{EVERY}\{u', u\}]$$

This DRS will be true if the maximal sum of students who each laughed has a cardinality equal to the cardinality of the maximal sum of students.

Let us now consider the compositional translation of the structure in (15), where the quantificational DP remains *in situ*, below the event closure operator:

$$(21) \quad [\varepsilon; \mathbf{max}^u([\mathbf{dist}_{w/s}([student\{u\}]; [laugh\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])](u)); \\ \mathbf{max}^{u'}([\mathbf{dist}_{w/s}([student\{u'\}])](u')); [\mathbf{DET}\{u', u\}]$$

\exists_{ev}^ε
 $\lambda V. [\varepsilon; V(\varepsilon)]$

$\lambda \zeta. \mathbf{max}^u([\mathbf{dist}_{w/s}([student\{u\}]; [laugh\{\zeta\}, \mathbf{Ag}\{u, \zeta\}])](u)); \\ \mathbf{max}^{u'}([\mathbf{dist}_{w/s}([student\{u'\}])](u')); [\mathbf{DET}\{u', u\}]$

$[\mathbf{QD}^{u, u'} \text{ students}]^v$
 $\lambda P'. \mathbf{max}^u([\mathbf{dist}_{w/s}([student\{u\}]; P'(u))](u)); \\ \mathbf{max}^{u'}([\mathbf{dist}_{w/s}([student\{u'\}])](u')); [\mathbf{DET}\{u', u\}]$

laugh
 $\lambda v. \lambda \zeta. [laugh\{\zeta\}, \mathbf{Ag}\{v, \zeta\}]$

$\text{Lift: } \lambda Q. \lambda \zeta. Q(\lambda v. [laugh\{\zeta\}, \mathbf{Ag}\{v, \zeta\}])$

The final DRS in (21) will be true with respect to a singleton input info state $I = \{i\}$ if there exists a singleton output info state $J = \{j\}$, such that:

- a) j differs from i at most with respect to the values for ε , u and u' .

b) The value of u for j , i.e. uj , is the maximal sum of individuals such that the following conditions are satisfied:

1) If the distributivity operator is weak, there exists an info state H of the following form:

(22)

Info state H	...	u	ε	...
h_1	...	s_1	e	...
h_2	...	s_2	e	...
...
h_n	...	s_n	e	...

Here, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . Furthermore, e is a laughing event such that $e = \varepsilon j$, and **Ag** holds of $(s_1, e), (s_2, e), \dots, (s_n, e)$.

2) If the distributivity operator is strong, there exists a set of singleton info states H_1, \dots, H_n of the following form:

(23)

Info state H_1	...	u	ε	...
h_1	...	s_1	e	...
Info state H_2	...	u	ε	...
h_2	...	s_2	e	...
...				
Info state H_n	...	u	ε	...
h_n	...	s_n	e	...

Here, again, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . And again, e is a laughing event such that $e = \varepsilon j$, and **Ag** holds of $(s_1, e), (s_2, e), \dots, (s_n, e)$.

c) The value of u' for j , i.e. $u'j$, stores the maximal individual, such that each of its atomic sub-individuals is a student.

d) The static quantifier **DET** must hold of uj and $u'j$.

Note, that since the event ε is introduced outside the scope of the distributivity operator in the final DRS in (21), its value stays the same across all the assignments in H and in H_1, \dots, H_n (represented as e in 22 and 23). Now, recall that thematic relations are subject to a Role Uniqueness constraint. I repeat it here for convenience:

(24) **Role Uniqueness:**

For any x, e , and Θ if $\Theta(x, e) = 1$ then there is no y such that $y \neq x$ and $\Theta(y, e) = 1$.

It follows, that **Ag** can only hold of $(s_1, e), (s_2, e), \dots, (s_n, e)$ in (22) and (23), if $s_1 = s_2 = \dots = s_n$. And since s_1, s_2, \dots, s_n are atomic individuals and $s_1 \oplus s_2 \oplus \dots \oplus s_n = uj$, it must be the case that uj returns an atomic individual.

This means that for any QD, the structure in (15) will generate a DRS which is true only if the maximal sum of students who laughed is atomic, i.e. if only one student laughed. If the QD is *all* or *every*, the resulting DRS will be true only if there is only one student in the model and that student laughed. For *most*, the resulting DRS will always be false.

Thus, the truth conditions that are derived for structures where a quantificational DP stays below the event closure operator are pragmatically degraded for many QDs. In this respect it is interesting to consider the downward-entailing QD *few*. Take sentence (25).

(25) $\text{Few}^{u, u'}$ students laughed $^\varepsilon$.

If the subject DP raises above event closure, as in (14), we obtain the following DRS:

(26) $\text{max}^u([\mathbf{dist}_w([\text{student}\{u\}]; [\varepsilon]; [\text{laugh}\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}])(u))];$
 $\text{max}^{u'}([\mathbf{dist}_w([\text{student}\{u'\}])](u')); [\mathbf{FEW}\{u', u\}]$

Given the definition for **FEW** in (5d), this DRS will be true if the cardinality of the maximal set of students S , such that for each $s \in S$ there is an event where s laughed, is smaller than the contextually defined threshold for what counts as few. This adequately captures the truth conditions of sentence (25).

Now suppose that sentence (25) is assigned the structure in (15), with the subject DP remaining *in situ*. The resulting DRS will be the following:

$$(27) \quad [\varepsilon]; \mathbf{max}^u([\mathbf{dist}_w([student\{u\}]; [laugh\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}](u))]; \\ \mathbf{max}^{u'}([\mathbf{dist}_w([student\{u'\}](u'))]; [\mathbf{FEW}\{u', u\}]$$

This DRS will be true if there is an event in which one student laughed, and one is below the contextually defined threshold for few. These truth conditions are clearly too weak. For instance, if there is an event e where 10 students laughed, and the threshold for few is taken to be 5, then sentence (25) will be judged false. However, the DRS in (27) will be true. This is so because the predicate *laugh* is lexically distributive, which means that there will necessarily exist an event $e' < e$, where one student laughed.

So ideally we would like to have a way to rule out the DRS in (27) as a possible translation for sentence (25). I would like to suggest, albeit somewhat speculatively, that this DRS is ruled out for pragmatic reasons. Specifically, I will adopt the following principle:

$$(28) \quad \textit{Contingency Constraint for QDs}$$

A DRS D which translates a structure involving a QD is pragmatically infelicitous if the cardinality condition associated with the QD in D is not contingent.

In (27) the cardinality constraint associated with the QD, i.e. **FEW** $\{u', u\}$, states that the cardinality of the sum returned by u must be smaller than a contextually given threshold. Since, for reasons discussed above, the preceding conditions on u restrict its cardinality to 1, the cardinality condition becomes non-contingent, and thus the DRS in (27) is ruled out.

Summing up, I have shown that the proposed translations for plural and singular QDs generate adequate truth conditions for simple sentences like those in (13) under the assumption that the quantificational DP raises above the event closure operator. On the other hand, if the quantificational DP is allowed to remain *in situ* in the scope of the event closure operator, the resulting truth conditions are either very restrictive, contradictory or, assuming the principle in (28), pragmatically infelicitous. For this reason, in the following discussion I will only consider structures where DPs involving quantificational determiners scope above event closure.

4.3 Dependent Plurals under QDs: Licensing Generalisation

In Chapter 1 (cf. section 1.3.1) we established the following generalisation regarding the licensing of dependent plurals:

(29) *Licensing Generalisation*

DPs that involve complement NPs in the singular do not license dependent plurals.

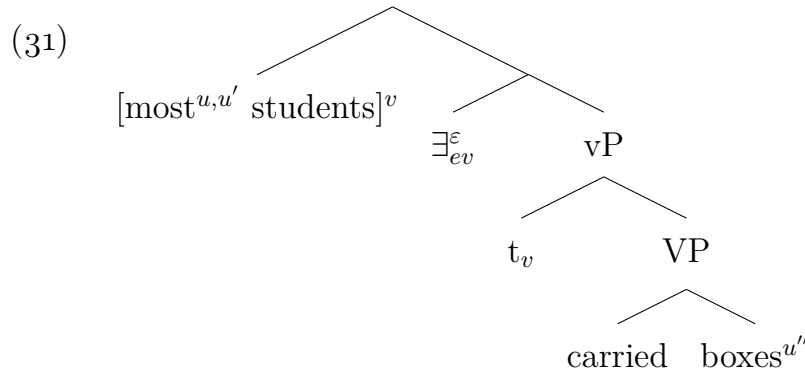
In this section I will demonstrate how this generalisation follows with respect to quantificational determiners from the analysis in (6) and (7). I will proceed by first analysing the interpretation of bare plural DPs in the scope of plural QDs, and demonstrating how the basic properties of dependent plurals (i.e. co-distributivity and overarching multiplicity) are derived. I will then show that in the scope of singular QDs, dependent plural interpretations of bare plurals are predicated to be blocked. The essence of this analysis should already be familiar from the discussion in sections 3.8-3.9.2 in the previous chapter. Indeed, since plural and singular QDs are taken to involve weak and strong distributivity operators in their translations, it is not unexpected that the behaviour of bare plural DPs in their scope is parallel to that in the scope of syntactically introduced weak and strong distributivity operators, i.e. δ_w and δ_s . Finally, I demonstrate that the link between number

marking on the restrictor NP and the weak vs strong nature of the distributivity operator in the translation of a QD is not accidental, but can be derived from a version of the *Conservativity Universal*, proposed in Barwise and Cooper 1981.

4.3.1 Dependent Plurals under Plural QDs

Let us start by examining the interpretation of bare plural indefinites in the scope of plural quantifiers. Take example (30), with the structure in (31):

(30) Most^{*u, u'*} students carried^{*ε*} boxes^{*u''*}.



The translation of the quantifier, given the schema in (6), is the following:

(32) $\mathbf{most}^{u,u'} \rightsquigarrow \lambda P_{\text{et}}. \lambda P'_{\text{et}}. \mathbf{max}^u([\mathbf{dist}_w(P(u); P'(u))(u)]); \mathbf{max}^{u'}([\mathbf{dist}_w(P(u'))(u')]);$
 $[\mathbf{MOST}\{u', u\}]$

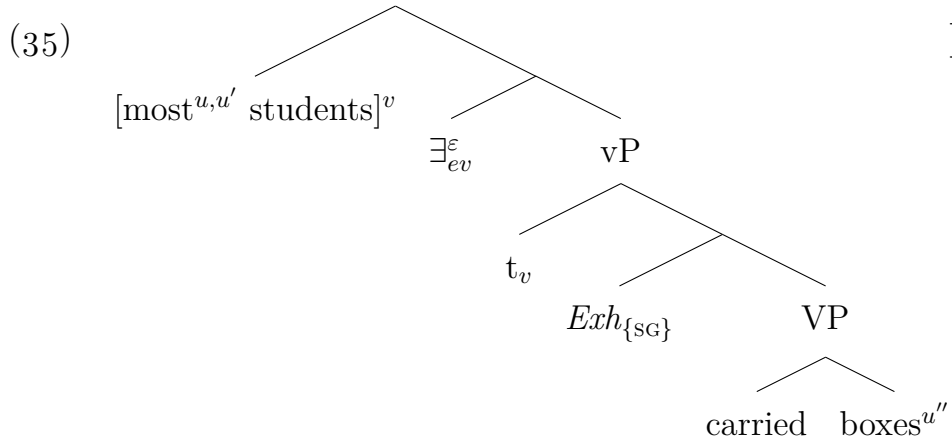
In (30), the restrictor predicate is derived as the translation of the plural noun *students*:

(33) $\mathbf{students} \rightsquigarrow \lambda v. [\mathbf{student}\{v\}]$

The translations of the VP was already calculated in section in the previous chapter. I repeat it here:

(34) $[_{VP} \mathbf{carried} \mathbf{boxes}^{u''}] \rightsquigarrow \lambda v'. \lambda \zeta. [u'']; [\mathbf{box}\{u''\}]; [\mathbf{carry}\{\zeta\}, \mathbf{Th}\{u'', \zeta\}, \mathbf{Ag}\{v', \zeta\}]$
 $:= \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u'']J \wedge \mathbf{box}\{u''\}J \wedge \mathbf{carry}\{\zeta\}J \wedge \mathbf{Th}\{u'', \zeta\}J \wedge$
 $\mathbf{Ag}\{v', \zeta\}J$

Now, following the Locality Principle in (62), the exhaustivity operator *Exh* is inserted directly above the VP:



As was already shown in section 3.9.1.2, the combination of the *Exh* with the VP in (34) yields in the following strengthened term:

$$(36) \quad \lambda v'. \lambda \zeta. \lambda I. \lambda J. I[u'']J \wedge \text{box}\{u''\}J \wedge \text{carry}\{\zeta\}J \wedge \mathbf{Th}\{u'', \zeta\}J \wedge \mathbf{Ag}\{v', \zeta\}J \wedge (\neg \mathbf{atom}\{u''\}J \vee \neg \mathbf{unique}\{u''\}J)$$

This term is then combined with the subject trace and the event closure operator to yield the following DRS:

$$(37) \quad \exists_{ev}^\varepsilon t_v \text{ carry boxes}^{u''} \rightsquigarrow \lambda I. \lambda J. I[\varepsilon, u'']J \wedge \text{box}\{u''\}J \wedge \text{carry}\{\varepsilon\}J \wedge \mathbf{Th}\{u'', \varepsilon\}J \wedge \mathbf{Ag}\{v, \varepsilon\}J \wedge (\neg \mathbf{atom}\{u''\}J \vee \neg \mathbf{unique}\{u''\}J)$$

Finally, after combining the quantifier in (32) with the predicate in (33), and then with the DRS in (37) via the Quantifying-In rule, we arrive at the following translation for (30):

$$(38) \quad \mathbf{max}^u([\mathbf{dist}_w(\lambda I. \lambda J. \text{student}\{u\}I \wedge I[\varepsilon, u'']J \wedge \text{box}\{u''\}J \wedge \text{carry}\{\varepsilon\}J \wedge \mathbf{Th}\{u'', \varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge (\neg \mathbf{atom}\{u''\}J \vee \neg \mathbf{unique}\{u''\}J))(u)]); \\ \mathbf{max}^{u'}([\mathbf{dist}_w([\text{student}\{u'\}]](u'))]; [\mathbf{MOST}\{u', u\}]$$

This DRS will be true with respect to a singleton input info state I iff there exists an info state J , also singleton, such that:

a) The unique assignment j in J differs from the unique assignment i in I at most with respect to the values for u and u' ;

b) Given the adopted definitions of the **max** and **dist**_{*w*} operators, the value of *u* for *j*, i.e. *uj*, is such that there exists an info state *H* of the following form:

(39)

Info state <i>H</i>	...	<i>u</i>	ε	<i>u''</i>	...
<i>h</i> ₁	...	<i>s</i> ₁	<i>e</i> ₁	<i>b</i> ₁	...
<i>h</i> ₂	...	<i>s</i> ₂	<i>e</i> ₂	<i>b</i> ₂	...
...
<i>h</i> _{<i>n</i>}	...	<i>s</i> _{<i>n</i>}	<i>e</i> _{<i>n</i>}	<i>b</i> _{<i>n</i>}	...

Here, s_1, s_2, \dots, s_n are atomic individuals, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to *uj*. Next, *student* must be true of s_1, s_2, \dots, s_n , *box* must be true of b_1, b_2, \dots, b_n , *carry* must be true of e_1, e_2, \dots, e_n , **Ag** must be true of $(s_1, e_1), (s_2, e_2), \dots, (s_n, e_n)$, and **Th** must be true of $(b_1, e_1), (b_2, e_2), \dots, (b_n, e_n)$. Finally, it must be the case that the cardinality of the sum $b_1 \oplus b_2 \oplus \dots \oplus b_n$ is greater than one.

In other words, it must be the case that for each atomic individual *s* in *uj*, *s* is a student and there exists a (possibly atomic) sum of boxes *b* such that *s* carried *b*, and overall more than one box must have been carried.

Moreover, according to the definition of the maximality operator, it must be the case that if there exists an info state *J'* such that its the unique assignment *j'* differs from the unique assignment *i* in *I* at most with respect to the value for *u*, and *uj'* satisfies the above condition, *uj'* must be a sub-individual of *uj*. It follows, that *uj* is the maximal sum of students such that each atomic student in that sum carried one or more box and more than one box was carried overall. Note, that if all the carrying events by students involved the same atomic box, there will be no maximal sum satisfying these conditions, and the DRS in (38) will be false. Thus, we correctly predict that sentence (31) will be true only if more than one box was carried overall.

c) The value of *u'* for *j*, i.e. *u'j*, stores the maximal individual, such that each of its atomic sub-individuals is a student.

d) Finally, the static quantifier **MOST** is applied to uj and $u'j$, adding the following condition:

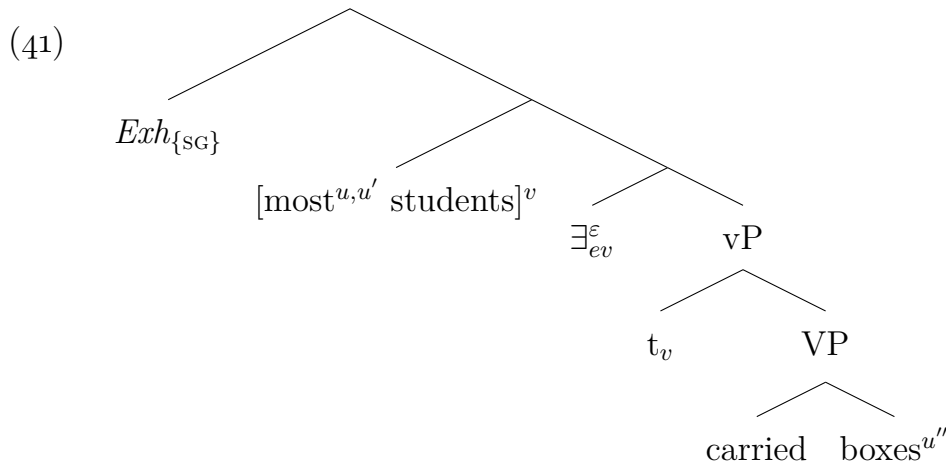
$$(40) \quad |uj| > |u'j| - |uj|$$

This condition states that the cardinality of uj must be greater than half the cardinality of $u'j$.

Summing up all the above conditions, the DRS in (38) will be true if there is a maximal set of students S , who each carried one or more boxes and who carried more than one box overall, and the cardinality of S is greater than half the cardinality of the maximal set of students. This is the required dependent plural reading.

We have thus derived the dependent plural reading licensed by a plural quantificational DP. This reading is derived if the *Exh*-operator is inserted directly above the VP (cf. 35).

Suppose now, that contrary to the Locality Principle *Exh* is inserted at the root, above the raised subject:



In this case implicature calculation will be performed after the quantificational subject is combined with its restrictor. For the sake of brevity, I will not perform the full calculation here, and simply present the resulting DRS:

$$\begin{aligned}
(42) \quad & \lambda I. \lambda J. (\mathbf{max}^u([\mathbf{dist}_w(\lambda H. \lambda K. student\{u\}H \wedge H[\varepsilon, u'']K \wedge box\{u''\}K \wedge \\
& carry\{\varepsilon\}K \wedge \mathbf{Th}\{u'', \varepsilon\}K \wedge \mathbf{Ag}\{u, \varepsilon\}K)(u)]); \\
& \mathbf{max}^{u'}([\mathbf{dist}_w([student\{u'\}])](u')); [\mathbf{MOST}\{u', u\}]IJ \wedge \\
& \neg(\mathbf{max}^u([\mathbf{dist}_w(\lambda H. \lambda K. student\{u\}H \wedge H[\varepsilon, u'']K \wedge \mathbf{atom}\{u''\}K \wedge \\
& \mathbf{unique}\{u''\}K \wedge box\{u''\}K \wedge carry\{\varepsilon\}K \wedge \mathbf{Th}\{u'', \varepsilon\}K \wedge \mathbf{Ag}\{u, \varepsilon\}K)(u)]); \\
& \mathbf{max}^{u'}([\mathbf{dist}_w([student\{u'\}])](u')); [\mathbf{MOST}\{u', u\}]IJ
\end{aligned}$$

This DRS will be true if: a) there exists a set of students S who each carried one or more boxes, every student who carried one or more boxes is part of S , and the cardinality of S is greater than half the cardinality of the maximal set of students, and b) it is not the case that there exists a set of students S' such that there exists an atomic box that all the students in S' carried, and any student who carried a box is part of S' , and the cardinality of S' is greater than half the cardinality of the maximal set of students. This reading is stronger than that represented by the DRS in (38). Indeed, suppose that there are three students, s_1 , s_2 and s_3 , such that student s_1 carried two boxes, b_1 and b_2 , student s_2 also carried b_1 , and student s_3 didn't carry any boxes. In this scenario the DRS in (38) will be true, but that in (42) will be false.

Recall, that we encountered a similar reading, stronger than the standard dependent plural interpretation, when we applied the exhaustivity operator above δ_w in section 3.9.1.2. As I noted in that section, there seems to be no evidence that such strengthened readings exist. In our system, they are ruled out by the principle of Locality of *Exh*-Insertion, which rules out structures like (41) if structures like (35) are available and do not lead to a weakening of the overall interpretation.

4.3.2 Bare Plurals under Singular QDs

Let us now move on to the interpretation of bare plural DPs in the scope of singular quantifiers. Consider the following sentence:

$$(43) \quad \text{Every}^{u, u'} \text{ student carried}^\varepsilon \text{ boxes}^{u''}.$$

This sentence does not have a dependent plural interpretation, i.e. it will not be judged true if each student carried a single box. Instead, it can be paraphrased as stating that each student carried *more than one* box. I will demonstrate how this result is derived in the current system.

The translation of the QD *every*, given the schema in (7), is the following:

$$(44) \quad \text{every}^{u,u'} \rightsquigarrow \lambda P_{\text{et}}.\lambda P'_{\text{et}}. \mathbf{max}^u([\mathbf{dist}_s(P(u); P'(u))(u)]); \mathbf{max}^{u'}([\mathbf{dist}_s(P(u'))(u')]);$$

$$[\mathbf{EVERY}\{u', u\}]$$

The QD first combines with its restrictor NP, which in this case is the singular noun *student* with the following translation:

$$(45) \quad \lambda v. [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]; [student\{v\}]$$

It then combines with the nuclear scope DRS, which includes the translation of the VP combined the exhaustivity operator, the subject trace and the event closure operator:

$$(46)$$

The nuclear scope DRS is the same one as in (37), repeated here:

$$(47) \quad \exists_{ev}^{\varepsilon} \mathbf{t}_v \text{ carry boxes}^{u''} \rightsquigarrow \lambda I.\lambda J. I[\varepsilon, u'']J \wedge \mathbf{box}\{u''\}J \wedge \mathbf{carry}\{\varepsilon\}J \wedge$$

$$\mathbf{Th}\{u'', \varepsilon\}J \wedge \mathbf{Ag}\{v, \varepsilon\}J \wedge (\neg \mathbf{atom}\{u''\}J \vee \neg \mathbf{unique}\{u''\}J)$$

The combination of the quantifier in (44) with the predicate in (45) and, via the Quantifying-In rule, with the DRS in (47) yields the following DRS as the translation of (43):

$$(48) \quad \mathbf{max}^u([\mathbf{dist}_s(\lambda I. \lambda J. \mathit{student}\{u\}I \wedge \mathbf{atom}\{u\}I \wedge \mathbf{unique}\{u\}I \wedge I[\varepsilon, u'']J \wedge \mathit{box}\{u''\}J \wedge \mathit{carry}\{\varepsilon\}J \wedge \mathbf{Th}\{u'', \varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge (\neg \mathbf{atom}\{u''\}J \vee \neg \mathbf{unique}\{u''\}J))(u)]);$$

$$\mathbf{max}^{u'}([\mathbf{dist}_s([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\mathit{student}\{u'\}]](u'))]; [\mathbf{EVERY}\{u', u\}]$$

This translation is different from the one in (38) in three respects. First, (48) involves strong distributivity operators in place of weak distributivity operators. Second, the values of u and u' are constrained by atomicity and uniqueness conditions, which derive from the translation of the singular restrictor noun, cf. (45). Finally, (48) involves the static quantifier **EVERY** instead of **MOST**.

Let us examine the truth conditions of (48) closer, and compare them with those of (38). The DRS in (48) will be true with respect to a singleton input info state I iff there exists an info state J , also singleton, such that:

- a) The unique assignment j in J differs from the unique assignment i in I at most with respect to the values for u and u' ;
- b) The value of u for j , i.e. uj , is such that there exists a set of info states $H_1 \dots H_n$ of the following form:

(49)

Info state H_1	...	u	ε	u''	...
h_1	...	s_1	e_1	b_1	...
...					
Info state H_n	...	u	ε	u''	...
h_n	...	s_n	e_n	b_n	...

Here, $s_1 \dots, s_n$ are atomic individuals, and the sum $s_1 \oplus \dots \oplus s_n$ must be equal to uj . Furthermore, *student* must be true of s_1, \dots, s_n , *box* must be true of b_1, \dots, b_n ,

carry must be true of e_1, \dots, e_n , **Ag** must be true of $(s_1, e_1), \dots, (s_n, e_n)$, and **Th** must be true of $(b_1, e_1), \dots, (b_n, e_n)$.

Crucially, the value of u is distributed by the strong distributivity operator in (48), which means that it is distributed across separate info states, not across the assignments within a single info state, as in (39). This means that all the conditions on $s_1, \dots, s_n, e_1, \dots, e_n$ and b_1, \dots, b_n are applied separately to each info state $H_1 \dots H_n$, including the non-atomicity/non-uniqueness conditions applied to the values of u'' . Consequently, it must be the case that the cardinality of b_m is greater than one for every $b_m \in \{b_1, \dots, b_n\}$.

In other words, it must be the case that for each atomic individual s in uj , s is a student and there exists a non-atomic sum of boxes b such that s carried b .

The maximality operator further ensure that if there exists a singleton info state J' such that its the unique assignment j' differs from the unique assignment i in I at most with respect to the value for u , and uj' satisfies the above condition, uj' must be a sub-individual of uj . In other words, uj must return the maximal sum of students where each student carried more than one box.

c) As in the case of (38), the value of u' for j , i.e. $u'j$, stores the maximal individual, such that each of its atomic sub-individuals is a student (since the predicate *student* is already lexically distributive, the addition of a weak or strong distributivity operator is not consequential).

d) The static quantifier **EVERY** is applied to uj and $u'j$, adding the following condition:

$$(50) \quad |uj| = |u'j|$$

In sum, the DRS in (48) will be true if there exists a maximal set of students S , who each carried more than one box, and the cardinality of S is equal to the cardinality of the maximal set of students. This is indeed the expected interpretation of (43).

Inserting the *Exh*-operator at the root, in violation of the Locality Principle, leads to an un-enriched interpretation for (43), i.e. ‘each student carried one or

more boxes'. Thus, this option is correctly ruled out.

4.3.3 Accounting for the Licensing Generalisation

I have shown how the difference between singular and plural QDs in terms of their ability to license dependent plurals is captured in the current system. This difference was accounted for by analysing singular QDs as incorporating a strong distributivity operator in their translation, and plural QDs as incorporating a weak distributivity operator. Now I would like to address a broader issue, namely the question whether the link between the number marking on the restrictor NP and the type of distributivity operator involved in a QD's translation is accidental, or conversely, can be derived in a principled way.

Specifically, one may ask whether we expect to find a language that possesses a singular QD, i.e. a QD combining with a restrictor NP carrying a singular number feature, and at the same time is weakly distributive with respect to its nuclear scope predicate, thus licensing dependent plurals in its scope. Logically, such a QD may exist. Consider, for instance a hypothetical determiner *every**, which by assumption combines with a singular restrictor NP, and has the following translation:

$$(51) \quad \mathbf{every}^{*u,u'} \rightsquigarrow \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. \mathbf{max}^u([\mathbf{dist}_w(P'(u))(u)]); \mathbf{max}^{u'}([\mathbf{dist}_s(P(u'))(u')]);$$

$$[\mathbf{EVERY}^*\{u', u\}],$$

$$\text{where } \mathbf{EVERY}^*(u', u) := \lambda I_{st}. \forall i \in I. (u'i \leq ui)$$

This QD introduces a maximal dref that satisfies the nuclear scope predicate taken under a weak distributivity operator, and compares it to the maximal dref that satisfies the restrictor predicate, taken under a strong distributivity operator. Such a quantifier would violate the Licensing Generalisation as formulated above, allowing for a singular restrictor NP (due to the fact that its translation is placed under a strong distributivity operator) and at the same time licensing dependent plurals as part of its nuclear scope (since the nuclear scope predicate occurs under a weak distributivity operator).

As far as I know, quantificational determiners of this type have never been identified, and I believe that there are theoretical reasons to expect that such quantifiers should not exist in natural language. These reasons have to do with the so-called *Conservativity Universal*, first proposed (albeit, in slightly different terms) by Barwise and Cooper (1981) (see also Keenan and Stavi 1986, and much subsequent work):

(52) *Conservativity Universal*

For all natural language determiners the following holds:

$$D(P)(Q) \leftrightarrow D(P)(P \cap Q),$$

where D is the interpretation of the determiner, and P and Q are sets.

The following examples illustrate that this generalisation holds of the English determiners *every* and *most*:

- (53) a. Every box is red. \leftrightarrow Every box is such that it is a box and it is red.
 b. Most boxes are red. \leftrightarrow Most boxes are such that they are boxes and they are red.

In a compositional dynamic framework, the *Conservativity Universal* can be re-formulated in the following way, adapted from Chierchia 1995:

(54) *Dynamic Conservativity Universal*

For all natural language determiners and all models M the following holds:

$$\llbracket D(P)(Q) \rrbracket^M = \llbracket D(P)(\lambda v.P(v); Q(v)) \rrbracket^M,$$

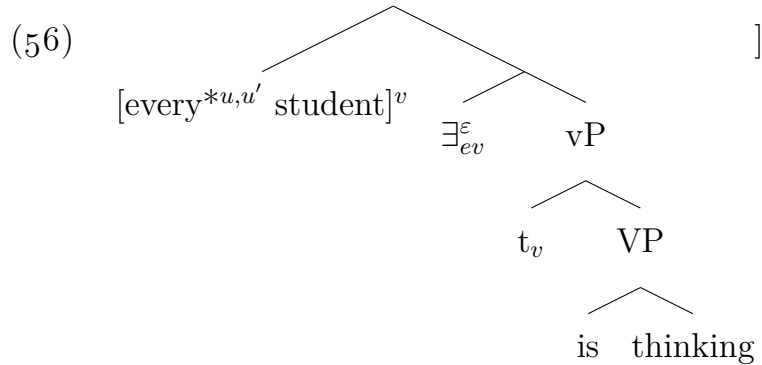
where D is the translation of the determiner, P and Q are translations of the restrictor and nuclear scope constituents, respectively, and $;$ is dynamic conjunction.

All the English QDs we have talked about conform to this universal (in fact, the translations we adopted for these QDs already involve a dynamic conjunction of the restrictor and nuclear scope predicates), and so do the indefinite and definite determiners. However, the hypothetical QD *every*^{*} defined in (51) violates it. To

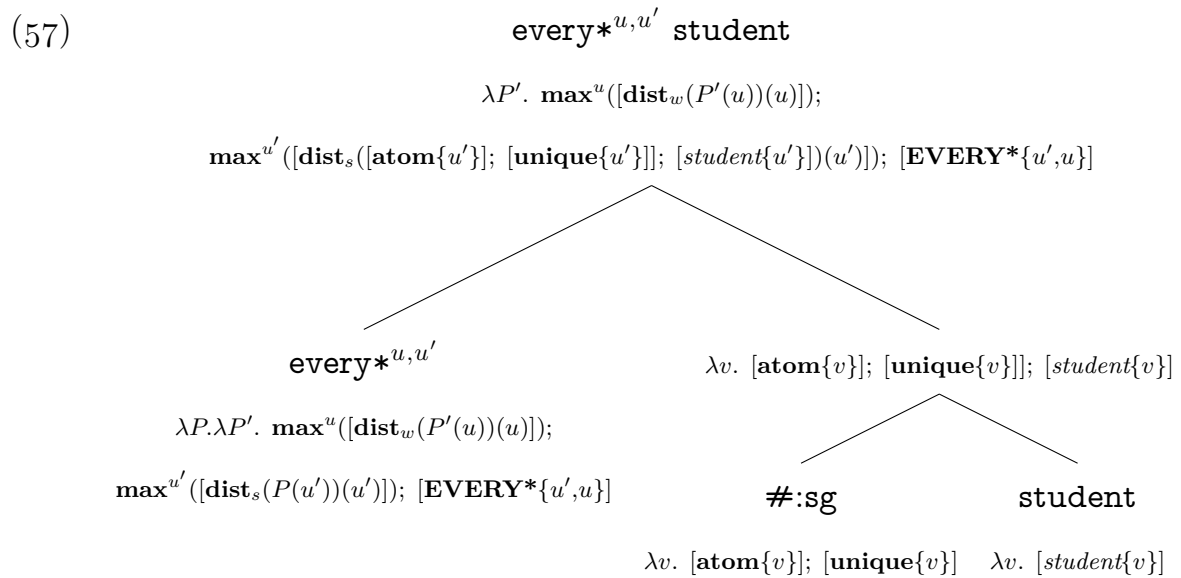
see why let us consider the translation of the following example involving this hypothetical determiner:

(55) Every*^{*u, u'*} student is thinking^{*ε*}.

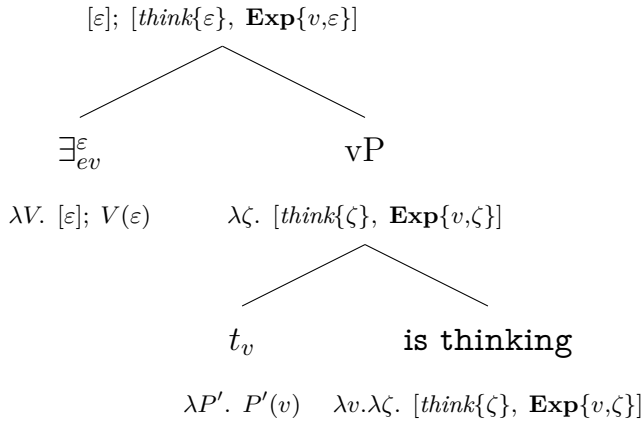
The syntactic structure of (55) would be the following:



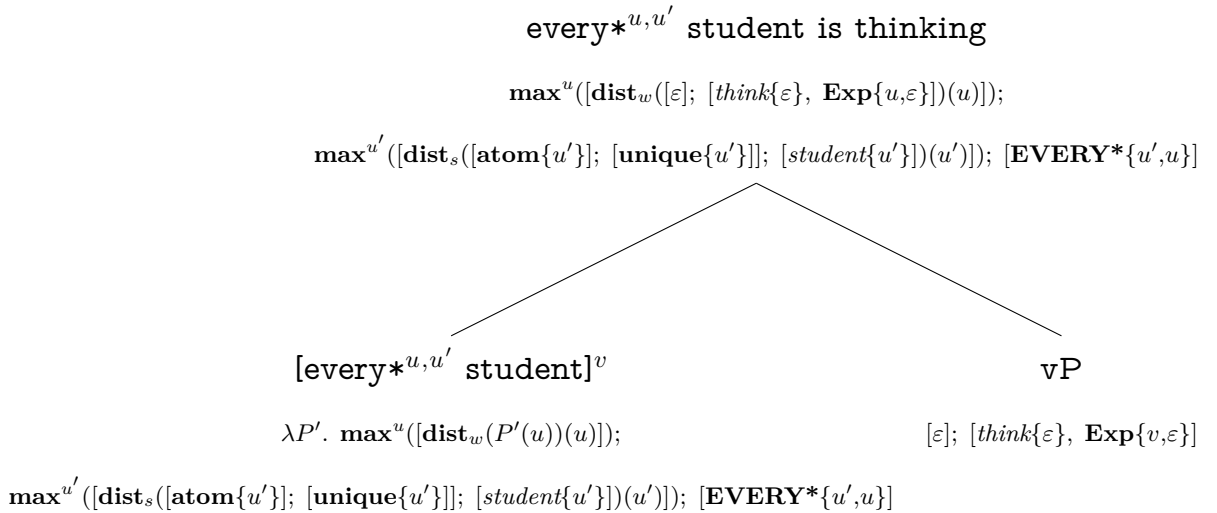
The tree in (57) illustrates the compositional translation of the subject DP, and the tree in (58) shows how the nuclear scope DRS is derived. Finally, (59) illustrates the composition of the subject with the DRS in (58) via the Quantifying-In rule.



(58)



(59)



Let us examine what it means for the DRS in (59) to apply to a pair of input and output info state. For simplicity, let's take two singleton info states: $I = \{i\}$ and $J = \{j\}$. The DRS in (59) will apply to I and J if uj and $u'j$ satisfy the following conditions:

a) uj is the maximal individual that satisfies the nuclear scope predicate under a weak distributivity operator. This means that it is the maximal individual, such that there exists an info state H of the following form, where $x_1 \dots, x_n$ are atomic individuals, the sum $x_1 \oplus \dots \oplus x_n$ is equal to uj , and $e_1 \dots, e_n$ are thinking events, and for each k , x_k is the experiencer of e_k :

(60)

Info state H , such that $J\langle u \rangle H$	...	u	ε	...
h_1	...	x_1	e_1	...
h_2	...	x_2	e_2	...
...
h_n	...	x_n	e_n	...

b) $u'j$ is the maximal individual that satisfies the restrictor predicate under a strong distributivity operator. This means that it is the maximal individual, such that there exists an *set of info states* $\{H_1, \dots, H_m\}$ of the following form, where $s_1 \dots, s_m$ are atomic individuals, the sum $s_1 \oplus \dots \oplus s_n$ is equal to $u'j$, and *student* is true of every s_k in $\{s_1, \dots, s_m\}$:

(61)

Info state H_1	...	u'	...
h_1	...	s_1	...
...			
Info state H_m	...	u'	...
h_m	...	s_m	...

Note that the restrictor NP is singular, so it imposes a uniqueness requirement on the values of u' . But since the restrictor predicate occurs under a strong distributivity operator, this condition is checked against each individual info state in $\{H_1, \dots, H_m\}$, and is thus satisfied.

c) Finally, $u'j$ must be a sub-individual of uj .

In sum, (55) will be true if the the maximal set of students is a sub-set of the maximal set of individuals who are thinking.

Now, lets go back to the Dynamic Conservativity Universal in (54). If *every** conforms to this universal, the DRS in (59) should be equivalent to the DRS that results from applying the same quantifier to the restrictor predicate and the

dynamic conjunction of the restrictor and nuclear scope predicates. Namely, to the predicates in (62a) and (62b):

- (62) a. $\lambda v. [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]; [student\{v\}]$
 b. $\lambda v. [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]; [student\{v\}]; [\varepsilon]; [think\{\varepsilon\}, \mathbf{Exp}\{v, \varepsilon\}]$

Applying *every** to these predicates yields the following DRS:

- (63) $\mathbf{max}^u([\mathbf{dist}_w([\mathbf{atom}\{u\}]; [\mathbf{unique}\{u\}]; [student\{u\}]; [\varepsilon]; [think\{\varepsilon\}, \mathbf{Exp}\{u, \varepsilon\}](u))];$
 $\mathbf{max}^{u'}([\mathbf{dist}_s([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [student\{u'\}](u'))]; [\mathbf{EVERY}'\{u', u\}]$

Now, if we apply this DRS to two singleton input states, $I = \{i\}$ and $J = \{j\}$, we encounter a problem. The conditions on $u'j$ and the relation between uj and $u'j$ are the same as in (59). The conditions on uj , however, are different. The first maximality operator in (63) applies to a dynamic conjunction of DRSs under a weak distributivity operator. This means that uj must be the maximal individual such that there exists an info state H where the atomic parts of uj are distributed as values for u across the assignments in H :

(64)

Info state H , such that $J\langle u \rangle H$	...	u	ε	...
h_1	...	x_1	e_1	...
h_2	...	x_2	e_2	...
...
h_n	...	x_n	e_n	...

Here $x_1 \dots, x_n$ are atomic individuals, the sum $x_1 \oplus \dots \oplus x_n$ is equal to uj , and $e_1 \dots, e_n$ are thinking events whose agents are $x_1 \dots, x_n$, respectively. This is similar to what we had in (60) above. However, the conjoined DRS under the \mathbf{dist}_w operator in (63) places additional conditions on the values of u in H . Specifically, it requires *student* to be true of every x_k in $\{x_1, \dots, x_n\}$, and, crucially, for all the individuals in $\{x_1, \dots, x_n\}$ to be atomic and identical. Since, by definition of

\mathbf{dist}_w , $uj = x_1 \oplus \dots \oplus x_n$, it follows that uj must be atomic. Moreover, since uj is required to be the maximal individual that satisfies the conditions for H (i.e. every individual that satisfies these conditions must be part of or equal to uj), it will only exist in a model which contains a single student who is thinking. Finally, the conditions imposed of $u'j$ and the relation between uj and $u'j$ in (63) entail that there must be only one student overall.

In sum, (63) will only be true with respect to any pair of input and output info states in a model where there is only one student, and that student is thinking. Clearly, then, the DRS in (63) is not equivalent to that in (59), and we may conclude that *every*^{*} violates the Dynamic Conservativity Universal.

The reason that the Dynamic Conservativity Universal is violated in this case is that placing the translation of the singular restrictor NP under a weak distributivity operator results in an undesired global atomicity condition on the value of the maximal dref satisfying the nuclear scope predicate. This problem does not arise, however, if the translation of the QD involves a strong distributivity operator scoping over the nuclear scope predicate, because in that case the global atomicity condition becomes in effect neutralised.

In fact, quite generally, if a QD combines with a restrictor carrying a singular number feature, it must be interpreted as involving a strong distributivity operator scoping over its nuclear scope, otherwise the unwelcome global atomicity effect obtains and the Dynamic Conservativity Universal is violated. This in turn means that such QDs will not be able to license dependent plurals as part of their nuclear scope.

To conclude, the Licensing Generalisation can be derived in the current system from a general Dynamic Conservativity Universal, as stated in (54), which restricts the class of quantificational determiners possible in natural language.³

³An interesting question is whether the converse of the Licensing Generalisation, stating that all QDs that combine with restrictor NPs in the plural do license dependent plurals in their scope, holds of all QDs. At the moment, I am not aware of any counter-examples. If it does indeed hold, it cannot be derived directly from the Conservativity Universal. I will leave this question for future research.

4.4 DPs with Numerals under QDs: Neutrality Generalisation

Let us now consider the interpretation of DPs with numerals and cardinal modifiers in the scope of quantificational DPs:

- (65) a. All^{*u, u'*} students made ^{ε} five^{*u''*} mistakes.
 b. Every^{*u, u'*} student made ^{ε} five^{*u''*} mistakes.

Neither of these sentences has a co-distributive interpretation, where the numeral characterises the total number of mistakes made by the students. Instead, both of these sentences must be interpreted distributively, as stating that for each student there are five mistakes that she made. I will now show how this result follows directly from our analysis of QDs and numerals.

Recall, that I have analysed numerals as imposing a *domain-level* condition on the cardinality of a referent:

- (66) a. **five** $\rightsquigarrow \lambda v_e. [\mathbf{5_atoms}\{v\}]$
 b. $\mathbf{5_atoms}\{u\} := \lambda I_{st}. \forall i \in I. \mathbf{5_atoms}(ui)$,
 where $\mathbf{5_atoms}(x_e) := |\{y_e : y \leq x \wedge \mathbf{atom}(y)\}| = 5$.

Then, the translations of (65a) and (65b) will be the following:

- (67) a. $\mathbf{max}^u([\mathbf{dist}_w([\varepsilon]; [u'']; [student\{u\}]; [mistake\{u''\}]; [\mathbf{5_atoms}\{u''\}]; [make\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}]](u));$
 $\mathbf{max}^{u'}([\mathbf{dist}_w([student\{u'\}]](u'))]; [\mathbf{ALL}\{u', u\}]$
 b. $\mathbf{max}^u([\mathbf{dist}_s([\varepsilon]; [u'']; [student\{u\}]; [mistake\{u''\}]; [\mathbf{5_atoms}\{u''\}]; [make\{\varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}]](u));$
 $\mathbf{max}^{u'}([\mathbf{dist}_s([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [student\{u'\}]](u'))]; [\mathbf{EVERY}\{u', u\}]$

The truth conditions of these DRSs are analogous to those of (38) and (48), discussed above, except for the presence of the **5_atoms** condition in the scope

of the distributivity operators. Thus, (67a) will be true with respect to a singleton input info state I if there exists an info state J , also singleton, such that:

a) The unique assignment j in J differs from the unique assignment i in I at most with respect to the values for u and u' ;

b) The value of u for j is such that there exists an info state H of the following form:

(68)

Info state H	...	u	ε	u''	...
h_1	...	s_1	e_1	m_1	...
h_2	...	s_2	e_2	m_2	...
...
h_n	...	s_n	e_n	m_n	...

Here, s_1, s_2, \dots, s_n are atomic individuals, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ is equal to uj . Next, *student* is true of s_1, s_2, \dots, s_n , *mistake* is true of m_1, m_2, \dots, m_n , *make* is true of e_1, e_2, \dots, e_n , **Ag** is true of $(s_1, e_1), (s_2, e_2), \dots, (s_n, e_n)$, and **Th** is true of $(m_1, e_1), (m_2, e_2), \dots, (m_n, e_n)$.

Crucially, since the **5_atoms** condition occurs in the scope of the weak distributivity operator in (67a), it will be interpreted with respect to the derived info state H . Given that it is a domain-level condition that applies individually to each value of a dref in an info state, it follows that the cardinality of each m_k in $\{m_1, \dots, m_n\}$ must be five.

In other words, it must be the case that for each atomic individual s in uj , s is a student and there exists a sum of five mistakes m such that s made the mistakes m .

The semantics of the maximality operator also ensure that uj is the maximal individual satisfying these conditions.

c) The value of u' for j , i.e. $u'j$, stores the maximal individual, such that each of its atomic sub-individuals is a student.

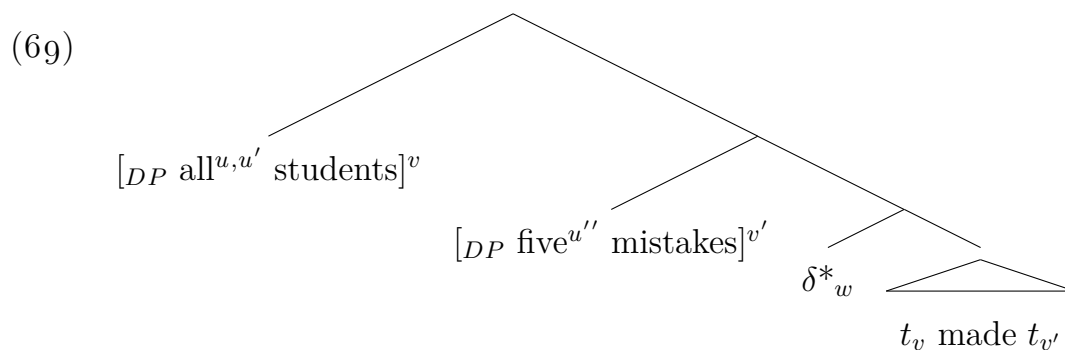
d) Finally, the static quantifier **ALL** applies to uj and $u'j$, stating that their cardinalities must be equal.

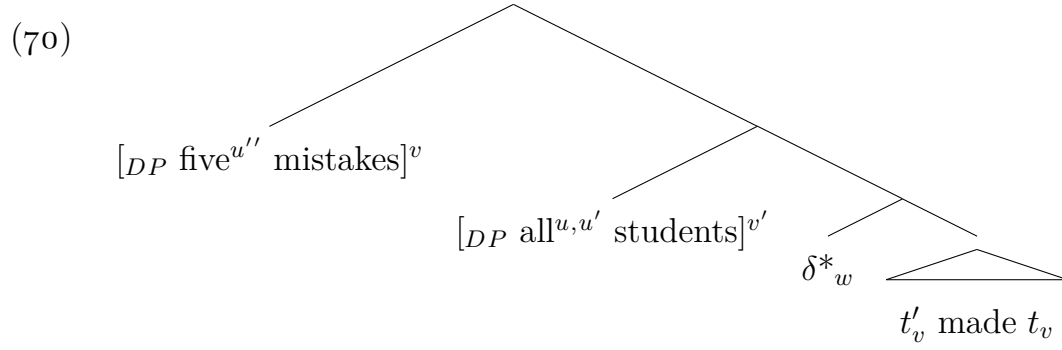
In sum, the DRS in (67a) will be true if there is a maximal set of students S , who each made five mistakes, and the cardinality of S is equal to the cardinality of the maximal set of students. This is the desired distributive interpretation. A co-distributive interpretation, on the other hand, is correctly predicted to be unavailable.

It is easy to see that the same result will be obtained for (67b), except that in this case the atomic individuals in uj are distributed across multiple info states. This difference, however, does not affect the interpretation of the numeral. Again, the system correctly predicts only a distributive interpretation for numerals in the scope of singular QDs.

This result should not be completely surprising, as we have already seen in the previous chapter that numerals in the scope of syntactic distributivity operators, both weak and strong, only allow for a distributive interpretation, and QDs share central aspects of their semantics with such operators. However, before we conclude that co-distributive readings between quantificational DPs and DPs involving numerals are ruled out in the proposed system, we must consider the possibility that such readings may be derived via the application of phrasal cumulativity operators, discussed in section 3.11.2.

Specifically, nothing in the system prevents e.g. the sentence in (65a) to have one of the following underlying structures, where both plural DPs have been quantifier-raised to the specifier positions of a phrasal cumulativity operator δ^*_w :





We must ensure that these structures do not give rise to undesirable cumulative interpretations. Fortunately, they do not. As an example, consider the structure in (70). It is translated via the *Two-Place Distributive Quantifying-In* rule, introduced in section 3.11.2 and repeated here for convenience. The translation of the weak phrasal cumulativity operator is repeated in (72).

(71) *Two-Place Distributive Quantifying-In*

If A is a constituent of the following form:

$$[A DP^v [DP^{v'} [\delta *_{w/s} [B \dots]]]],$$

such that $DP^v \rightsquigarrow \alpha$, $DP^{v'} \rightsquigarrow \beta$, $\delta *_{w/s} \rightsquigarrow \delta$, and $B \rightsquigarrow \gamma$, then:

$$A \rightsquigarrow \alpha(\delta(\lambda v'. \lambda v. \gamma)(\beta)),$$

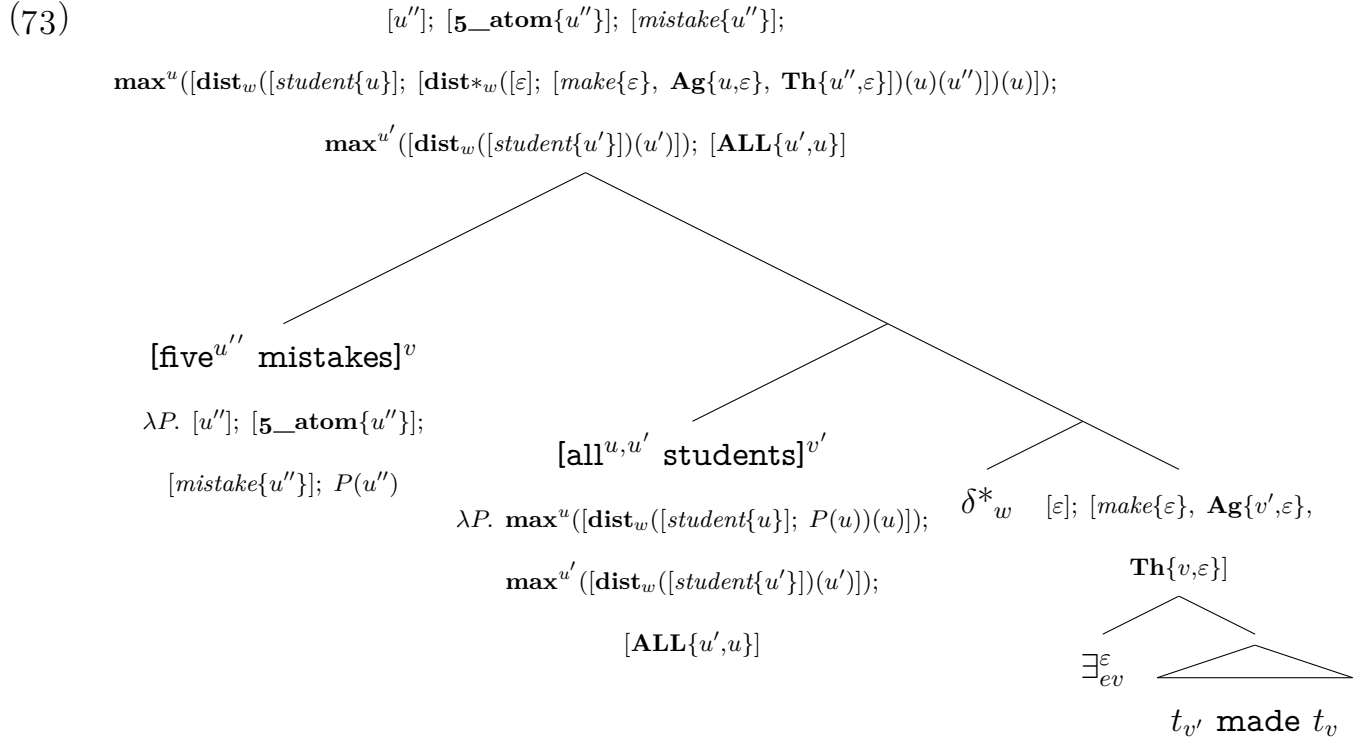
provided that this is a well-formed term.

(72) $\delta_w^* \rightsquigarrow$

$$\lambda P_{\mathbf{e}(\mathbf{et})}. \lambda Q_{(\mathbf{et})\mathbf{t}}. \lambda v_{\mathbf{e}}. Q(\lambda v'. [\mathbf{dist}_w^*(P(v')(v))(v')(v)])$$

$$:= \lambda P_{\mathbf{e}(\mathbf{et})}. \lambda Q_{(\mathbf{et})\mathbf{t}}. \lambda v_{\mathbf{e}}. \lambda I_{st}. \lambda J_{st}. Q(\lambda v'. I = J \wedge$$

$$\exists H_{st}. [J\langle v, v' \rangle H \wedge \exists H'_{st}. (P(v')(v))HH']])$$



If we unpack the final DRS in (73), replacing \mathbf{dist}_w and \mathbf{dist}^*_w with their definitions, we obtain the following DRS, equivalent to (73):

(74)

$$[u'']; [\mathbf{5_atom}\{u''\}]; [mistake\{u''\}];$$

$$\mathbf{max}^u(\lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. (J\langle u\rangle H \wedge student\{u\}H \wedge \exists H'_{st}. (H\langle u'', u\rangle H' \wedge \exists H''_{st}. (H'[\varepsilon]H'' \wedge make\{\varepsilon\}H'' \wedge \mathbf{Ag}\{u,\varepsilon\}H'' \wedge \mathbf{Th}\{u'',\varepsilon\}H''))));$$

$$\mathbf{max}^{u'}(\lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. (J\langle u'\rangle H \wedge student\{u'\}H)); [\mathbf{ALL}\{u',u\}]$$

Let us unwrap the truth conditions of this DRS. It will be true with respect to a singleton input info state $I = \{i\}$ iff there exists a singleton info state $J = \{j\}$, such that j differs from i at most with respect to the values for u , u' and u'' , and the following conditions hold:

a) $u''j$ is a sum of five mistakes.

b) uj is the maximal individual such that there exists an info state H such that each $h \in H$ differs from j at most with respect to the values of u , the atomic individuals in uj are distributed across the assignments in H , and for each $h \in H$, uh is a student:

(75)

Info state H	...	u	u''	...
h_1	...	s_1	$m_1 \oplus m_2 \oplus m_3 \oplus m_4 \oplus m_5$	...
h_2	...	s_2	$m_1 \oplus m_2 \oplus m_3 \oplus m_4 \oplus m_5$	...
...
h_n	...	s_n	$m_1 \oplus m_2 \oplus m_3 \oplus m_4 \oplus m_5$	...

Here, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ is equal to u^j . Since each $h \in H$ differs from j only with respect to the values for u , the values for u'' in H stay constant, and are equal to u''^j . This value is represented as a sum of five atomic mistakes $m_1 \oplus m_2 \oplus m_3 \oplus m_4 \oplus m_5$ in (75).

Now, the second distributivity operator applies and splits the values of u'' in H into separate assignments. Since this is done separately for each h in H , we obtain an info state H' of the following form:

(76)

Info state H'	...	u	u''	...
h'_1	...	s_1	m_1	...
h'_2	...	s_1	m_2	...
h'_3	...	s_1	m_3	...
h'_4	...	s_1	m_4	...
h'_5	...	s_1	m_5	...
h'_6	...	s_2	m_1	...
h'_7	...	s_2	m_2	...
h'_8	...	s_2	m_3	...
h'_9	...	s_2	m_4	...
h'_{10}	...	s_2	m_5	...
...
h_{n1}	...	s_n	m_1	...
h_{n2}	...	s_n	m_2	...
h_{n3}	...	s_n	m_3	...
h_{n4}	...	s_n	m_4	...
h_{n5}	...	s_n	m_5	...

Finally, the event dref ε is introduced. Formally, there must exist an info state H'' , ε -different from H' , such that for each $h'' \in H''$, $\varepsilon h''$ is a making event whose agent is uh'' and whose theme is $u''h''$:

(77)

Info state H''	...	u	u''	ε	...
h''_1	...	s_1	m_1	e_{11}	...
h''_2	...	s_1	m_2	e_{12}	...
h''_3	...	s_1	m_3	e_{13}	...
h''_4	...	s_1	m_4	e_{14}	...
h''_5	...	s_1	m_5	e_{15}	...
h''_6	...	s_2	m_1	e_{21}	...
h''_7	...	s_2	m_2	e_{22}	...
h''_8	...	s_2	m_3	e_{23}	...
h''_9	...	s_2	m_4	e_{24}	...
h''_{10}	...	s_2	m_5	e_{25}	...
...
h'_{n1}	...	s_n	m_1	e_{n1}	...
h'_{n2}	...	s_n	m_2	e_{n2}	...
h'_{n3}	...	s_n	m_3	e_{n3}	...
h'_{n4}	...	s_n	m_4	e_{n4}	...
h'_{n5}	...	s_n	m_5	e_{n5}	...

In sum, uj is the maximal sum individual such that each of the atomic individuals in uj is a student and made the five mistakes $u''j$.

- c) $u'j$ is the maximal sum of students.
- d) The cardinality of uj is equal to that of $u'j$.

Summing up, the truth conditions for the DRS in (74) (and equivalently, 73) state that there must be a sum of five mistakes, such that the maximal set of students who each made those five mistakes is the same as the maximal set of students, i.e. there is a sum of five mistakes such that each student made those mistakes. This is not a co-distributive interpretation, and it is indeed one of the possible interpretations for sentence (65a).

I have shown that the structure in (70) does not give rise to an undesirable

co-distributive interpretation between a quantificational DP and a DP involving a numeral. The same conclusion will obtain if we analyse the translation of the structure in (69), or of similar structures involving a strong phrasal cumulativity operator. For the sake of brevity, I will not do this here. The fundamental reason for the lack of cumulative readings in all these cases is that quantificational determiners already introduce distributivity operators in their translations, which effectively block co-distributive interpretations.

4.4.1 QDs and Comparative Numerals

One of the advantages of the proposed analysis is that it can easily be extended to DPs involving comparative numerals such as *fewer than n*, and other constructions involving comparison of quantity. As I have argued in Chapter 2, these cases are problematic for several existing accounts of dependent plurals, including Champollion's (2010) presupposition-based mereological account and Ivlieva's (2013) mixed theory. Consider, for instance, the following examples:

- (78) a. Most^{*u'*, *u''*} students made fewer than five^{*u*} mistakes.
 b. Most^{*u'*, *u''*} students made fewer^{*u*} mistakes than there are prime numbers less than 12.

Both Champollion's (2010) and Ivlieva's (2013) accounts predict that the sentences in (78) should have interpretations on which the direct object DPs impose a restriction on the total number of mistakes that the students made. In fact such interpretations are impossible.

In this section I will consider two approaches to the semantics of comparative numerals, the individual quantifier analysis and the degree quantifier analysis, and demonstrate how both of them can be re-cast in the present framework in such a way as to deliver the correct interpretations for sentences like (78).

4.4.1.1 Comparative Numerals as Individual Quantifiers

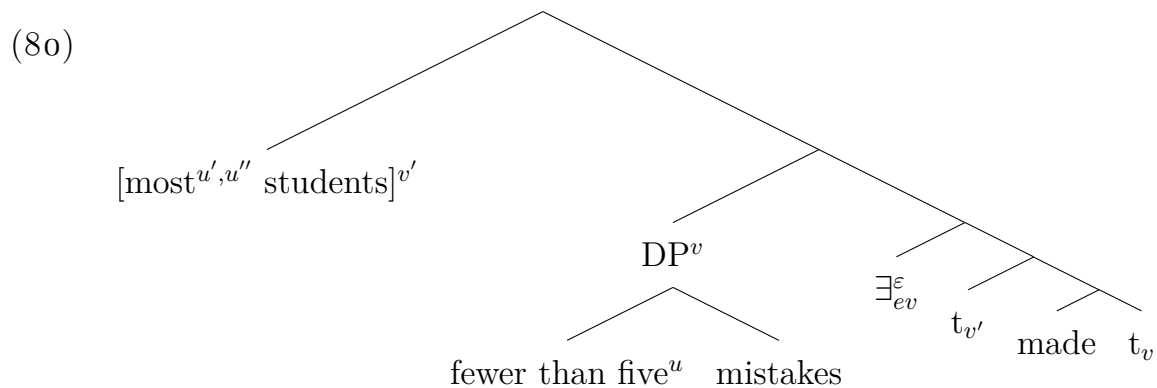
The more traditional way of accounting for the semantics of sentences like (78a) would be to translate comparative numerals, taken as non-decomposable linguistic items, as quantifiers that impose domain-level cardinality restrictions on the values of a maximal individual dref that satisfies both the restrictor and nuclear scope predicates. This approach would be in line with the treatment of comparative numerals in Generalised Quantifier Theory (cf. e.g. Keenan and Stavi 1986):

(79) a. **fewer than five**^{*u*} $\rightsquigarrow \lambda P_{\text{et}}.\lambda P'_{\text{et}}.\text{max}^u(P(u); P'(u)); [\text{fewer_5_atoms}\{u\}]$

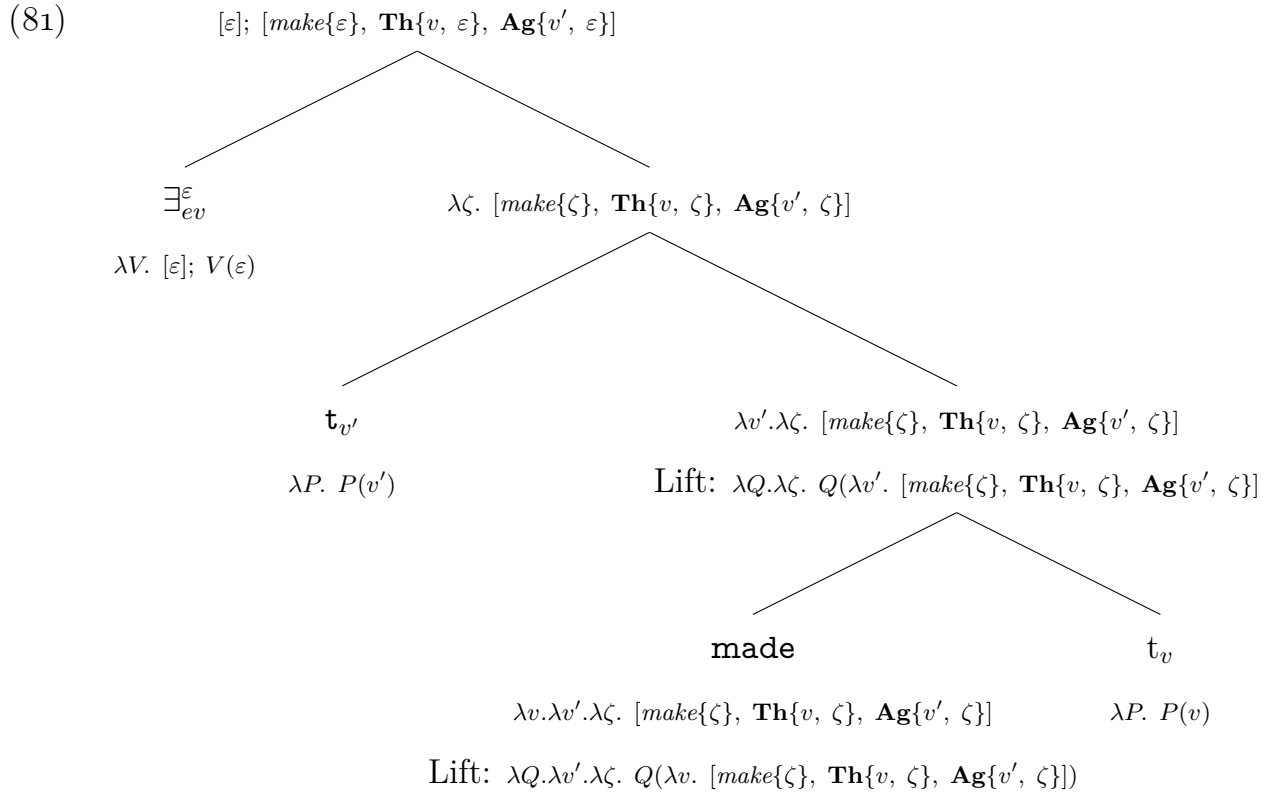
b. **fewer_5_atoms** $\{u\} := \lambda I_{st}.\forall i \in I.\text{fewer_5_atoms}(ui),$

where **fewer_5_atoms** $(x_e) := |\{y_e : y \leq x \wedge \text{atom}(y)\}| < 5.$

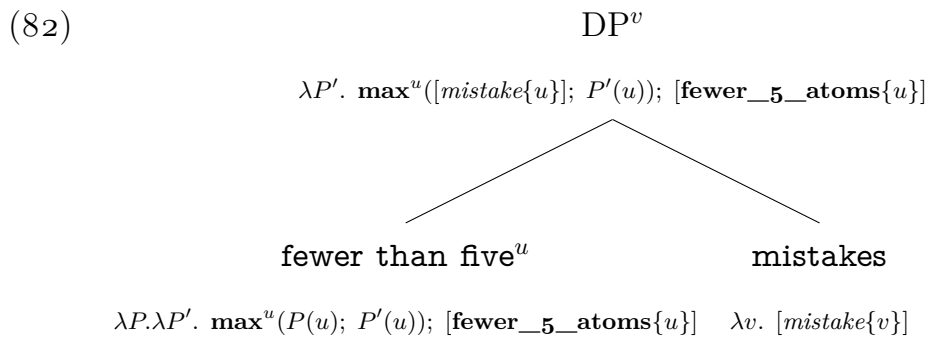
Given this definition of the comparative numeral, we can calculate the translation of (80), which corresponds to example (78a):



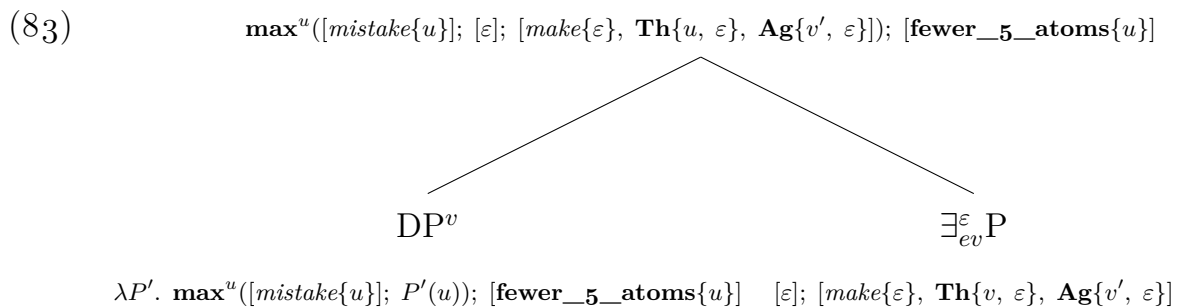
The compositional translation of (80) proceeds as follows. The verb combines with the object and subject traces and the event closure operator, resulting in the following DRS:



The object DP is translated as a generalised quantifier of the following form:



The vP in (81) combines with this DP via Quantifying-In:



Finally, the DRS in (83) combines with the quantified subject via the Quantifying-In rule:

$$(84) \quad \begin{array}{c} \mathbf{max}^{u'}([\mathbf{dist}_w([\mathit{student}\{u'\}]); \\ \mathbf{max}^u([\mathit{mistake}\{u\}]; [\varepsilon]; [\mathit{make}\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}, \mathbf{Ag}\{u', \varepsilon\}]; [\mathbf{fewer_5_atoms}\{u\}](u'))]; \\ \mathbf{max}^{u''}([\mathbf{dist}_w([\mathit{student}\{u''\}](u''))]; [\mathbf{MOST}\{u'', u'\}] \\ \hline [\mathbf{most}^{u', u''} \mathit{students}]^{v'} \qquad \mathbf{max}^u([\mathit{mistake}\{u\}]; [\varepsilon]; [\mathit{make}\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}, \mathbf{Ag}\{v', \varepsilon\}]); \\ \lambda P. \mathbf{max}^{u'}([\mathbf{dist}_w([\mathit{student}\{u'\}]; P(u'))(u')); \qquad [\mathbf{fewer_5_atoms}\{u\}] \\ \mathbf{max}^{u''}([\mathbf{dist}_w([\mathit{student}\{u''\}](u''))]; [\mathbf{MOST}\{u'', u'\}]) \end{array}$$

The final DRS in (84) will be true with respect to a singleton input info state I iff there exists a singleton output info state J , such that:

a) The unique assignment j in J differs from the unique assignment i in I at most with respect to the values for u' and u'' .

b) $u'j$ is the maximal individual such that the following conditions are met:

1) There exists an info state H , such that $J\langle u' \rangle H$, i.e. the atomic sub-individuals in $u'j$ are distributed as values of u' for the assignments in H , and for each $h \in H$, $u'h$ is a student:

(85)

Info state H , such that $J\langle u' \rangle H$	...	u'	...
h_1	...	s_1	...
h_2	...	s_2	...
...
h_n	...	s_n	...

2) There exists an info state H' , such that $H[u]H'$ and each value of u for the

assignments in H' , i.e. m_1, m_2, \dots, m_n in (86) below, is a sum of mistakes of a cardinality smaller than 5.

(86)

Info state H'	...	u'	u	...
h'_1	...	s_1	m_1	...
h'_2	...	s_2	m_2	...
...
h'_n	...	s_n	m_n	...

Moreover, the values of u for the assignments in H' must be the maximal individuals such that there exists an info state H'' satisfying the following conditions: $H'[\varepsilon]H''$ and for each $h'' \in H''$, $\varepsilon h''$ is a making event whose agent is $u'h''$ and whose theme is uh'' :

(87)

Info state H'	...	u'	u	ε	...
h''_1	...	s_1	m_1	e_1	...
h''_2	...	s_2	m_2	e_2	...
...
h''_n	...	s_n	m_n	e_n	...

In sum, uj must return the maximal sum of students, for each of whom the maximal sum of mistakes she made has a cardinality less than 5.

c) The value of u'' for j , i.e. $u''j$, stores the maximal individual, such that each of its atomic sub-individuals is a student.

d) Finally, the static quantifier **MOST** is applied to uj' and $u''j$, adding the following condition:

$$(88) \quad |u'j| > |u''j| - |u'j|$$

This condition states that the cardinality of $u'j$ must be greater than half the cardinality of $u''j$.

In sum, the DRS in (84) will be true if there is a maximal set of students S , such that for each $s \in S$ the maximal sum of mistakes that s made is less than 5, and the cardinality of S is greater than half the cardinality of the maximal set of students. This is the required distributive, non-cumulative interpretation of sentence (78a). A cumulative interpretation of such examples is blocked by the presence of the \mathbf{dist}_w operator in the translation of the subject DP scoping over the comparative numeral, and the fact that the cardinality condition associated with the numeral, i.e. $[\mathbf{fewer_5_atoms}\{u\}]$ in (84), is defined distributively as holding for each assignment in a plural info state (cf. 79b).

4.4.1.2 Comparative Numerals as Degree Quantifiers

Let us now turn to an alternative approach to comparative numerals, proposed by Hackl (2000), which treats them as degree quantifiers. My aim is to demonstrate that this approach can also be adequately re-formulated in the semantic framework developed here, and that combined with our assumptions on the semantics of weakly distributive QDs, it delivers the required results for sentences such as (78a) and (78b).

As a starting point, I will take Nouwen's (2010) simplified exposition of Hackl's (2000) proposal. This version of the analysis has three main components. First, all argument DPs containing modified numerals are taken to involve a phonologically null parametrised determiner *many*:

$$(89) \quad \llbracket \mathit{many} \rrbracket = \lambda n. \lambda P_{et}. \lambda P'_{et}. \exists x. (\#x = n \ \& \ P(x) \ \& \ P'(x)),$$

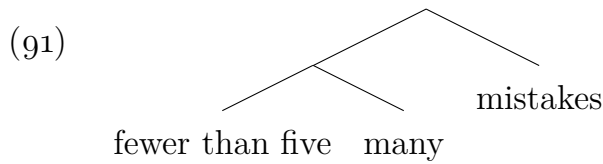
where n is a variable over degrees.

Next, comparative numerals are analysed as degree comparatives:

$$(90) \quad \llbracket \mathit{fewer\ than\ five} \rrbracket = \lambda M_{dt}. \max_n(M(n)) < 5,$$

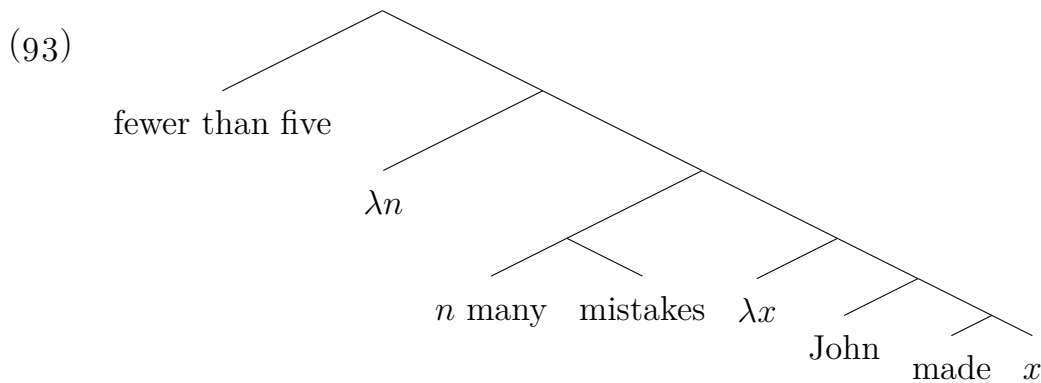
where d is the type of degrees and $\max_n(M(n))$ returns the maximal degree that satisfies M .

The underlying structure of a DP containing a modified numeral will be the following:



Given the interpretations in (89) and (91) this structure leads to a type clash, since the comparative numeral needs to combine with a predicate of type dt , while *many* is interpreted as a function of type $(d((et)((et)t)))$. This leads to the third basic component of the analysis, namely the assumption that the comparative numeral, being essentially a generalised quantifier over degrees, is able to quantifier raise out of the DP to a higher position, leaving behind a trace of type d . Thus, a sentence like (92) is assigned the underlying syntactic structure in (93), where the object DP is quantifier raised out of its base position leaving a trace of type e , and the comparative numeral is in turn raised out of the object DP, leaving a trace of type d :⁴

(92) John made fewer than five mistakes.



This structure can now be compositionally interpreted, yielding the following truth conditions:

$$(94) \quad [\lambda M_{dt}. \max_n(M(n)) < 5] [\lambda n. \exists x. (\#x = n \ \& \ \text{mistake}(x) \ \& \ \text{make}(j, x))] =_{\beta} \\ \max_n(\exists x. (\#x = n \ \& \ \text{mistake}(x) \ \& \ \text{make}(j, x))) < 5$$

⁴Here, for simplicity I am disregarding the details of how Quantifying In is implemented.

These truth conditions state that sentence (92) will be true iff the maximal number n such that that John made n mistakes, is smaller than 5.

This approach to the semantics of comparative numerals has several advantages over the Generalised Quantifier approach. Conceptually, it unifies the semantics of comparative numerals with that of a broader class of comparative constructions, treating cardinalities as a sub-type of degrees. Empirically, it allows for an account of the ambiguity of sentences like (95a):

- (95) a. John is required to read fewer than six books.
 b. ‘John shouldn’t read more than six books.’
 c. ‘The minimal number of books that John should read is fewer than six.’

The reading in (95b) is derived by taking the modal verb to have wide scope with respect to the comparative quantifier. The reading in (95c), on the other hand, arises if the comparative quantifier raises above the modal verb (cf. Hackl 2000 for a more detailed discussion and further arguments in favour of this approach).⁵

I will now show how this approach can be rendered in a dynamic semantic framework involving plural info states, and made compatible with our assumptions on the semantics of distributivity. First, we need to add a new basic type d for degrees. The domain of d is the set of non-negative integers, with the $<$ -relation defined in the standard way. Next, we need to introduce the notion of drefs over degrees of type (sd). I will use $d, d_1, d_2 \dots$ for constants of type (sd), and $n, n_1, n_2 \dots$

⁵Hackl’s (2000) analysis of comparative numerals is in fact more complicated than the version presented in Nouwen 2010, and repeated here. Specifically, Hackl assumes that *than*-clauses associated with comparative numerals include an elided copy of the determiner *many* together with its original restrictor and nuclear scope constituents. Under this assumption the truth conditions of sentence (92) can be informally states as ‘the maximal number n such that that John made n mistakes is smaller than the number of mistakes that John would make in a situation where John made five mistakes’. This allows Hackl to explain the degraded status of sentences like (96a), given the interpretation in (96b):

- (96) a. ??More than two students were forming a triangle.
 b. ‘More students were forming a triangle than the number of students in a situation where two students would be forming a triangle.’

In the following, I will restrict myself to the simplified version of the approach.

for variables of type (*sd*). Then, the null quantifier *many* proposed by Hackl (2000) can be re-defined in the following way:

$$(97) \quad \mathbf{many}^u \rightsquigarrow \lambda n_{sd} . \lambda P_{\mathbf{et}} . \lambda P'_{\mathbf{et}} . [u]; [\mathbf{card}\{u, n\}]; P(u); P'(u),$$

where $\mathbf{card}\{u, d\} := \lambda I_{st} . \forall i \in I. (|\{x_e : x \leq ui \wedge \mathbf{atom}(x)\}| = di)$

Defined in this way, *many* combines with a dref over degrees *n* and two dynamic predicates, *P* and *P'*, and introduces a new individual dref, *u*, such that for each assignment *i* in the updated info state the cardinality of *ui* is equal to the value returned by *n* for *i*, i.e. *ni*. Moreover, *u* must satisfy the two dynamic predicates *P* and *P'*.

Next, we need to provide a translation for the comparative numeral. Recall, that in Hackl's (2000) system the comparative numeral combines with a predicate of degrees and places a condition on the value of the *maximal* degree that satisfies that predicate. In our dynamic system, the same idea can be represented in the following way:

$$(98) \quad \mathbf{fewer}^d \mathbf{than} \mathbf{five} \rightsquigarrow \lambda M_{(sd)t} . \mathbf{max}^d(M(d)); [d < 5],$$

where $d < 5 := \lambda I_{st} . I \neq \emptyset \wedge \forall i \in I. (di < 5)$

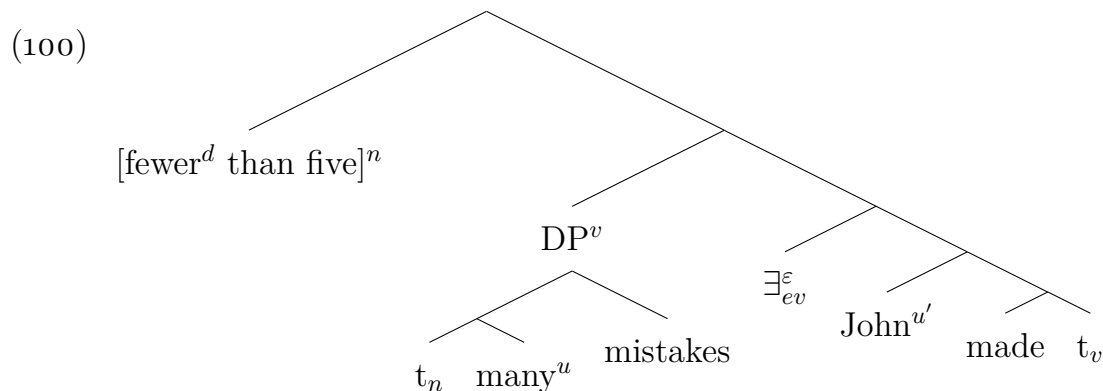
Here, the comparative numeral combines with a predicate of degree drefs *M*, and introduces a new dref over degrees *d* which is maximal with respect to *M*. Maximality is encoded with the help of the same **max** operator that we used in the translations of definites and QDs (cf. the definition in 2). Recall, that this operator ensures *distributive maximality* for the values of a dref, i.e. it states that for each assignment in the current info state, the value of the dref it introduces is maximal with respect to a particular DRS. Finally, (98) states that for each assignment in the current info state, the value returned by *d* is smaller than 5.

The final piece of Hackl's (2000) analysis is the idea that comparative numerals can quantifier raise out of their base positions leaving behind a degree-type trace. In our system, this would mean that the comparative numeral leaves a trace whose

index is a variable of type (sd) , i.e. the type of degree drefs. The translation of such traces is then directly parallel to that of standard traces indexed with se -variables:

$$(99) \quad \mathbf{t}_n \rightsquigarrow \lambda M_{(sd)\mathbf{t}}. M(d)$$

Having these translations in place, we can now calculate the truth conditions of the simple example (92). The syntactic structure assigned to (92) in our system is (100), which is directly parallel to the one in (93) above but incorporates our assumptions on indices, traces and event closure:



Before I provide a compositional translation for this structure, one more comment is in order. The type of trace t_n in our system is $(sd)(\mathbf{t})$, while *many* requires a term of type (sd) as its first argument. This means that we cannot directly combine *many* with t_n . To solve this problem, I will adopt a type-shifting rule, which is conceptually analogous to the Lift rules that we have used for the combination of verbs with their arguments:⁶

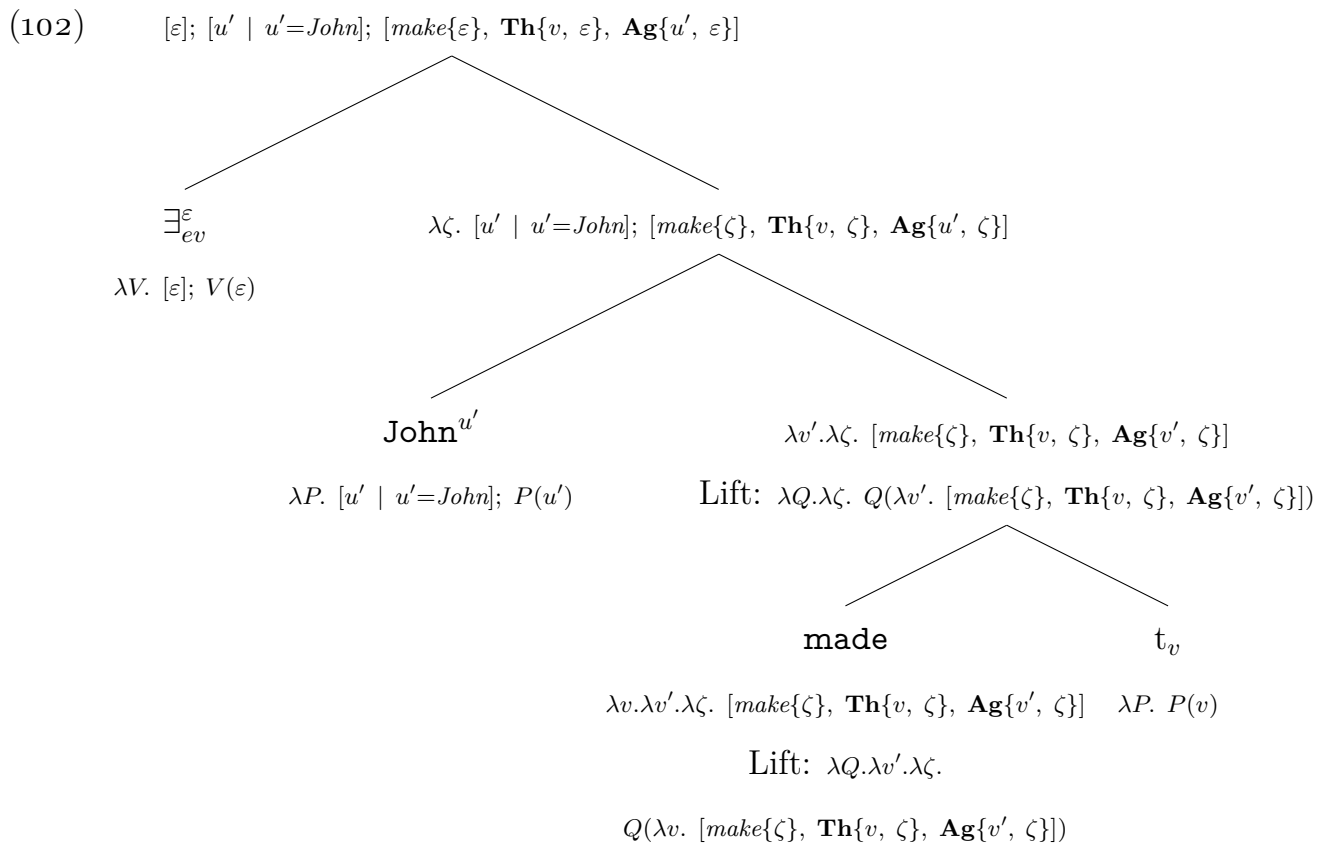
(101) **Parametrised Quantifier Lift:**

$$\lambda n_{sd}. \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. [\dots] \Rightarrow \lambda M_{(sd)\mathbf{t}}. \lambda P_{\mathbf{et}}. \lambda P'_{\mathbf{et}}. M(\lambda n. [\dots])$$

We can now proceed with the compositional translation of (100).⁷ The vP combined with the event closure operator is translated in the familiar way:

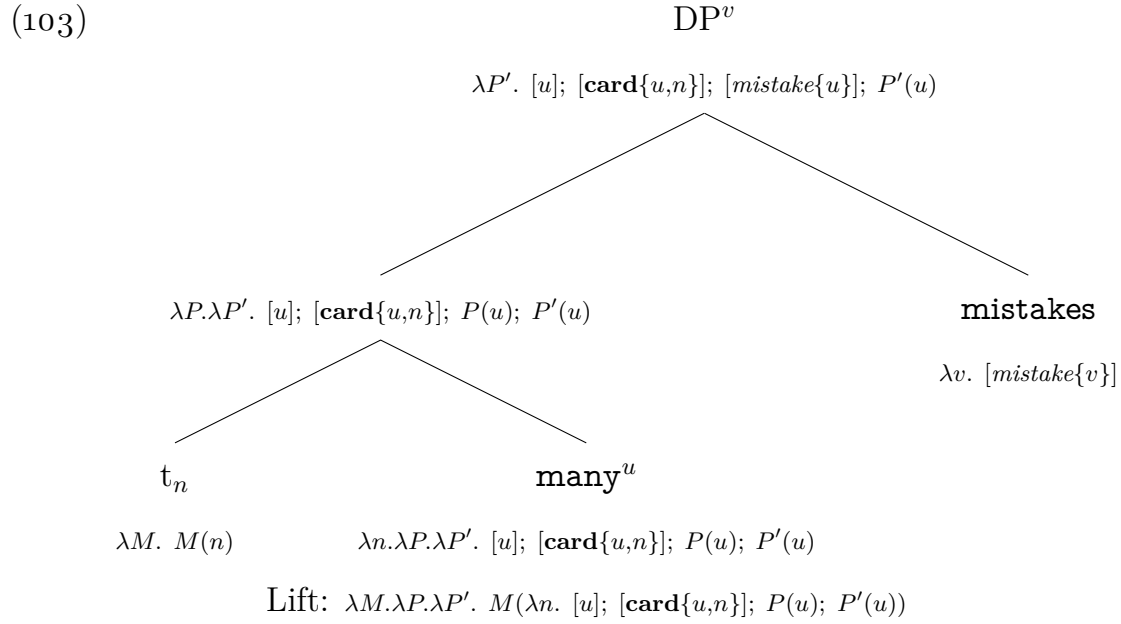
⁶Alternatively, we could adopt the lifted variant as the basic translation for the parametrised quantifier *many*. I chose the simpler variant in (97) primarily for expository purposes, to underscore the parallelism between the way this item functions in the current system and its original interpretation in Hackl 2000.

⁷In fact, in our system both the quantifier raising of the object DP and that of the comparative numeral, assumed in (100), are not obligatory. Given our assumptions on type-shifting, the

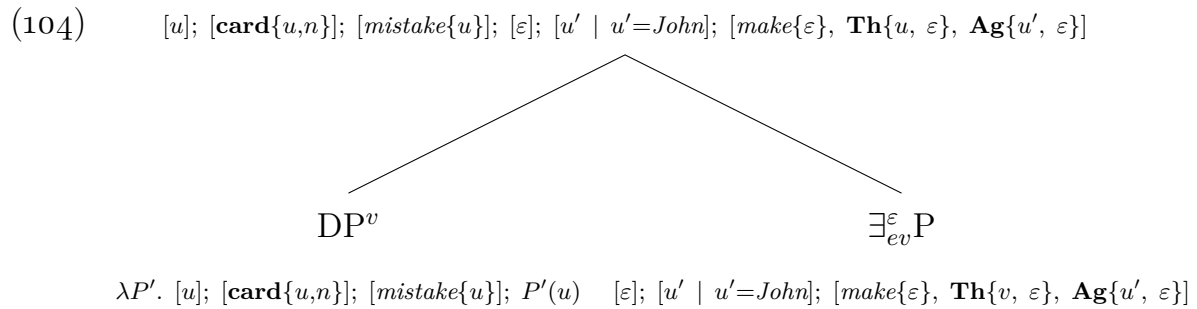


Next, we calculate the translation of the object DP, which involves a degree-trace:

structure would be interpretable in the absence of one or both of these movements. However, as discussed below, some of the potential options appear to be unavailable. Specifically, the comparative numeral must have wide scope with respect to the event closure operator.

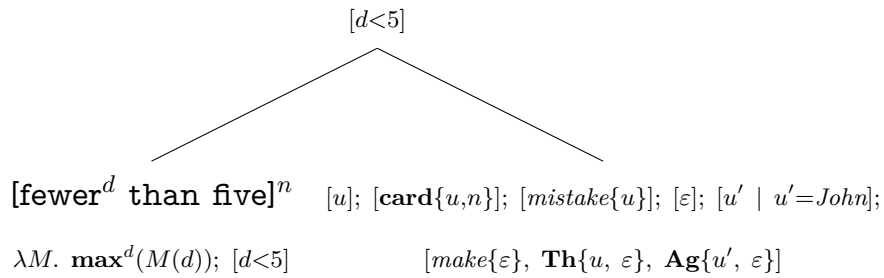


The DP combines with its sister in (102) via Quantifying-In, resulting in the following DRS:



The translation of the comparative numeral was given in (98). It too combines with its sister, translated in (104), via Quantifying-In. This yields the following DRS as the final translation for the structure in (100):

(105) $\max^d([u]; [\mathbf{card}\{u,d\}]; [mistake\{u\}]; [\varepsilon]; [u' \mid u'=John]; [make\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}, \mathbf{Ag}\{u', \varepsilon\}]);$

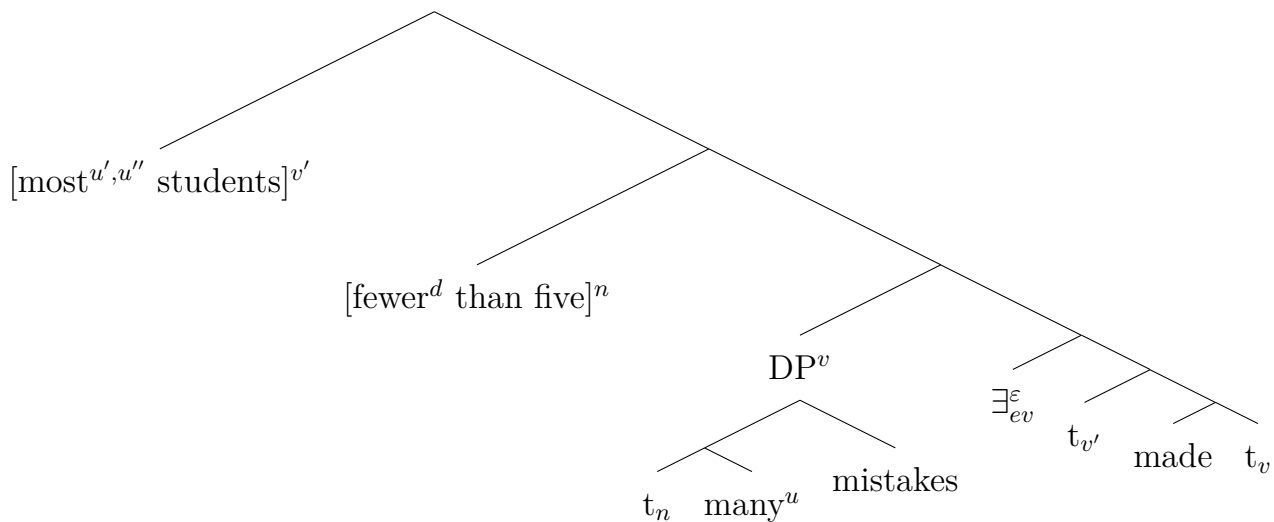


Given that the truth of a DRS is determined with respect to a singleton input info state, it is easy to see that this DRS captures the required truth conditions for sentence (92). Specifically, the DRS in (105) will be true if there exists a maximal degree n , such that there is a sum of mistakes m of cardinality n and a making event e , whose agent is John and whose theme is m , and n is smaller than 5.

This example was meant to illustrate how Hackl's (2000) analysis of comparative numerals can be in essence reproduced in the current semantic system. I will now turn to example (78a), and show how this approach, combined with our proposal regarding the semantics of weakly distributive quantifiers, correctly blocks cumulative readings in such constructions.

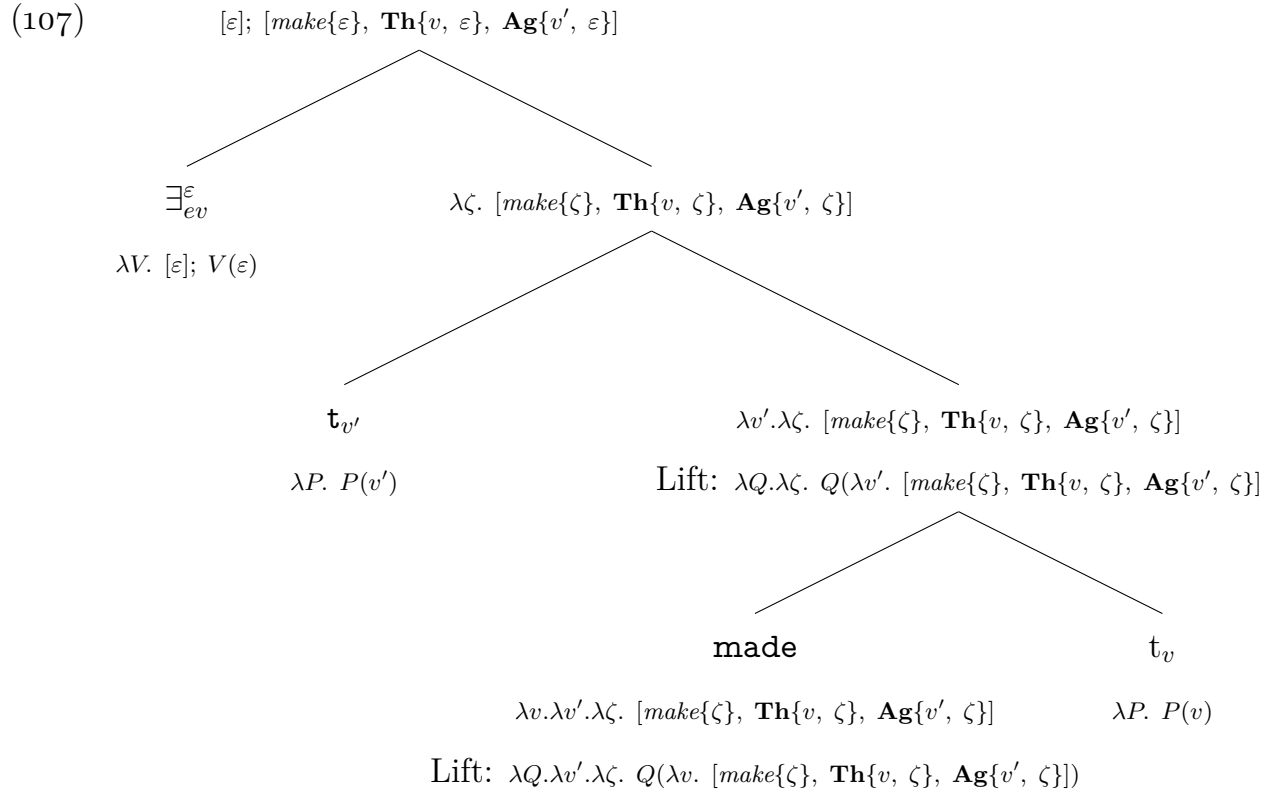
I will assume the following syntactic structure for sentence (78a):

(106)

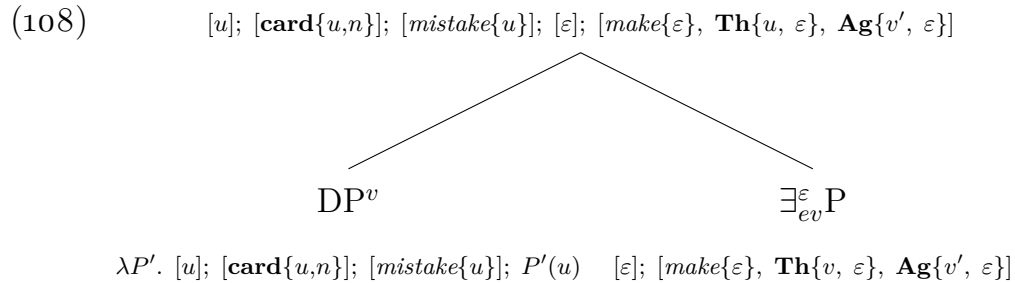


This structure is analogous to that in (100), except that, by assumption, the quantified subject must raise to a position higher than the quantified numeral (cf. discus-

sion of this point below). The compositional translation of this structure proceeds as follows. The verb combines with the object and subject traces, and the event closure operator, resulting in the following DRS:

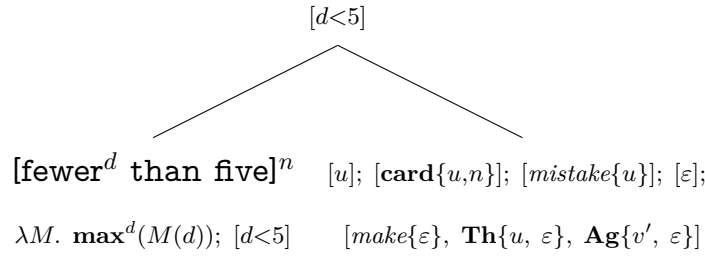


This structure then combines with the object DP, translated in (103), via Quantifying-In:



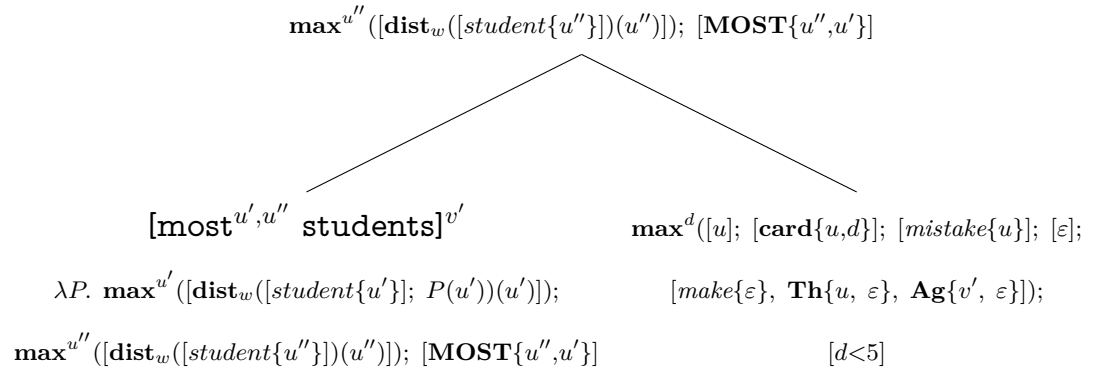
The structure in (108) combines with the comparative numeral, translated in (98), via Quantifying-In:

(109) $\max^d([u]; [\mathbf{card}\{u,d\}]; [\mathit{mistake}\{u\}]; [\varepsilon]; [\mathit{make}\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}, \mathbf{Ag}\{v', \varepsilon\}]);$



Finally, we introduce the raised subject and combine it with (109) via the Quantifying-In rule:

(110) $\max^{u'}([\mathbf{dist}_w([\mathit{student}\{u'\}]; \max^d([u]; [\mathbf{card}\{u,d\}]; [\mathit{mistake}\{u\}]; [\varepsilon]; [\mathit{make}\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}, \mathbf{Ag}\{u', \varepsilon\}]); [d < 5])(u')];$



The resulting DRS in (110) is the final translation for the structure in (106). The truth conditions of this DRS turn out to be equivalent to those of (84), discussed above. Let us see why. The DRS in (110) will be true with respect to a singleton input info state $I = \{i\}$ iff there exists a singleton output info state $J = \{j\}$, such that:

a) j differs from i at most with respect to the values for u' and u'' .

b) $u'j$ is the maximal sum of individuals such that:

1) by definition of the the \mathbf{dist}_w operator, there exists an info state H , such that $J \langle u' \rangle H$, i.e. the atomic sub-individuals in $u'j$ are distributed as values of u' for the assignments in H , and for each $h \in H$, $u'h$ is a student:

(111)

Info state H , such that $J\langle u' \rangle H$	...	u'	...
h_1	...	s_1	...
h_2	...	s_2	...
...
h_n	...	s_n	...

2) There exists an info state H' , such that $H[d]H'$ and each value of d for the assignments in H' , i.e. d_1, d_2, \dots, d_n in (112) below, is smaller than 5.

(112)

Info state H'	...	u'	d	...
h'_1	...	s_1	d_1	...
h'_2	...	s_2	d_2	...
...
h'_n	...	s_n	d_n	...

Furthermore, the \mathbf{max}^d operator ensures that the values of d for the assignments in H' are the maximal degrees such that there exists an info state H'' satisfying the following conditions: $H'[u, \varepsilon]H''$ and for each $h'' \in H''$, uh'' is a sum of mistakes of cardinality dh'' and $\varepsilon h''$ is a making event whose agent is $u'h''$ and whose theme is uh'' :

(113)

Info state H''	...	u'	d	u	ε	...
h''_1	...	s_1	d_1	m_1	e_1	...
h''_2	...	s_2	d_2	m_2	e_2	...
...
h''_n	...	s_n	d_n	m_n	e_n	...

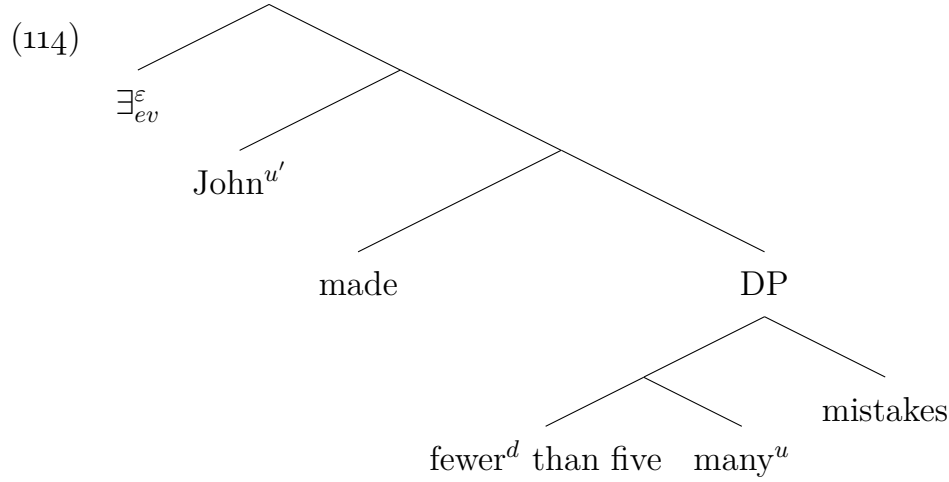
In sum, u_j must return the maximal sum of students, for each of whom the maximal number of mistakes she made is less than 5.

c) The value of u'' for j , i.e. $u''j$, stores the maximal individual, such that each of its atomic sub-individuals is a student.

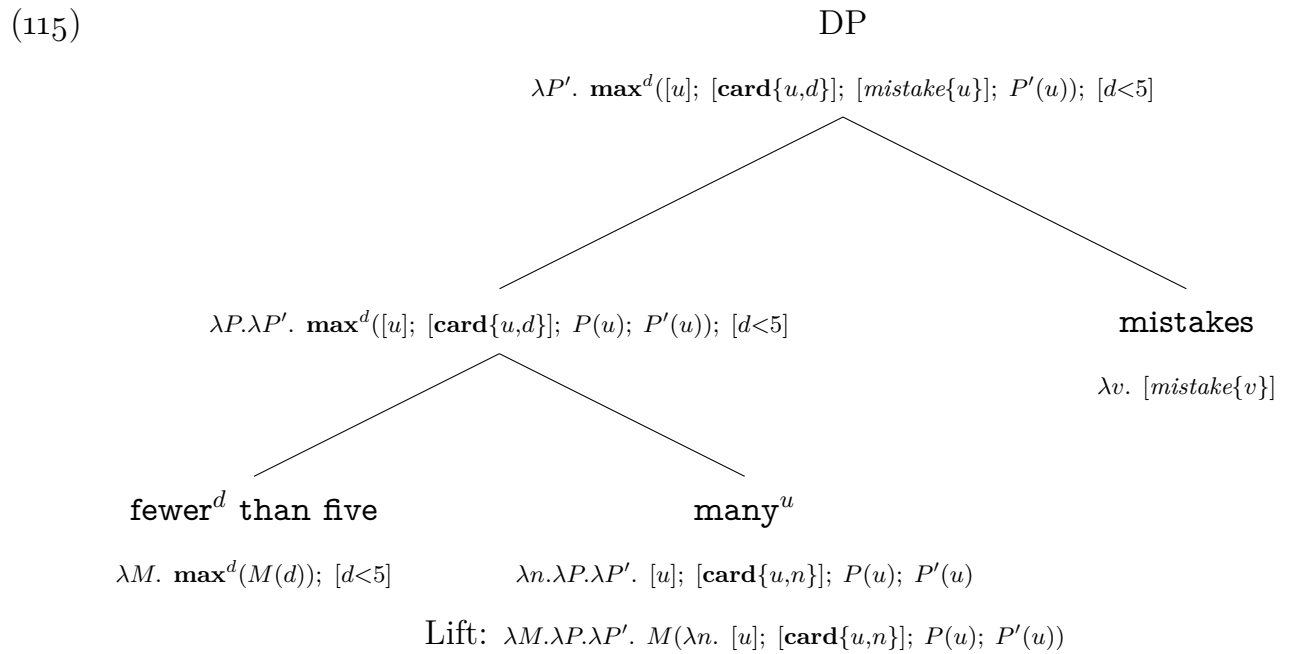
d) Finally, the static quantifier **MOST** is applied to $u'j$ and $u''j$ requiring for the cardinality of $u'j$ to be greater than half the cardinality of $u''j$.

In sum, the DRS in (110) will be true if there is a maximal set of students S , such that for each $s \in S$ the maximal number of mistakes that s made is less than 5, and the cardinality of S is greater than half the cardinality of the maximal set of students. These conditions are equivalent to those for the DRS in (84), derived under the individual quantifier analysis of the comparative numeral. And again, on the proposed implementation of the degree quantifier analysis, a cumulative interpretation of examples like (78a) is blocked due to the fact that the translation of the quantificational subject involves the \mathbf{dist}_w operator scoping over the comparative numeral, and the fact that the cardinality condition associated with the numeral, i.e. $[d < 5]$ in (110), is defined as a domain-level condition holding for each assignment in a plural info state (cf. 98).

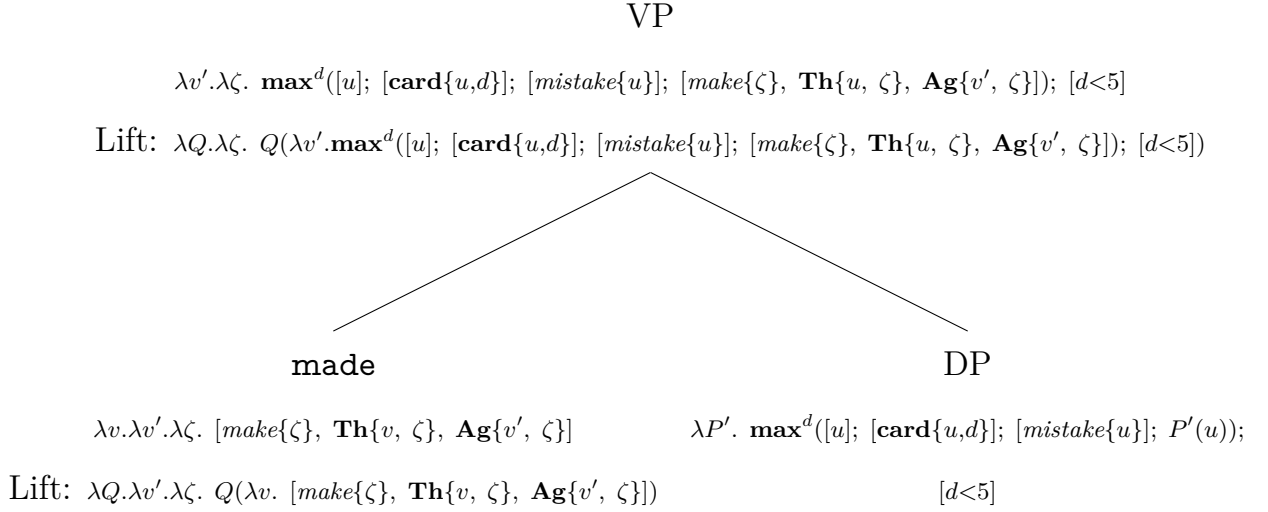
Some brief comments are in order regarding the discussed analysis of comparative numerals. One may note that given the free and optional character of quantifier raising, the structures in (100) and (106) are not the only ones that can be assigned to the sentences in (92) and (78a), respectively. With regard to this, two issues are of particular significance. First, nothing in our system prevents the comparative numeral from taking scope below the event closure operator. For instance, sentence (92) could be assigned the structure in (114), with both the object DP and the comparative numerals staying *in situ*.



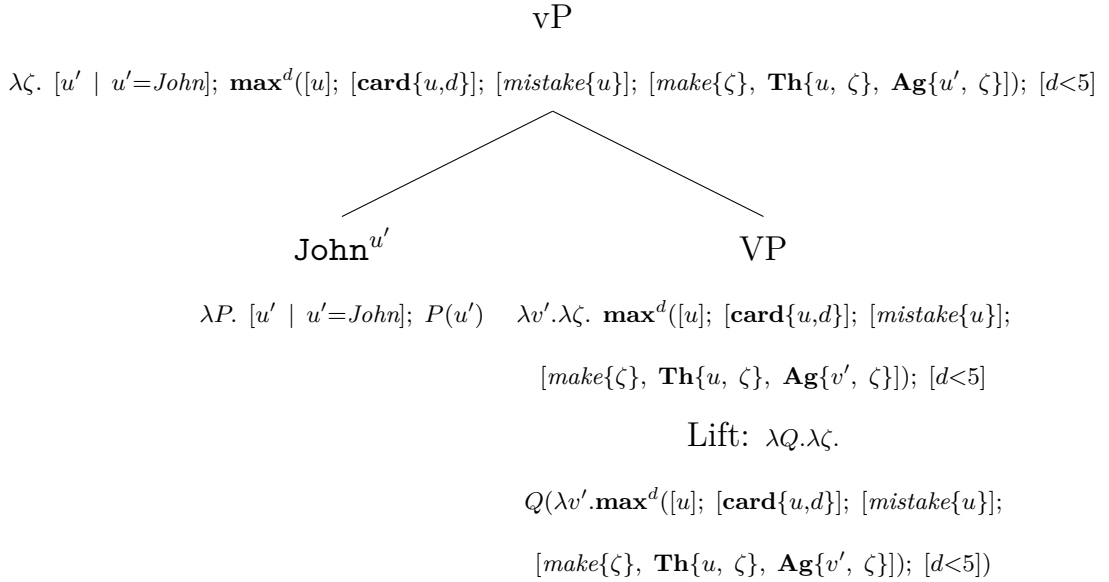
The Lift type-shifting rules that we have adopted ensure that this structure is interpretable. The compositional translation of (114) proceeds as follows:



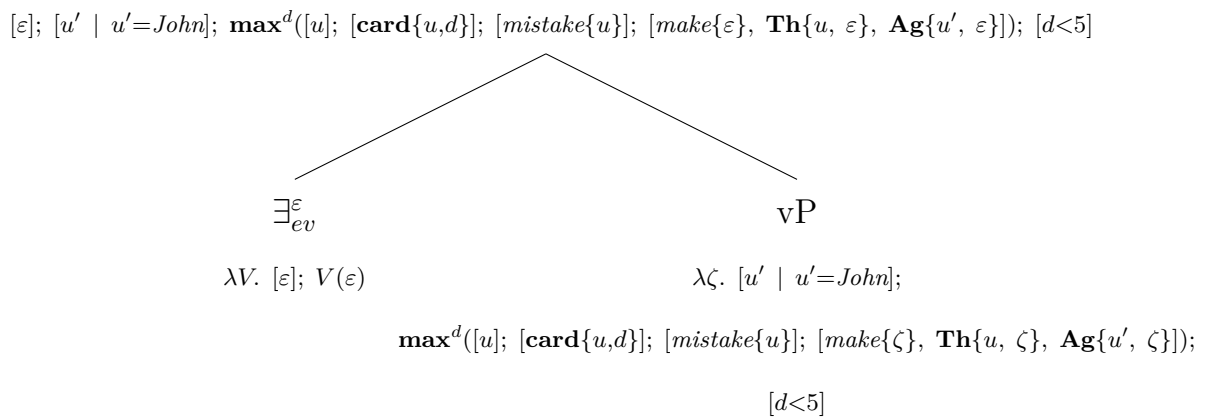
(116)



(117)



(118)



The truth conditions of the final DRS in (118) can be informally stated as follows: there is an event e and a degree n , such that n is the maximal number of mistakes that John made in e , and n is less than 5. These truth conditions are overly weak: if for instance there is an event e of John making 10 mistakes, the DRS in (118) will still be true, because due to the lexical distributivity of *make* there necessarily exists a sub-event $e' < e$ in which John made less than 5 mistakes.

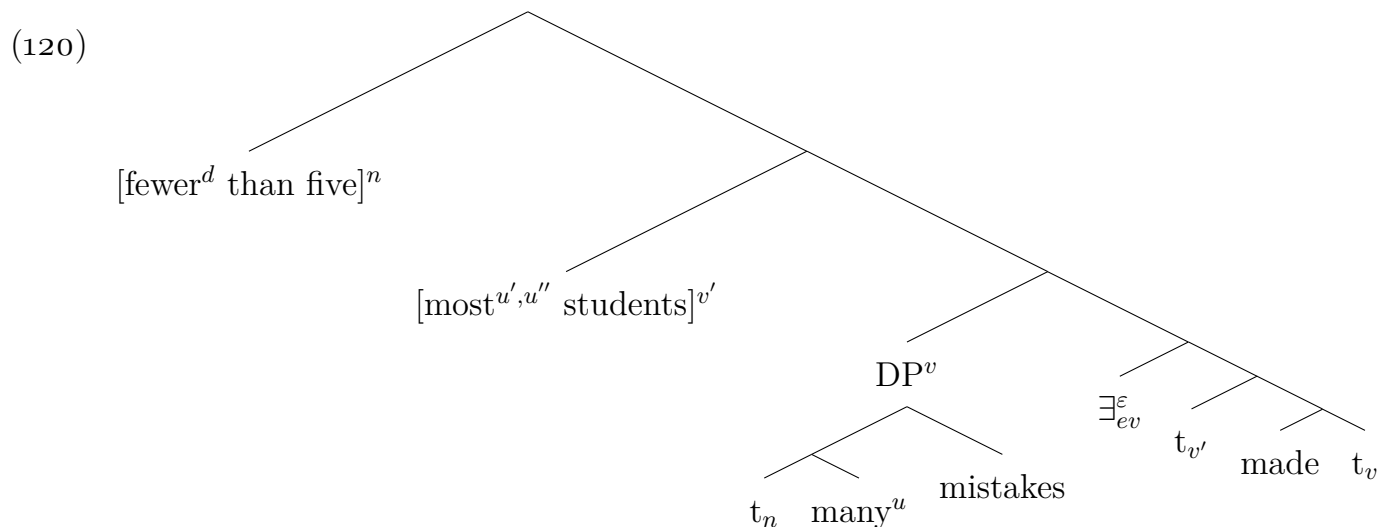
This kind of weak interpretation will be derived for any structure where the comparative numeral ends up scoping below the event closure operator, so we would want to find a way to rule out such a configuration. One way to avoid it is to assume that the comparative numeral is forced to raise above event closure to ensure type compatibility with *many*. This is the approach adopted by Hackl (2000), and to implement it in the present system we would need to make two modifications. First, traces would have to be translated directly as dref variables, not as generalised quantifiers, e.g.:

- (119) a. $t_v \rightsquigarrow v$
 b. $t_n \rightsquigarrow n$

And second, the type-shifting rule in (101) would have to be abandoned. Given these modifications, the structure in (114) where the comparative numeral remains *in situ*, would be uninterpretable due to a clash in types between the translations of the comparative numeral and *many*. The structure in (100), on the other hand, could be compositionally translated, because in this case *many*, with the translation in (97), would combine with the trace of the comparative numeral of type *sd* via Functional Application. The above modifications would not affect the final translation of the structure in (100), discussed above.

The second issue related to the potential scope of the comparative numeral has to do with the underlying structure of sentences like (78a). Above, I assumed that this sentence has the structure in (106), with the comparative numeral scoping below the quantificational subject. However, nothing in the system would block

an alternative, inverse-scope structure, as in (120):



When translated, this structure yields the following DRS:

- (121) $\mathbf{max}^d(\mathbf{max}^{u'}([\mathbf{dist}_w([student\{u'\}]; [u]; [\mathbf{card}\{u, d\}]; [mistake\{u\}]; [\varepsilon]; [make\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}, \mathbf{Ag}\{u', \varepsilon\}]](u')));$
 $\mathbf{max}^{u''}([\mathbf{dist}_w([student\{u''\}]](u''))); [\mathbf{MOST}\{u'', u'\}]; [d < 5]$

Informally, this DRS will be true if the maximal degree n , such that for most students s there is an event where s made n mistakes, is smaller than 5. In fact, this is not a possible interpretation of sentence (78a).

The problem of such spurious readings arises for the analysis of comparatives in terms of degree quantifiers in general, as noted by Heim (2000) (cf. also the discussion in Hackl 2000). For instance, sentence (122a) has the interpretation represented in (122b), which states that for every girl the maximal degree to which she is tall is less than 4 feet. This is the reading that arises if the quantificational subject scopes above the degree quantifier. On the other hand, the reading represented in (122c), which states that the maximum degree to which each girl is tall is less than 4 feet, is absent. This is the reading that would arise if the degree quantifier was allowed to scope above the quantificational subject.

(122) a. (John is 4' tall.) Every girl is less tall than that.

b. $\forall x.(girl(x) \rightarrow \max_n(tall(x, n)) < 4')$

c. $\max_n(\forall x.(girl(x) \rightarrow tall(x, n)) < 4')$

Heim (2000) formulates the following constraint, which she refers to as *Kennedy's Generalisation*:

(123) *Kennedy's Generalisation*

If the scope of a quantificational DP contains the trace of a DegP, it also contains that DegP itself.

Given this constraint, the undesired reading in (122b) is predicated to be blocked. Applied to example (78a), this restriction would rule out the structure in (120), thus eliminating the undesired interpretation in (121). The exact nature the constraint in (123) is not clear (however, see Lassiter 2010, 2012 for a semantic analysis), and I will have nothing more to say on this issue here.

Summing up, I have demonstrated how two existing accounts of the semantics of comparative numerals can be re-stated in the current system. Combining these accounts with the proposed semantics for quantificational determiners, we were able to derive the correct distributive interpretation for comparative numerals in the scope of quantificational DPs, while blocking the undesired cumulative interpretation. This result is significant since, as we have seen, ruling out the cumulative reading in such constructions is problematic for previous accounts of weakly distributive QDs.

4.4.2 The Status of the Neutrality Generalisation

Recall the Neutrality Generalisation formulated in Chapter 1:

(124) *Neutrality Generalisation*

Number-neutral plurals can be dependent on the whole range of licensors, including quantificational nominal licensors and pluractional adverbials, while non-number neutral plurals can have a co-distributive (cumulative) reading only with non-quantificational nominal licensors.

I have demonstrated above how the proposed account of weakly quantificational licensors, grammatical number features and cardinality modifiers, e.g. numerals, can derive the effects of this generalisation. Specifically, I proposed that cardinality features encode conditions which apply at the assignment level. This means that they are applied distributively to each value of a dref in a plural info state generated by a weak distributivity operator, i.e. must be interpreted distributively in the scope of such operators. On the other hand, plurals lacking cardinality modifiers were analysed as underlyingly number-neutral. However, in non-downward entailing contexts, their semantics is enriched with a disjoint non-atomicity/non-uniqueness condition, which is the negation of the conjoined atomicity+uniqueness condition encoded by the singular number feature. The disjoint condition associated with non-cardinal plurals allows their drefs to return atomic values for the assignments in a plural info state, as long as they do not return the same value for all the assignments. This accounts for the possibility of dependent plural readings of non-cardinal plurals in the scope of weak distributivity operators.

We may now consider a more general question regarding the status of the generalisation in (124). Specifically, is this generalisation the consequence of a particular constellation of grammatical properties which is characteristic of English, and maybe a sub-set of other languages, or is there a deeper link between number-neutrality and the availability of dependent plural readings in (weakly) quantificational contexts? For instance, can we expect to discover a language where the semantics of cardinal modifiers and/or number features is different from that in English in such a way that this generalisation no longer holds? This is first and

foremost an empirical question. We have seen in Chapter 1 that there are intriguing indications that the Neutrality Generalisation may be valid cross-linguistically (cf. the discussion of the contrast between European and Brazilian Portuguese in section 1.4.7.4), however much more research is needed to provide a definitive answer. Let us however briefly consider, in the context of our current proposal, what it would mean if the generalisation in (124) did prove to be a universal property of natural language.

In principle, nothing in the proposed theory prevents cardinal modifiers in some language L from having translations as in (125a), or the plural feature from having a translation as in (125b):

- (125) a. **several*** $\rightsquigarrow \lambda v_e. \lambda I_{st}. \lambda J_{st}. I = J \wedge \neg \mathbf{atom}(\oplus uJ)$
 b. **#:pl*** $\rightsquigarrow \lambda v_e. \lambda I_{st}. \lambda J_{st}. I = J \wedge \neg \mathbf{unique}\{u\}J$

The hypothetical cardinal modifier *several** in (125a) applies a non-atomicity condition to the *sum of the values* of a dref in an info state. DPs involving such a modifier in L would not be number-neutral, but would allow for cumulative readings in the scope of weak distributivity operators. Similarly, the hypothetical **#:pl*** feature in (125b) involves a non-atomicity condition as part of its direct translation, which means that DPs carrying this feature would not be number-neutral. However, they would allow for a co-distributive interpretation in the scope of weak-distributivity operators.

This means that if the Neutrality Generalisation indeed holds as a universal property of language, its source needs to be located outside the semantic theory proper. There are several options. First, there may be a functional explanation for the non-existence of certain types of interpretations for grammatical items. Note, for instance, that the distribution of DPs carrying the **#:pl*** feature in (125b) would be severely limited. Given that, on our assumptions, non-singleton info states are generated only in the scope of weak distributivity operators, this is the only context where the non-uniqueness condition as in (125b) can be satisfied. Second, it may be that the Neutrality Generalisation is, at least partly, due to universal

principles of mapping between the conceptual system and semantic representation, e.g. the concept of cardinality (one, two, etc.) may be universally mapped onto the domain level in the semantic representation. Finally, some aspects of the Neutrality Generalisation may be the consequence of syntactic universals. For instance, if uniqueness is universally encoded as a privative feature on the number head, translations like (125b) would be ruled out. Non-uniqueness could then only be derived for number-neutral forms in competition with stronger alternatives carrying the uniqueness feature.

Which, if any, of these explanations are correct, or if indeed the Neutrality Generalisation holds across languages, is a question for future research.

4.5 QDs and Collective Predication

In this section I will consider the restrictions that apply to the combination of quantificational DPs with different types of collective predicates. I will start by presenting the relevant data, and then briefly describe two previous approaches to this problem pointing out some conceptual and empirical drawbacks that they face. I will then present an alternative account, based on the approach to distributivity advocated here.

4.5.1 QDs and Mixed Predicates

In an early work, Lakoff (1970) noted that DPs involving *all* allow for collective readings in a way that DPs involving *every* do not. He provides the following examples:

- (126) a. All the boys carried the couch upstairs.
 b. Every boy carried the couch upstairs.

Sentence (126a), according to Lakoff (1970), is ambiguous between a distributive and a collective interpretation. On the former, each boy carries the couch upstairs independently. On the latter, the boys carries the couch upstairs together.

Sentence (126b), on the other hand, only allows for the distributive interpretation. The collective reading is blocked (see also Link 1983, Scha 1984, Roberts 1990, a.o. for similar observations). Following the widely adopted terminology, I will use the term *mixed predicates* for predicates which have collective readings that can be distinguished from their distributive readings, such as *carry the couch upstairs*.

Dowty (1987) cites a similar contrast:

- (127) a. All the students in my class performed Hamlet.
 b. Every student in my class performed Hamlet.

According to Dowty's (1987) judgement, both sentences in (127) allow for a distributive reading, but only (127a) allows for a collective reading, which is not equivalent to (127b). However, Winter (2000, 2001) reports that some speakers consider sentence (127a) to be unambiguously distributive, and thus equivalent to (127b). For these speakers, collective readings of sentences like (127a) only arise in the presence of the collectivizing adverb *together*. Winter (2000) further notes that the the same point applies to many other mixed predicates, such as *drink a whole glass of beer*, *lift a piano*, and *write a book*. Thus, there appears to be cross-speaker variation with respect to the availability of collective readings of mixed predicates when they are combined with DPs involving *all*. Following Winter (2000, 2001) (see also Champollion 2010), I use the term *Dowty's dialect* to refer to the variant of grammar that allows for such readings. On the othe hand, I will refer to the variant that disallows collective readings in such contexts as *Winter's dialect*.

4.5.2 QDs and Collective Predicates

In a similar vein, Vendler (1967) observed that the quantifier word *all*, on the one hand, and singular QDs like *every* and *each*, on the other, display contrasting behaviour when the corresponding DPs are combined with predicates such as *be similar*:

(128) a. All those blocks are similar.

b. *Each (every one) of those blocks is similar.

DPs involving *all* can occur as subjects of *be similar*, as demonstrated by the well-formedness of (128a), while those involving *each* and *every* cannot, as shown (128b). The class of predicates that behave like *be similar* includes *fit together*, *gather*, *meet*, *live together*, *be alike*, *be brothers*, *be fans of each other*, etc. (cf. Scha 1984, Dowty 1987, Winter 2000, 2001, Hackl 2002, Champollion 2010, among others):

(129) a. All the students gathered in the dining room / live together / met in the hall.

b. *Each / every student gathered in the dining room / lives together / met in the hall.

Unlike the collective readings of sentences involving mixed predicates combined with DPs involving *all*, e.g. (126a) and (127a), which as pointed out above appear to be subject to cross-speaker variation, the availability of collective readings in sentences like (128a) and (129a) is widely accepted. Following Champollion (2010), I will refer to the predicates that conform to the pattern in (128) and (129) as *gather-type* collective predicates (Winter 2000, 2001 uses the term *set predicates* for this class, Hackl 2002 calls them *essentially plural predicates*).

However, as noted by Dowty (1987), another class of collective predicates exhibits a different pattern, disallowing both DPs involving *each* and *every*, and those involving *all*:

(130) a. *All the students are numerous / are a good team.

b. *Each / every student is numerous / is a good team.

This class of predicates includes *be numerous*, *be a good team*, *suffice to defeat the army*, *decide unanimously to skip class*, *elect a president*, *outnumber*, *constitute a majority* etc. (see Dowty 1987, Taub 1989, Winter 2000, 2001, Hackl 2002,

Champollion 2010). Again, I will adopt Champollion's (2010) terminology, and refer to this class as *numerous-type* collective predicates (Hackl 2002 refers to them as *genuine collective predicates*, they are a subset of Winter's (2000, 2001) *atom predicates*).

As the examples in (128)-(130) show, *gather-* and *numerous-type* collective predicates differ with respect to their ability to combine with DPs involving *all*. On the other hand, they are similar in that they both disallow quantificational subjects involving the QDs *each* and *every* (at least when the quantifier's restrictor is not a group-denoting noun, see below). There are some other similarities. First, both types of collective predicates disallow singular non-quantificational subjects if they do not involve group nouns:

- (131) *The student is similar / gathered in the hall / is numerous / is a good team.

On the other hand, both *numerous-type* predicates and a subset of *gather-type* predicates combine with singular DPs involving group-denoting nouns, such as *team*, *committee*, *group*, *army*, *pack*, etc.:⁸

- (133) The committee / team / group gathered in the hall / met in the dining room / is numerous / elected a president.

Moreover, these predicates can combine with DPs headed by *each* and *every* if the restrictor NP involves a group noun:

- (134) Each committee / team / group gathered in the hall / met in the dining room / is numerous / elected a president.

⁸Another sub-set of *gather-type* predicates does not easily combine with singular group-denoting DPs. This sub-set includes predicates involving overt reciprocals, such as *be fans of each other*, as well as those that can be analysed as involving covert reciprocals, such as *be brothers* and *be similar*:

- (132) ??The committee likes each other / is similar.

The analysis of reciprocal predicates lies beyond the scope of this thesis.

4.5.3 Classes of QDs and Collective Predication

As Winter (2000, 2001) notes, the contrasts illustrated in (128)-(130) are not restricted to *all* vs *every / each*, but apply to broader classes of QDs. Thus, such determiners as *most (of the)*, *many*, *no_{pl}*, *few*, *exactly four* pattern with *all*, while *no_{sg}*, *more than one*, *many a* pattern with *every / each*:

(135) a. Many / no / exactly four students gathered in the hall last night / are similar.

b. *No / more than one student gathered in the hall last night / is similar.

(136) a. *Many / no / exactly four students are numerous / are a good team.

b. *No / more than one student is numerous / is a good team.

It is evident that, generally, the ability of a QD to combine with *gather*-type predicates correlates with its ability to license dependent plurals. This correlation extends to floating quantifiers *each* and *all*, which we have analysed as distributivity operators. Here again, the strong distributivity operator *each* which, as we have seen, blocks dependent plural readings, also blocks collective predication with *gather*-type predicates. The weak distributivity operator *all*, on the other hand, allows for dependent plural readings, and also allows for collective predication with *gather*-type predicates:

(137) a. The students all gathered in the hall last night.

b. *The students each gathered in the hall last night.

There are, however, two complications with regards to the above correlation. First, some authors report that collective readings with DPs of the form *all/most* + NP are unavailable, awkward, or dispreferred (cf. Kamp and Reyle 1993, Gil 1995, Crnič 2010, Dobrovie-Sorin 2014). Thus, Gil (1995) notes that sentences like (138a) “are judged to be somewhat awkward”, and takes this to be the result of the fact that DPs of the form *all* + NP have a preference for generic contexts. Similarly, Gil (1995) judges sentence (138b) to be awkward, but still clearly more acceptable than (139c).

- (138) a. All men gathered at dawn.
 b. Most men gathered at dawn.
 c. *Every men gathered at dawn.

The fact that DPs of the form *all/most* + NP have a preference for generic contexts has been noted by Partee (1995) and Brisson (1998) for *all*, and Cooper (1996) for *most*.⁹ This issue is discussed at length in Matthewson 2001. Now, if Gil (1995) is correct in attributing the degraded status of examples like (138a)-(138b) to the genericity requirement associated with these types of DPs rather than to their incompatibility with *gather*-type collective predicates *per se*, we would expect the awkwardness to disappear once the genericity requirement is met. This appears to be correct, as illustrated by the following freely occurring examples of such DPs combining with *gather*-type predicates in generic contexts:

- (139) a. If all human beings are similar in some fundamental respect in a way requiring moral recognition, then it is a violation of right order to disregard this.
 b. Most Toronto self employed mortgage programs are similar with respect to terms and conditions of the mortgage.
 c. The face, the look on his face, or do all black cats just look alike?
 d. Relax, most dogs look pretty much alike.

The following examples, again taken from the Internet, illustrate the fact that DPs of the form *all/most* + NP freely license dependent plurals in generic contexts:

- (140) a. If all dogs had tails, burglars would have to learn that any dog COULD bite.
 b. Most cats have tails that are long, straight and proportionate to their body size.

⁹Cooper (1996) makes a similar observation regarding *few* and *many*.

Thus we can conclude, that once the independent conditions on the use of *all/most* + NP-type DPs are satisfied, they conform to the correlation between the licensing of dependent plurals and the ability to combine with *gather*-type collective predicates.

The second complication has to do with the quantifier *both*. We have seen that dependent plurals are licensed in the scope of *both* when it's used as a QD, as well as when it functions as a floating quantifier:

- (141) a. Both girls bought new cars.
 b. The girls both bought new cars.

However, the ability of *both* to combine with *gather*-type collective predicates appears to be limited at least in some dialects. On the one hand, Schwarzschild (1996) and Brisson (1998) argue that such combinations are possible, as indicated by the following examples (example 142a is from Schwarzschild 1996, example 142b is due to Brisson 1998):

- (142) a. They both saw each other.
 b. The students both collided in the hallway.

In a similar vein, Schwarzschild (1996) and Brisson (1998) argue that *both* allows for collective readings with mixed predicates, citing examples (143a) (Schwarzschild 1996) and (143b) (Brisson 1998):

- (143) a. John made the soup, I made the eggplant and we both made the roast.
 b. The students both carried the piano upstairs.

Schwarzschild (1996) further notes that this pattern extends to *both* functioning as a determiner, and provides the following quote from von Stechow (1980):

“Napoleon and Squealer sold Boxer to the knacker” does not imply that Napoleon sold Boxer to the knacker, nor does it imply that Squealer did so. It entails that both of them sold Boxer to the knacker. (von Stechow 1980:91)

These judgements have however been challenged. Thus, Brisson (1998) reports that William Ladusaw (p.c.) judged the sentences in (142b) and (142b) (on the collective reading) to be ill-formed. Similarly, Glanzberg (2008) states that sentence (144) involving *both* as a QD in combination with a mixed predicate lacks a collective interpretation:

(144) Both men lifted the piano.

Finally, Szabolcsi (2010), citing Livitz (2009), reports cross-speaker variation with respect to the acceptability of (145):

(145) % Both (of) these people hate each other.

While some speakers accept (145) as grammatical, in parallel to (146), others perceive a contrast between (145) and (146), judging the former to be unacceptable.

(146) All (of) these people hate each other.

Szabolcsi (2010) also notes that this variation does not extend to *numerous*-type collective predicates, with (147) being unacceptable for all speakers (cf. Brisson 1998 and Ladusaw 1982 for similar judgements):

(147) *Both / all (of) these people are a good team.

Thus, it seems that at least for a subset of speakers *both* patterns with *each* and *every* in that it cannot felicitously combine with either *numerous*-type, or *gather*-type collective predicates, and does not license a collective interpretation with mixed predicates (although, as we have seen, the availability of such interpretations with plural QDs in general is already subject to some degree of inter-speaker variation). On the other hand, the licensing of dependent plurals does not appear to be subject to the same variation. Thus, two speakers that I consulted who indeed find examples like (142a) and (142b) degraded or unacceptable, find the examples in (141) acceptable on the dependent plural interpretation.

To conclude, there is a general correlation between the ability of QDs and floating quantifiers to license dependent plurals and their ability to combine with

gather-type collective predicates, as well as to license collective readings with mixed predicates (with the latter property subject to some degree of inter-speaker variation). Specifically, the ability of a QD or floating quantifier to combine with *gather*-type collective predicates universally entails their ability to license dependent plurals. The converse implication is also generally valid, once independent conditions on the use of particular QDs are met, with the exception of *both*, which at least for some speakers is incompatible with all types of collective predicates, while still licensing dependent plurals in its scope. This is summarised in the following generalisation:

(148) *Licensing of Dependent Plurals and Collective Predicates*

The ability of QDs and floating quantifiers to combine with *gather*-type collective predicates and (in some dialects) to license collective readings with mixed predicates entails their ability to license dependent plurals. The converse is also generally true, with the exception of *both* in some dialects.

I will not attempt to provide an analysis of the special properties of *both* here. However, the fact that a weakly distributive QD may encode certain *additional* conditions which block its combination with *gather*-type collective predicates, is not in principle incompatible with the analysis that I propose in section 4.5.6 below.¹⁰

The generalisation in (148) is re-enforced by cross-linguistic data. Thus, in Russian QDs that combine with plural restrictor NPs, e.g. *use* ‘all’, *bolšinstvo* ‘most’, *mnogije* ‘many’, etc. both license dependent plurals and combine with *gather*-type collective predicates, as demonstrated in (149a) and (149b). Sentence (149a) allows for a dependent plural interpretation which is compatible with each

¹⁰One possibility is that *both* restricts the values of the event dref argument of the predicate it combines with, requiring it to return different events for the assignments in a plural info state. This would derive the incompatibility of *both* with *gather*-type collective predicates on the analysis developed below. However, to make this account work we would need to adopt a different type of translation for *both*, which would allow it to combine directly with event predicates, in line with the proposals in Schein 1993 and Kratzer 2000. In fact this kind of interpretation may be independently needed for all QDs to account for example like *Three copy editors caught every mistake in the manuscript*, cf. Kratzer 2000. I leave this issue for future research.

boy buying a single new book, as long as more than one book was involved overall. On the other hand, DPs involving *každyj* ‘each’, which requires a singular restrictor NP, neither license dependent plurals nor combine with *gather*-type collectives, as shown in (150a) and (150b). Sentence (150a), while grammatical, requires for each boy to have bought more than one new book, i.e. a dependent plural interpretation is blocked:

- (149) a. Vse mal’čiki / bolšinstvo mal’čikov kupili novyje knigi.
 all boys / most boys bought new books
 ‘All the boys / most of the boys bought new books’.
- b. Vse mal’čiki / bolšinstvo mal’čikov sobralis’ v zale.
 all boys / most boy gathered in hall
 ‘All the boys / most of the boys gathered in the hall’.
- (150) a. Každyj mal’čik kupil novyje knigi.
 each boy bought.3.SG new books
 ‘Each boy bought new books’.
- b. *Každyj mal’čik sobralis’a v zale.
 each boy gathered in hall
 Lit: ‘Each boy gathered in the hall’.

These data are mirrored by the properties of floating *vse* ‘all’ and *každyj* ‘each’:

- (151) a. Eti mal’čiki vse kupili novyje knigi.
 these boys all bought new books
 ‘These boys all bought new books’.
- b. Eti mal’čiki vse sobralis’ v zale.
 these boys all gathered in hall
 ‘These boys all gathered in the hall’.
- (152) a. Eti mal’čiki každyj kupili novyje knigi.
 these boys each bought.3.SG new books
 ‘These boys each bought new books’.
- b. *Eti mal’čiki každyj sobralis’ v zale.
 these boys each gathered in hall
 Lit: ‘These boys each gathered in the hall’.

Here, too, the floating quantifier *vse* ‘all’ licenses dependent plurals, as in (151a), which is compatible with a situation where each boy buys a single new book,

and combines with *gather*-type collective predicates, as in 151b). Conversely, the floating quantifier *každyj* ‘each’ blocks dependent plural readings. Thus, (152a) will be judged true only if each boy bought more than one new book. And as demonstrated in (152b), floating *každyj* ‘each’ does not combine with *gather*-type collective.

In the following sections I discuss two existing analyses of the data related to collective predication presented in the last three sections, proposed in Champollion 2010 and Ivlieva 2013. I focus on these proposals because they also include accounts of dependent plural licensing, and can thus be evaluated in relation to the generalisation in (148). I will argue that while these approaches are successful in accounting for the core observations discussed above (specifically, the pattern in 128-130), neither of them provides an explanation for the correlation in (148). I will then move on to provide an account of collective predication within the general theory of distributivity proposed in this thesis, and demonstrate how this approach is able to capture the discussed correlation between the availability of collective predication with *gather*-type collective predicates and the licensing of dependent plurals.

4.5.4 Champollion’s (2010) Account

Champollion (2010) develops an account of collective predication based on Landman’s (1989, 2000) notion of *group*, or *impure atom* (see also Link 1984). Landman (2000) assumes that definite DPs are ambiguous between a sum and a group interpretation, e.g. the DP *the students* has the following two interpretations:

(153) a. $\sigma(*boy)$

b. $\uparrow(\sigma(*boy))$,

where \uparrow is the group formation operator.

Here, (153a) represents the sum of all the boys, while (153b) represents the group formed on the basis of that sum. Thus the \uparrow -operator maps sums to impure atoms.

Champollion uses the contrast between pure and impure atoms to capture the distinction between *gather*-type and *numerous*-type collective predicates on the one hand, and between *each* and *all*, both as QDs and as floating quantifiers, on the other.

Starting with the former, Champollion proposes to capture the distinction between the two classes of collective predicates in the following way: while *gather*-type (or, in Champollion's terms, *thematic*) collective predicates can apply to events whose agents are impure atoms (i.e. groups), *numerous*-type (or *nonthematic*) collective predicates can never apply to such events. Thus, in (154b), which is the interpretation of (154a), the agent is a group individual formed on the basis of the sum of boys. On the other hand, in (155b), which is the interpretation of (155a), the agent is the sum of boys itself.

(154) a. The boys gathered.

b. $\exists e.[*gather(e) \wedge *ag(e) = \uparrow(\oplus boy)]$

(155) a. The boys are numerous.

b. $\exists e.[*numerous(e) \wedge *ag(e) = \oplus boy]$

Moreover, Champollion assumes that *gather*-type predicates are lexically distributive with respect to their agent argument, i.e. they apply to an event whose agent is a sum individual only if they apply to events whose agents are the atomic parts of that individual. This condition is satisfied in (154b) because in this case the agent is an impure atom, and thus its only atomic part is the group itself. On the other hand, as evident from (155b), *numerous*-type collective predicates are not lexically distributive in the above sense.

Let us now turn to the distinction between *all* and *each*. As already discussed in Chapter 2, Champollion assumes that the function of these items is to impose a particular type of presupposition on the predicate, which he refers to as *Stratified Reference*. For instance, the DP-internal *all* when it occurs as part of the the agent DP is assigned the following interpretation:

- (156) a. $\llbracket \text{all}_{ag} \rrbracket = \lambda x. \lambda P_{\langle vt \rangle}. \lambda e : \text{SR}_{ag, Atom}(P). [P(e) \wedge *ag(e) = x]$
 b. $\text{SR}_{ag, Atom}(P) \stackrel{\text{def}}{=} \forall e. [P(e) \rightarrow e \in * \lambda e'. (P(e') \wedge Atom(*ag(e')))]$
 (Every event in P consists of one or more events, which are also in P and whose agents are atomic.)

The DP-internal *each*, when it occurs as part of the the agent DP, is assigned the minimally different interpretation in (157):

- (157) a. $\llbracket \text{each}_{ag} \rrbracket = \lambda x. \lambda P_{\langle vt \rangle}. \lambda e : \text{SR}_{ag, PureAtom}(P). [P(e) \wedge *ag(e) = x]$
 b. $\text{SR}_{ag, PureAtom}(P) \stackrel{\text{def}}{=} \forall e. [P(e) \rightarrow e \in * \lambda e'. (P(e') \wedge PureAtom(*ag(e')))]$
 (Every event in P consists of one or more events, which are also in P and whose agents are pure atoms.)

As evident from the interpretations in (156) and (157), the contrast between *all* and *each* is, again, based on the theoretical distinction between pure and impure atoms. The presupposition associated with *all* requires for any event in the denotation of the predicate to be a sum of events, also in the denotation of that predicate, whose agents are atoms (either pure or impure). On the other hand, *each* imposes a stronger presupposition: it requires for any event in the denotation of the predicate to be a sum of events, also in the denotation of that predicate, whose agents are *pure atoms*.

Let us now see how these assumptions are used to account for the patterns of collective predication discussed in the previous sections. First, recall that *all* is compatible with *gather*-type collective predicates, but not with *numerous*-type collective predicates:

- (158) a. All the boys gathered.
 b. *All the boys are numerous.

Since *gather* is a thematic collective predicate, and is lexically distributive with respect to its subject, it follows that the VP in (158a) must apply to a group individual, specifically the group individual formed on the basis of the maximal sum

of boys. Otherwise, if it applied to the sum of boys itself, it would follow that each atomic individual in that sum (i.e. each boy) gathered, which in Champollion's terms is a 'category mistake'. Thus, the only adequate interpretation of (158a) is the following:

$$(159) \quad \exists e : \text{SR}_{ag,Atom}(\lambda e.[*gather(e)]).[*gather(e) \wedge *ag(e) = \uparrow (\oplus \text{boy})]$$

This interpretation is different from that in (154) above in that it imposes a stratified reference requirement on the predicate denoted by *gather*. This presuppositional condition is due to the semantics of *all*, as given in (156), and amounts to the following:

$$(160) \quad \text{SR}_{ag,Atom}(\lambda e.[*gather(e)]) \stackrel{\text{def}}{=} \forall e.[*gather(e) \rightarrow e \in * \lambda e'.(*gather(e') \wedge \text{Atom}(*ag(e')))]$$

(Every event in the denotation of *gather* consists of one or more events, which are also in the denotation of *gather* and whose agents are atomic.)

Since *gather* is a thematic collective predicate, and is lexically distributive with respect to its subject, it follows that the condition in (58) is satisfied. Thus, the system correctly predicts that DPs involving *all* should be compatible with thematic collective predicates like *gather*.

Consider now example (158b). Since *be numerous* is a nonthematic collective predicate, it cannot, by assumption, apply to group individuals. Thus the only potentially valid interpretation of (158b) is the one where the subject is interpreted as a sum:

$$(161) \quad \exists e : \text{SR}_{ag,Atom}(\lambda e.[*numerous(e)]).[*numerous(e) \wedge *ag(e) = \oplus \text{boy}]$$

Again, this interpretation is very similar to that in (155), except for the presence of a stratified reference condition supplied by *all*. This condition can be spelled out as follows:

- (162) $SR_{ag,Atom}(\lambda e.[*numerous(e)]) \stackrel{\text{def}}{=} \forall e.[*numerous(e) \rightarrow e \in *\lambda e'.(*numerous(e') \wedge Atom(*ag(e')))]$
 (Every event in the denotation of *numerous* consists of one or more events, which are also in the denotation of *numerous* and whose agents are atomic.)

Since *numerous* is a nonthematic collective predicate, it applies to sums and is not lexically distributive. Hence, if there is an event of a sum of individuals being numerous, it does not follow that each atomic individuals in that sum is numerous (e.g. if a sum of 25 boys is numerous, it does not need to be the case that each individual boy in that sum is numerous). This means that the condition in (162) is not satisfied, and the interpretation in (59) is ruled out. Quite generally, Champollion's system predicts that DPs involving *all* will be incompatible with nonthematic collective predicates, which is the desired result.

Turning now to the properties of DPs involving *each* in the context of collective predicates, consider again the following examples:

- (163) a. *Each boy gathered.
 b. *Each boy is numerous.

The interpretations of (163a) and (163b) are analogous to those for (158a) and (158b), discussed above, except that the stratified reference presupposition associated with *each* is stricter than that associated with *all* (cf. the interpretation in 157):

- (164) a. $\exists e : SR_{ag,PureAtom}(\lambda e.[*gather(e)].[*gather(e) \wedge *ag(e) = \uparrow (\oplus boy)])$
 b. $SR_{ag,PureAtom}(\lambda e.[*gather(e)]) \stackrel{\text{def}}{=} \forall e.[*gather(e) \rightarrow e \in *\lambda e'.(*gather(e') \wedge PureAtom(*ag(e')))]$
 (Every event in the denotation of *gather* consists of one or more events, which are also in the denotation of *gather* and whose agents are pure atomic.)

- (165) a. $\exists e : \text{SR}_{ag, \text{PureAtom}}(\lambda e. [*numerous(e)]) . [*numerous(e) \wedge *ag(e) = \oplus \text{boy}]$
 $\text{SR}_{ag, \text{PureAtom}}(\lambda e. [*numerous(e)]) \stackrel{\text{def}}{=} \forall e. [*numerous(e) \rightarrow e \in * \lambda e'. (*numerous(e') \wedge \text{PureAtom}(*ag(e')))]$
 (Every event in the denotation of *numerous* consists of one or more events, which are also in the denotation of *numerous* and whose agents are pure atomic.)

Consider first the condition in (164b). *Gather* is a thematic collective predicate, so it can apply to events whose agents are group individuals (i.e. impure atoms), as e.g. in (154). But in this case, the event *gather* applies to cannot be a sum of events whose agents are pure atoms. It follows that the stratified reference presupposition in (164b) is not satisfied, and examples like (163a) are ruled out.

Nonthematic collective predicates, like *numerous*, also fail to satisfy the stratified reference presupposition associated with *each*. In this case the reasoning is basically the same as for the weaker presupposition in (162): if *numerous* applies to an event whose agent is a sum individual, it does not necessarily apply to its sub-events whose agents are the pure atoms in that sum. Hence, examples like (163b) are ruled out on a par with (158b).

I have shown how the assumptions that Champollion (2010) makes regarding the semantics of *all* and *each* on the one hand, and *gather*-type and *numerous*-type collective predicates, on the other, allow him to successfully account for the core data discussed in section 4.5.2, above.¹¹ However, it turns out that the particular properties of *all* and *each* that Champollion invokes to account for their contrasting behaviour in combination with *gather*-type collective predicates are independent from those that he relies on to explain their difference in terms of licensing dependent plurals.

Recall Champollion's (2010) analysis of dependent plurals in the context of *all*, as in (166a). He analyses such sentences as involving cumulative predication, as

¹¹Champollion (2010) further invokes covert distributivity operators to account for examples like *All the enemy armies were numerous* and *The committees each gathered*. I refer the reader to Champollion 2010:208-219 for a detailed exposition of the proposal.

in (67), with *all* imposing a Stratified Reference presupposition on the predicate denoted by the the VP:

(166) a. All the women gave birth to girls.

b. Each woman gave birth to girls.

(167) $\exists e : \text{SR}_{ag,Atom}(\lambda e.[*give.birth(e) \wedge *girl(*th(e))]).[*give.birth(e) \wedge *ag(e) = \oplus woman \wedge *girl(*th(e)) \wedge |*th(e)| \geq 2]$

Crucially, Champollion assumes that the subject in sentences like (166a) is able to stay in a position below the point of implicature calculation for the bare plural object, hence the presupposition is checked against an un-enriched predicate with the bare plural introducing a number-neutral predicate. The un-enriched predicate is able to satisfy the presupposition imposed by *all*, since e.g. any event of giving birth to one or more girls is necessarily a sum of events of giving birth to one or more girls whose agents are atoms. The strict plurality condition on the theme is then added after the Stratified Reference presupposition had already been checked.

Consider now example (166b). This sentence does not have a dependent plural interpretation. Instead it can only be true if each woman gave birth to more than one girl. However, this result does not follow directly from the difference between *each* and *all* as stated in (156) and (157), above. Indeed, if the subject in (166b) is taken to behave syntactically in the same way as that in (166a), i.e. if it is allowed to remain in a position below the point of implicature calculation, we expect (166b) to have the interpretation in (168):

(168) $\exists e : \text{SR}_{ag,PureAtom}(\lambda e.[*give.birth(e) \wedge *girl(*th(e))]).[*give.birth(e) \wedge *ag(e) = \oplus woman \wedge *girl(*th(e)) \wedge |*th(e)| \geq 2]$

The Stratified Reference condition imposed by *each* is stricter than that associated with *all*. However, the un-enriched predicate in (168) does satisfy this condition: any event of giving birth to one or more girls is necessarily a sum of events of giving birth to one or more girls whose agents are pure atoms. Hence, it is predicted

that the interpretation in (168), which corresponds to a cumulative/dependent plural reading, should be available for the sentence in (166b), contrary to fact.

Champollion (2010) is forced to make additional assumptions to rule out dependent plural readings of sentences involving *each*. Specifically, he stipulates that all DPs involving *each* as a determiner, as opposed to those with *all*, are forced to raise outside the domain of implicature calculation for the bare plural objects. This means that the Stratified Reference presupposition associated with *each* must apply to the enriched form of the predicate, with the bare plural imposing a strictly plural cardinality condition. This in turn fails unless a silent distributivity operator is inserted below the subject, which leads to a distributive, non-dependent reading in sentences like (166a).

The same issue arises with respect to floating *all* and *each*. Thus, sentence (68a) has a dependent plural reading, while sentence (68b) does not:

- (169) a. The women all gave birth to girls.
 b. The women each gave birth to girls.

Again, the distinction between *all* and *each* in terms of their associated presuppositions does not itself account for this pattern, which means that additional assumptions must be adopted. Champollion (2010) proposes two potential solutions. One could assume that the subject associated with the floating *each* is forced to quantifier raise higher than the domain of implicature calculation, thus reducing the contrast between (68a) and (68b) to that in (66). Alternatively, one could state that the floating *each* is a “barrier to implicature movement”, which somehow forces the scalar implicature to be calculated in its scope. Either move amounts to an additional stipulation on the syntactic properties of *all* and *each*, which is independent of their assumed semantic distinctions.

Summing up, I have provided an overview of Champollion’s (2010) approach to collective predication, and showed how it is able to account for the core data discussed in the previous sections. However, I have also demonstrated that the semantic distinction between *all* and *each* that Champollion (2010) employs to

account for their contrasting behaviour in combination with collective predicates is not sufficient to explain their difference in terms of licensing dependent plurals. To account for the latter, Champollion (2010) is forced to make independent stipulations regarding the syntactic properties of these items. This in turn means that Champollion's (2010) account is unable to provide an explanation for the systematic correlation, discussed in section 4.5.3, between the ability of QDs and floating quantifier to license dependent plurals and their ability to combine with *gather*-type collective predicates.

4.5.5 Ivlieva's (2013) Account

Consider now Ivlieva's (2013) account of the data on collective predication presented in section 4.5.2. With respect to the distinction between *gather*-type and *numerous*-type collective predicates, Ivlieva (2013) adopts Champollion's (2010) proposal, discussed above. In other words, she assumes that *gather*-type collective predicates are thematic and are able to apply both to sums and groups, while *numerous*-type collective predicates are nonthematic, and apply only to sums. She also follows Landman (2000) and Champollion (2010) in assuming that definite DPs are ambiguous between a sum and a group interpretation.

Consider again the contrast in (170):

- (170) a. All the boys gathered.
 b. *All the boys are numerous.

The definite DP that *all* combines with is ambiguous, denoting either the maximal sum of boys or the group formed on the basis of that sum. This entails that *all the boys* is also ambiguous. Now recall, that in Ivlieva's system, the semantics of *all* involves both a cumulative and a distributive component (cf. the discussion in section 2.4), yielding the following two interpretations for *all the boys*:

- (171) a. $\llbracket \text{all the boys} \rrbracket = \lambda P. \lambda e. P(e)(\sigma * \text{boy}) \wedge \forall y [y \leq \sigma * \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$

- b. $\llbracket \text{all the boys} \rrbracket = \lambda P. \lambda e. P(e)(\uparrow \sigma^* \text{boy}) \wedge \forall y [y \leq \uparrow \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$

Thus, the two potential interpretations of sentence (170a) are the following:

- (172) a. $\exists e. *gather(e)(\sigma^* \text{boy}) \wedge \forall y [y \leq \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge *gather(e')(y)]]$
 b. $\exists e. *gather(e)(\uparrow \sigma^* \text{boy}) \wedge \forall y [y \leq \uparrow \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge *gather(e')(y)]]$

In (172a) the predicate *gather* applies to the maximal sum of boys, and to each atomic individual in that sum. This interpretation fails since it is impossible for an individual boy to gather. In (172b), on the other hand, *gather* applies to the group formed on the basis of the maximal sum of boys. In this case, the distributive condition is trivially satisfied since groups are taken to be atoms. Hence, we have (172b) as the interpretation of sentence (170a).

Consider now sentence (170b). This sentence is again ambiguous, depending on whether the DP *the boys* is interpreted as a sum or a group:

- (173) a. $\exists e. *numerous(e)(\sigma^* \text{boy}) \wedge \forall y [y \leq \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge *numerous(e')(y)]]$
 b. $\exists e. *numerous(e)(\uparrow \sigma^* \text{boy}) \wedge \forall y [y \leq \uparrow \sigma^* \text{boy} \wedge \text{atom}(y) \rightarrow \exists e' [e' \leq e \wedge *numerous(e')(y)]]$

Given that *numerous*, by assumption, is a nonthematic collective predicate, it cannot apply to groups, and thus (173b) is ruled out. We are left with (173a) as the only possible interpretation for sentence (170b). Here, *numerous* applies both to the maximal sum of boys and to each atomic individual in that sum. However, since an atomic boy cannot be numerous, this interpretation is also disqualified. Thus, the analysis correctly predicts that sentence (170b) should lack a felicitous interpretation.

Consider now the contrast between *all* and *every*, repeated in (174):

- (174) a. All the boys gathered.
 b. *Every boy gathered.

Ivlieva (2013) attributes this contrast to a syntactic distinction between *all* and *every*: whereas *all* combines with a definite DP, which is ambiguous between a sum and group interpretation, *every* combines with an NP, and hence there is no constituent that the \uparrow -operator can apply to. Note, that this explanation is different from Champollion's (2010), who attributes the contrast in (174) to a semantic distinction between the presuppositions associated with *all* and *every*.

There are several issues with Ivlieva's (2013) syntactic account of the contrast in (174). First, consider the examples in (175):

- (175) a. All of the boys gathered.
 b. *Each of the boys gathered.

Here, both *all* and *each* combine with the same type of restrictor constituent (*of DP*), which contains a definite plural. Nevertheless, the contrast with respect to collective predication is preserved. Similarly, the syntactic account cannot explain the contrast between *all* and *each* when they function as floating quantifiers, as in (137), repeated in (176):

- (176) a. The students all gathered in the hall last night.
 b. *The students each gathered in the hall last night.

A potential solution would be to assume that the distributive condition associated with *each* is stronger than that associated with *all*, making reference to *pure atoms*, e.g.:

- (177) $[[\text{each}]] = \lambda x. \lambda P. \lambda e. \exists y [pure.atom(y) \wedge y \leq x] \wedge \forall y [y \leq x \wedge pure.atom(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$

Then, (175b) and (176b) would be ruled out, since *each* would be incompatible with the group interpretation of the definite DP in its restrictor constituent, given that groups, by definition, are not pure atoms.

Note, however, that both the syntactic account that Ivlieva (2013) proposes, and the potential semantic account outlined above, require us to postulate additional distinctions between *all* and *each/every*, which are independent of the properties that, in Ivlieva's system, account for their contrasting behaviour in terms of licensing dependent plurals. Recall, that in this system, the ability of DPs involving *all* to license dependent plural readings hinges on the presence of a cumulative component in their semantics, cf. (171). The semantics of DPs involving *every*, on the other hand, lacks this component, and these DPs are not able to license dependent plurals, cf. (178).

$$(178) \quad \llbracket \text{every boy} \rrbracket = \lambda P. \lambda e. \forall y [boy(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$$

Nothing in the system rules out the existence of DPs with an interpretation as in (179):

$$(179) \quad \llbracket \text{each}^* \text{ (of) the boys} \rrbracket = \lambda P. \lambda e. \forall y [y \leq \uparrow \sigma^* \text{boy} \wedge atom(y) \rightarrow \exists e' [e' \leq e \wedge P(e')(y)]]$$

It is predicted, that such a DP would be able to combine with *gather*-type collective predicates, since its restrictor involves a definite plural DP and the distributivity condition is formulated in terms of atoms, rather than pure atoms as in (177). However, since its interpretation lacks a cumulative component which applies the nuclear scope predicate directly to the denotation of the restrictor, as in (171), this DP should not be able to license dependent plurals. However, as discussed in section 4.5.3, DPs with this combination of properties are in fact unattested.¹²

To conclude, Ivlieva (2013) adopts Champollion's (2010) account of the distinction between *gather*- *numerous*-type collective predicate, but proposes a syntactic explanation of the contrast between DPs containing *all* and *every* with respect to collective predication. This can further be supplemented with a semantics distinction between *all* and *each*, to account for the contrasts in (175) and (176). However,

¹²DPs as in (179) would, however, license *collective* readings in combination with e.g. bare plurals. The availability of genuine dependent plural readings can be tested using adverbials such *separately*, *independently*, *on their own*, etc.

both of these distinctions are theoretically independent of the property that in Ivlieva's (2013) system accounts for the contrast between *all* and *every/each* with respect to the licensing of dependent plural readings. Thus, the fact that *every* and *each* block both collective readings with *gather*-type predicates and dependent plural readings comes out as purely accidental in this system, and the generalisation in (148) is left unaccounted for.

Before I move on to the presentation of my analysis, I want to point out one further complication with both Champollion's (2010) and Ivlieva's (2013) accounts of collective predication, which has to do with the dialectal variation discussed in section 4.5.1 above. Recall, that the speakers of what I referred to as *Winter's dialect* do not accept collective readings of sentences involving plural quantificational DPs combined with mixed predicates, as in (180a). However, they do allow the combination of such DPs with *gather*-type collective predicates, as in (180b).

- (180) a. All the boys carried the couch upstairs. * in Winter's dialect
 b. All the boys gathered in the hall. ok in Winter's dialect

In Champollion's and Ivlieva's accounts, examples like (180b) are analysed as involving predication of a group individual, i.e. the predicate *gather* is applied to the group individual $\uparrow \sigma$ **boy*. The same analysis should then be available for examples like (180a), leading to a collective interpretation. However this interpretation is blocked for the speakers of Winter's dialect. Note, that we cannot assume that in Winter's dialect mixed predicates cannot in principle apply to groups, since collective predication with non-quantificational plurals is still possible:

- (181) Three boys carried the couch upstairs. ok in Winter's dialect

As far as I can see, the judgements exemplified in (180) and (181) are hard to reconcile under the approach to collective predication adopted in Champollion 2010 and Ivlieva 2013.

4.5.6 Proposal

The account of collective predication that I will propose relies heavily on the distinction between strong and weak distributivity that I have been advocating throughout this thesis. I have previously argued that this is the distinction that best explains the contrasting properties of QDs such as *each* and *every*, on the one hand, and *all* and *most*, on the other, with respect to the licensing dependent plural interpretations. Here, I would like to propose that the same distinction between weak and strong distributivity accounts for the contrast between these classes of quantifiers with respect to collective predication. This kind of unified account is preferable both from the methodological and empirical point of view, since it sheds light on the systematic correlation between the properties of quantificational items, as formulated in (148).

Recall, that we have analysed *each* and *every* as inducing strong distributivity, i.e. as dividing the value of the drefs they introduce into atomic parts, and distributing these parts as values of the drefs across multiple singleton info-states. QDs such as *all* and *most*, on the other hand, induce weak distributivity, i.e. they similarly divide the values of drefs into atomic parts, but distribute these atomic parts across multiple assignments within a single info-state. The distinction between *gather*-type and *numerous*-type collective predicates can then be stated as follows:

(182) *Gather*-types vs *Numerous*-type Collective Predicates

Numerous-type predicates apply distributively to each assignment in a plural info-state (in the standard way), whereas *gather*-type predicates are able to collect the values of their argument drefs across the assignments in a plural info-state.

Let us state this idea formally, starting with *numerous*-type collective predicates. These types of collective predicates have the standard type of translation, that we have so far been assuming for all lexical relations (cf. section 3.2.5 in Chapter 3), e.g.:

$$\begin{aligned}
(183) \quad \mathbf{numerous} &\rightsquigarrow \lambda v_{se}.\lambda \zeta_{sv}.[\mathbf{numerous}\{\zeta\}, \mathbf{Th}\{v, \zeta\}] \\
&:= \lambda v_{se}.\lambda \zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I = J \wedge \mathbf{numerous}\{\zeta\}J \wedge \mathbf{Th}\{v, \zeta\}J \\
&:= \lambda v_{se}.\lambda \zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I = J \wedge J \neq \emptyset \wedge \forall j \in J. (\mathbf{numerous}(\zeta j) \wedge \\
&\quad \mathbf{Th}(vj, \zeta j))
\end{aligned}$$

Numerous-type predicates combine with an event dref and an individual dref, and apply distributively to the values of these drefs for each assignment in the input/output info-state. The only difference between *numerous*-type predicates and standard distributive predicates, such as *laugh*, is that the former do not apply to events whose agents are atomic, non-group individuals.¹³

Consider now the examples in (130), repeated here for convenience:

- (184) a. *All the students are numerous / are a good team.
b. *Each / every student is numerous / is a good team.

The compositional translation of example (184a) yields the following DRS:¹⁴

$$\begin{aligned}
(185) \quad *All^{u,u'} \text{ the}_u \text{ students are numerous.} &\rightsquigarrow \\
&\mathbf{max}^u([\mathbf{dist}_w([student\{u''\}]; [u \leq u'']; [\varepsilon]; [\mathbf{numerous}\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}]](u)); \\
&\mathbf{max}^{u'}([\mathbf{dist}_w([student\{u''\}]; [u' \leq u''])(u')]; [\mathbf{ALL}\{u', u\}]
\end{aligned}$$

This DRS will be true with respect to a singleton input info state $I = \{i\}$ iff there exists a singleton output info state $J = \{j\}$, such that:

- a) j differs from i at most with respect to the values for u and u' .
- b) $u''j$ is a sum of students.
- c) The value of u' for j , i.e. $u'j$, stores the maximal individual, such that each of its atomic sub-individuals is a sub-part of $u''j$. It follows that $u'j = u''j$.

¹³By 'atomic group individuals' I will mean atomic individuals that are in the denotations of group nouns, such as *team*, *committee*, *class*, etc. This is not to be confused with group individuals in the sense of Landman (2000), which may be formed on the basis of non-atomic sums of individuals.

¹⁴For simplicity, I am treating the definite article as anaphoric, i.e. I take the DP *the students* to refer to some previously established sum of students. Alternatively, the definite article can be taken to introduce a new dref via the maximality operator. This choice has no bearing on the issue at hand.

d) Given the semantics of the \mathbf{dist}_w operator, the value of u for j , i.e. uj , is the maximal sum of individuals such that there exists an info state H of the following form:

(186)

Info state H	...	u	ε	...
h_1	...	s_1	e_1	...
h_2	...	s_2	e_2	...
...
h_n	...	s_n	e_n	...

Here, s_1, s_2, \dots, s_n are atomic sub-individuals of $u''j$, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . I.e. the atomic individuals in uj are distributed as values for u across the assignments in H . Next, e_1, e_2, \dots, e_n are numerous-events, whose themes are s_1, s_2, \dots, s_n , respectively.

Thus, uj must store the maximal sum of students in $u''j$ such that each of those students is numerous.

e) The static quantifier **ALL** must hold of uj and $u'j$, i.e. $|uj| = |u'j|$.

The fact that sentence (184a) is unacceptable follows from the conditions on uj in (d) above. Due to the presence of the weak distributivity operator, uj is divided into atomic sub-parts, which are distributed across the assignments in H . Furthermore, following the translation in (183), *numerous* must apply distributively to the values of its argument drefs for each assignment in H , i.e. it must apply to each atomic individual in uj . Since atomic individuals cannot be numerous, the unacceptability of (184a) follows. The same result is predicted to obtain for the combination of *numerous*-type collective predicates with all weakly distributive QDs, as well as with syntactic weak distributivity operators (e.g. floating *all*, as in **The students were all numerous*).

Turning to sentence (184b), we find that its unacceptability is explained in a very similar way. Consider the translation of (184b):

(187) *Each^{u,u'} student is numerous. \rightsquigarrow

$$\max^u([\mathbf{dist}_s([student\{u\}]; [\varepsilon]; [numerous\{\varepsilon\}, \mathbf{Th}\{u, \varepsilon\}])(u)]);$$

$$\max^{u'}([\mathbf{dist}_s([student\{u'\}](u'))]; [\mathbf{EACH}\{u', u\}])$$

This DRS will be true with respect to a singleton input info state $I = \{i\}$ iff there exists a singleton output info state $J = \{j\}$, such that:

a) j differs from i at most with respect to the values for u and u' .

b) The value of u' for j , i.e. $u'j$, stores the maximal sum of students.

c) Given the semantics of the \mathbf{dist}_s operator, the value of u for j , i.e. uj , is the maximal sum of individuals such that there exists a set of info-states $\{H_1, \dots, H_n\}$ of the following form:

(188)

Info state H_1	...	u	ε	...
h_1	...	s_1	e_1	...
...				
Info state H_2	...	u	ε	...
h_2	...	s_2	e_2	...
...				
Info state H_n	...	u	ε	...
h_n	...	s_n	e_n	...

Here, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . I.e. in this case the atomic individuals in uj are distributed as values for u across the singleton info states H_1, \dots, H_n . The values for $\varepsilon, e_1, e_2, \dots, e_n$, are again numerous-events, whose themes are s_1, s_2, \dots, s_n , respectively.

d) The static quantifier **EACH** must hold of uj and $u'j$, i.e. $|uj| = |u'j|$.

Given the conditions on uj in (c) above, *numerous* is again forced to apply to each individual student, leading to the unacceptability of sentences like (184b). This result extends to other strongly distributive QDs and syntactic strong distributivity operators (e.g. floating *each*, as in **The students were each numerous*).

Thus, I have shown that by taking *numerous*-type predicates to apply distributively to the values of their argument drefs for the assignments in a plural info-state, we correctly predict that such predicates will be incompatible with both plural (i.e. weakly distributive) and singular (i.e. strongly distributive) QDs.

Let us now consider *gather*-type collective predicates, which, as discussed above, distinguish between these two classes of QDs. The basic idea of the analysis is that *gather*-type predicates are distinct from standard lexical predicates in that they *do not* apply distributively to the values of drefs in a plural info state. Instead, they are able to collect the values of a dref across multiple assignments in a plural info state, and apply to the resulting sum individuals. I will formalise this idea by introducing collective variants of the thematic predicates, e.g.:

- (189) a. $\mathbf{Ag}_{coll}\{v, \zeta\} := \lambda I_{st}. \forall e \in \zeta I. \mathbf{Ag}(\oplus v I_{\zeta=e}, e)$
 b. $\mathbf{Th}_{coll}\{v, \zeta\} := \lambda I_{st}. \forall e \in \zeta I. \mathbf{Th}(\oplus v I_{\zeta=e}, e)$,

where ζI is the set of all the values of ζ for the assignments in I , and $\oplus v I_{\zeta=e}$ is the sum of the values of v for the assignments in I for which ζ returns e .

What these relations do is take each value e of the event dref in a plural info-state, collect the sum X of all the values of the individual dref across those assignments where the event dref returns e , and apply the standard thematic relation to X and e . For instance, suppose we have an info-state I , an individual dref u and an event dref ε with the following values:

Info state I	...	u	ε	...
h_1	...	x_1	e_1	...
h_2	...	x_2	e_1	...
h_3	...	x_3	e_2	...
h_4	...	x_4	e_2	...

Then, $\mathbf{Ag}_{coll}\{u, \varepsilon\}I = 1$ iff $\mathbf{Ag}\{x_1 \oplus x_2, e_1\} = 1$ and $\mathbf{Ag}\{x_3 \oplus x_4, e_2\} = 1$.

Collective thematic relations can then be used to translate *gather*-type collective predicates:

$$\begin{aligned}
 (190) \quad \mathbf{gather} &\rightsquigarrow \lambda v_{se}.\lambda \zeta_{sv}.[gather\{\zeta\}, \mathbf{Ag}_{coll}\{v, \zeta\}] \\
 &:= \lambda v_{se}.\lambda \zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I = J \wedge gather\{\zeta\}J \wedge \mathbf{Ag}_{coll}\{v, \zeta\}J \\
 &:= \lambda v_{se}.\lambda \zeta_{sv}.\lambda I_{st}.\lambda J_{st}. I = J \wedge J \neq \emptyset \wedge \forall j \in J. gather(\zeta j) \wedge \forall e \in \\
 &\quad \zeta J. \mathbf{Ag}(\oplus v J_{\zeta=e}, e)
 \end{aligned}$$

Consider now the examples in (129), repeated here:

- (191) a. All the students gathered in the dining room / live together / met in the hall.
- b. *Each / every student gathered in the dining room / lives together / met in the hall.

The translation of (a simplified version of) example (191a) is given in (77):

$$\begin{aligned}
 (192) \quad \mathbf{All}^{u,u'} \mathbf{the}_{u''} \mathbf{students gathered.} &\rightsquigarrow \\
 &\mathbf{max}^u([\mathbf{dist}_w([student\{u''\}]; [u \leq u'']; [\varepsilon]; [gather\{\varepsilon\}, \mathbf{Ag}_{coll}\{u, \varepsilon\}])](u)); \\
 &\mathbf{max}^{u'}([\mathbf{dist}_w([student\{u''\}]; [u' \leq u''])(u')]); [\mathbf{ALL}\{u', u\}]
 \end{aligned}$$

This DRS is very similar to the one (69) above, except that it involves the predicate *gather* rather than *numerous*, and the collective thematic relation \mathbf{Ag}_{coll} in place of the standard thematic relation \mathbf{Th} . As we will see, the latter difference is what accounts for the contrast in acceptability between examples like (191a), involving *gather*-type collective predicate combined with weakly distributive QDs, and examples like (184a), which involve *numerous*-type predicates in a similar context.

Consider the truth conditions for the DRS in (77). This DRS will be true with respect to a singleton input info state $I = \{i\}$ iff there exists a singleton output info state $J = \{j\}$, such that:

- a) j differs from i at most with respect to the values for u and u' .
- b) $u''j$ is a sum of students.

c) $u'j$, stores the maximal individual, such that each of its atomic sub-individuals is a sub-part of $u''j$, i.e. $u'j = u''j$.

d) uj is the maximal sum of individuals such that there exists an info state H of the following form:

(193)

Info state H	...	u	ε	...
h_1	...	s_1	e_1	...
h_2	...	s_2	e_2	...
...
h_n	...	s_n	e_n	...

Here, s_1, s_2, \dots, s_n are atomic sub-individuals of $u''j$, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . Next, e_1, e_2, \dots, e_n are gathering-events. Furthermore, given the definition of \mathbf{Ag}_{coll} in (74), these events are such that for each value e of ε in H , the sum of the values of u for all the assignments in H for which ε returns e , is the agent of e .

Thus, uj must store the maximal sum of students in $u''j$ such that this sum of students can be sub-divided into sub-sums which were agents of gathering events.

e) The static quantifier **ALL** must hold of uj and $u'j$, i.e. $|uj| = |u'j|$. Given (c), this entails $|uj| = |u''j|$, and consequently $uj = u''j$.

Summing up, the DRS in (77) will be true if the whole sum of students referred to by the DP *the students* can be sub-divided into sub-sums each of which was an agent of a gathering event.

Now, recall that the values of ε in H are unconstrained (cf. 78), except for the fact that they all have to be gathering events. This means that we predict the sentence in (77) to be compatible with a wide range of scenarios. On one possible scenario all the students gather together as one large group. This is the reading that arises if ε returns the same event for all the assignments in H , and it is arguably the most salient reading of the sentence in (77). Other readings may be facilitated by including additional material, e.g.:

(194) All the students gathered^ε in large rooms.

The most salient reading of sentence (81) is that the students were divided into sub-groups, which gathered separately in different rooms. This reading will obtain if ε returns different values for different sub-sets of assignments in H .

Similarly, the sentence in (82) will be true in a situation where all the committees gathered together in one place, as well as a situation where each committee gathered separately. The first reading will obtain if ε returns the same event for all the assignments in the plural info-state introduced by the distributivity operator, while the second reading will arise if all the values returned by ε are distinct.

(195) All the committees gathered^ε at 3 p.m.

Let us now turn to examples like (191b), which demonstrate that *gather*-type collective predicates are incompatible with DPs involving quantificational determiners such as *each* and *every* combined with non-group denoting nouns. This fact follows directly from the semantics of *each* and *every* based on the notion of strong distributivity, which I have argued for in this thesis. To see why, consider the following translation:

(196) *Each^{u,u'} student gathered. \rightsquigarrow

$$\mathbf{max}^u([\mathbf{dist}_s([student\{u\}]; [\varepsilon]; [gather\{\varepsilon\}, \mathbf{Ag}_{coll}\{u, \varepsilon\}])](u));$$

$$\mathbf{max}^{u'}([\mathbf{dist}_s([student\{u'\}])](u')); [\mathbf{EACH}\{u', u\}]$$

This DRS will be true with respect to a singleton input info state $I = \{i\}$ iff there exists a singleton output info state $J = \{j\}$, such that:

- a) j differs from i at most with respect to the values for u and u' .
- b) $u'j$, stores the maximal sum of students.
- c) uj is the maximal sum of individuals such that there exists a set of info-states $\{H_1, \dots, H_n\}$ of the following form:

(197)

Info state H_1	...	u	ε	...
h_1	...	s_1	e_1	...
...				
Info state H_2	...	u	ε	...
h_2	...	s_2	e_2	...
...				
Info state H_n	...	u	ε	...
h_n	...	s_n	e_n	...

Here, s_1, s_2, \dots, s_n are atomic students, and the sum $s_1 \oplus s_2 \oplus \dots \oplus s_n$ must be equal to uj . The values for $\varepsilon, e_1, e_2, \dots, e_n$, are gathering-events. Crucially, the thematic condition $\mathbf{Ag}_{coll}\{u, \varepsilon\}$ applies separately to each of the info-states in $\{H_1, \dots, H_n\}$. Since each of these info-states is singleton, the collective thematic relation is in this case equivalent to the corresponding standard thematic relation. It follows that for each $H_m \in \{H_1, \dots, H_n\}$, uh_m is the agent of εh_m , i.e. each individual student must be the agent of a gathering event.

d) The static quantifier **EACH** must hold of uj and $u'j$, i.e. $|uj| = |u'j|$.

Thus, the presence of the strong distributivity operator in the translation of (83) forces an interpretation where each atomic individual in the maximal sum of students is the agent of a separate gathering event. Since gathering events require non-atomic or atomic group agents, the sentence in (83) is ruled out. We thus predict that *gather*-type predicates will in general be incompatible with QDs that induce strong distributivity (unless they are combined with group nouns, see below). Furthermore, we predict that they will be similarly incompatible with syntactic strong distributivity operators, i.e. floating *each*, which is indeed the case (cf. 137b).

Consider now example (85):

(198) Each committee gathered at 3 p.m.

The interpretation of this example is analogous to that of (83) discussed above, except that in this case u returns an atomic committee-individual for each assignment in $\{h_1, \dots, h_n\}$ (cf. 84). The *gather* predicate then requires for each of these committee-individuals to be the agent of a separate gathering event. Since atomic group individuals satisfy the lexical requirements of *gather*, the sentence in (85) is not ruled out, in contrast to (83). Furthermore, the current analysis correctly predicts that in contrast to sentence (82), sentence (85) should only have a distributive interpretation in which each committee gathered separately, but not the ‘globally collective’ interpretation, where all the committees gathered together. Given the Role Uniqueness requirement and the fact that each atomic committee is required to be an agent of a gathering event, it follows that that all these events must be distinct.

A brief comment is in order regarding the status of mixed predicates. Recall, that there appears to be dialectal variation with respect to such predicates. In what I called *Dowty’s dialect*, mixed predicates allow for collective readings when combined with DPs involving *all*. On the other hand, in *Winter’s dialect* mixed predicates only allow for distributive readings under *all* (cf. example (127), and the discussion in section 4.5.1). Under the proposed analysis of collective predicates, this difference can be stated in terms of the types of thematic relations that mixed predicates introduce. The fact that in Dowty’s dialect mixed predicates behave like *gather*-type predicates in allowing collective readings under weakly distributive quantifiers indicates that in this dialect such predicates introduce collective thematic relations. On the other hand, in Winter’s dialect collective thematic relations seem to be restricted to *gather*-type predicates, while mixed predicates may only be translated via the standard thematic relations.

Before I conclude this section, I would like to return to the generalisation in (148) (repeated below), and show how it is accounted for under the analysis of dependent plurals and collective predication proposed in this thesis.

(199) *Licensing of Dependent Plurals and Collective Predicates*

The ability of QDs and floating quantifiers to combine with *gather*-type collective predicates and (in some dialects) to license collective readings with mixed predicates entails their ability to license dependent plurals. The converse is also generally true, with the exception of *both* in some dialects.

I have argued that the core factor that determines whether or not a quantificational item (QD or floating quantifier) can license dependent plurals is the type of distributivity that this item induces. Items that induce weak distributivity, e.g. *all*, *most*, *many*, are able to license dependent plurals, while items that induce strong distributivity, e.g. *each* and *every*, are not. The analysis of collective predicates that I have proposed in this section relies on exactly the same property. Specifically, as I have shown above, the proposed analysis predicts that *gather*-type predicates should generally be compatible with weakly, but not strongly, distributive quantificational items.¹⁵ The fact that in the current system the same semantic property underlies both the ability to license dependent plurals and the compatibility with *gather*-type collective predicates, thus accounting for the correlation in (86), makes it superior to the alternative analyses proposed by Champollion (2010) and Ivlieva (2013), and discussed above.

Furthermore, assuming that all languages employ the same semantic representations, the proposed analysis makes strong predictions with respect to collective predication cross-linguistically. Specifically, if a language possesses quantificational items which can be shown to be strongly distributive, these items will never combine with any type of collective predicates, i.e. predicates that do not apply to atomic non-group individuals. This is so because strong distributivity operators distribute atomic values across multiple info-states, whereas predicates in the current system may only apply to one individual info-state at a time. Hence, there is

¹⁵As pointed out in section 4.5.3, the proposed analysis is in principle compatible with weakly distributive items imposing some additional semantic conditions which block their combination with *gather*-type collective predicates. I have hypothesised that this is the case with the quantifier *both* in some dialects. Crucially, however, the analysis predicts that all strongly distributive items will be compatible with collective predicates, which appears to be correct.

no way to ‘collect’ the values of a dref across multiple info-states.

4.6 Licensing by Pluractional Adverbials

In the previous sections I discussed the properties of two types of quantificational determiners, and demonstrated how they can be captured in a framework involving plural info states. I argued that dependent plural readings arise when plural noun phrases lacking cardinal modifiers occur in the scope of QDs inducing weak distributivity over the values of an individual dref. However, as discussed in section 1.3.2, plural and quantificational DPs are not the only class of items that can license dependent plural readings. Thus, dependent plurals are also licensed by a wide range of pluractional (e.g. quantificational, frequentative, iterative) adverbials, for instance:

- (200) a. John often wears loud neckties. (Roberts 1990, attributed to B. Partee)
 b. John always wears neckties when he goes to work.
 c. From here, trains leave regularly for Amsterdam. (de Mey 1981)

All these examples contain a plural noun phrase which can be interpreted as dependent on an adverbial licenser. Thus, sentence (200a) is naturally interpreted as stating that there is a set of frequently occurring events, each of which involves John wearing one (or possibly more) neckties, and more than one necktie is worn overall. Similarly, sentence (200b) does not entail that there each time John goes to work John wears more than one necktie. Instead, it allows for the pragmatically salient reading where each time he goes to work John wears a single necktie, and the neckties vary across the different occasions. Finally, sentence (200c) is compatible with only one train leaving for Amsterdam at any one time, as long as more than one train is involved overall.

To account for the semantics of quantificational adverbials I will expand the set of basic types to include temporal intervals. I will use the letter *i* for this type. By analogy with the domains of individuals and events, the domain of type

i , \mathcal{D}_i , is the powerset of the set of temporal intervals, **TI**. The sum operation on temporal intervals is identified with set union. The precedence relation \prec and the sub-interval relation \subseteq are defined for the atomic time intervals in \mathcal{D}_i . I will further assume that events are related to time intervals via the temporal trace function, τ , whose range is the set of atomic time intervals, i.e. singleton sets of time intervals. The symbols ι, ι', \dots will be used for drefs of type *si*, and t, t', \dots for variables of this type. As usual, I will use the bold letter **i** as an abbreviation of the type *si*.

I will assume that pluractional adverbials encode quantification over time intervals. For instance, consider the translation of the frequentative adverb *often*:

$$(201) \quad \mathbf{often}^t \rightsquigarrow \lambda P_{\mathbf{it}}. [\iota]; [\mathbf{dist}_w(P(\iota))(\iota)]; [freq_{often}\{\iota\}]$$

According to the translation in (201), *often* combines with a predicate of time interval drefs P and introduces a new time interval dref, ι . The value of ι is then split via the application of the \mathbf{dist}_w operator, with its atomic parts stored as values for ι in a plural info state, call it K . The predicate P is then applied to ι and K . Finally, the translation in (201) imposes a frequency condition on the value of ι . I will not attempt to make this condition explicit here, since the precise definition of what it means for an event to occur often is orthogonal to the main point of discussion. It is clear, however, that $freq_{often}$ should define a certain relation between the time intervals in the set returned by ι .

Note, that in order to make the translation in (201) work we need to generalise the definition of the weak distributivity operator:

$$(202) \quad \text{a. } \mathbf{dist}_w(D_t)(d_\sigma) := \lambda I_{st}. \exists J_{st}. (\langle d \rangle; D)IJ$$

$$\text{b. } \langle d_\sigma \rangle := \lambda I_{st}. \lambda J_{st}. \exists f. (I = \mathbf{Dom}(f) \wedge J = \cup \mathbf{Ran}(f) \wedge \forall i_s. \forall H_{st}. (f(i) = H \rightarrow \forall h_s \in H. (i[d]h \wedge \mathbf{atom}(dh)) \wedge \oplus dH = di)),$$

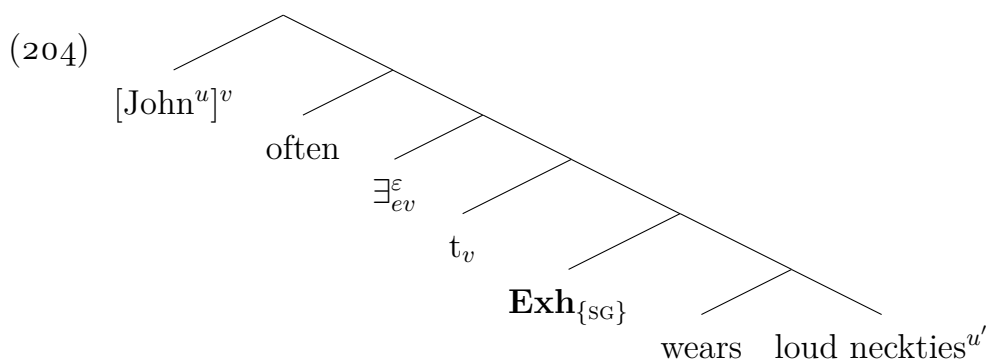
where σ is a dref type, i.e. $\sigma \in \mathbf{DRefTyp}$, f is a partial function from the domain of assignments \mathcal{D}_s to the set of info states $\wp(\mathcal{D}_s)$.

Thus, on this analysis *often* induces weak distributivity over a time interval

dref in essentially the same way that plural QDs induce weak distributivity over individual drefs. As an illustration, consider the translation of sentence (200a), with the indexing in (203):

(203) John^{*u*} often^{*t*} wears^{*ε*} loud neckties^{*u'*}.

I assume the following simplified syntactic structure for this sentence, abstracting away from the role of tense and aspect heads:



The VP in (204) is translated as follows:

(205) $\lambda v_e. \lambda \zeta_v. \lambda I_{st}. \lambda J_{st}. I[u']J \wedge loud\{u'\}J \wedge necktie\{u'\}J \wedge wear\{\zeta\}J \wedge$
 $\mathbf{Ag}\{v, \zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J$

This predicate is then strengthened in the familiar way via the application of the the exhaustification operator:

(206) $\lambda v_e. \lambda \zeta_v. \lambda I_{st}. \lambda J_{st}. I[u']J \wedge loud\{u'\}J \wedge necktie\{u'\}J \wedge wear\{\zeta\}J \wedge$
 $\mathbf{Ag}\{v, \zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J)$

Combining (206) with the translation of the subject trace, we arrive at the following event predicate;

(207) $\lambda \zeta_v. \lambda I_{st}. \lambda J_{st}. I[u']J \wedge loud\{u'\}J \wedge necktie\{u'\}J \wedge wear\{\zeta\}J \wedge$
 $\mathbf{Ag}\{v, \zeta\}J \wedge \mathbf{Th}\{u', \zeta\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J)$

The function of the event closure operator is now to turn an event predicate into a time interval predicate. I thus assume the following modified translation for \exists_{ev} :

$$(208) \quad \exists_{ev}^\varepsilon \rightsquigarrow \lambda V_{vt}. \lambda t_i. [\varepsilon]; V(\varepsilon); [\tau\{\varepsilon\} = t],$$

where $\tau\{\varepsilon\} = t := \lambda J. \forall j \in J. \tau(\varepsilon j) = tj$

The combination of the event closure operator with the predicate in (207) thus yields the following time interval predicate:

$$(209) \quad \lambda t_i. \lambda I_{st}. \lambda J_{st}. I[\varepsilon, u']J \wedge loud\{u'\}J \wedge necktie\{u'\}J \wedge wear\{\varepsilon\}J \wedge \mathbf{Ag}\{v, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J) \wedge (\tau\{\varepsilon\} = t)J$$

Next, the adverb translation in (201) applies to the time interval predicate in (209), and returns the following DRS:¹⁶

$$(210) \quad \lambda I_{st}. \lambda J_{st}. [\iota]; [\mathbf{dist}_w(\lambda I_{st}. \lambda J_{st}. I[\varepsilon, u']J \wedge loud\{u'\}J \wedge necktie\{u'\}J \wedge wear\{\varepsilon\}J \wedge \mathbf{Ag}\{v, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J) \wedge (\tau\{\varepsilon\} = \iota)J)(\iota)]; [freq_{often}\{\iota\}]$$

Finally, this DRS combines with the translation of the subject via the Quantifying-In rule, to yield the following DRS as the translation for sentence (203):

$$(211) \quad \lambda I_{st}. \lambda J_{st}. [u \mid u = John]; [\iota]; [\mathbf{dist}_w(\lambda I_{st}. \lambda J_{st}. I[\varepsilon, u']J \wedge loud\{u'\}J \wedge necktie\{u'\}J \wedge wear\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J) \wedge (\tau\{\varepsilon\} = \iota)J)(\iota)]; [freq_{often}\{\iota\}]$$

Consider the truth conditions of this DRS. It will be true with respect to a singleton input info state $I = \{i\}$ iff there exists an output info state $J = \{j\}$ such that the following conditions hold:

- a) j differs from i at most with respect to the values of u and ι , and uj is John:

¹⁶I assume that in the absence of overt items such as *often*, which introduce new time interval drefs, the time interval variable is closed via the application of a covert time closure operator:

(i) $\exists_{temp}^\iota \rightsquigarrow \lambda T_{it}. [\iota]; T(\iota)$

(212)

Info state J	...	u	ι	...
j	...	j	i	...

Moreover, it must be the case that the set of time intervals $\iota j (= i)$, satisfies the frequency condition $freq_{often}$.

b) There exists an info state K such that the atomic intervals in i are distributed as the values for ι across the assignments in K :

(213)

Info state K	...	u	ι	...
k_1	...	j	i_1	...
k_2	...	j	i_2	...
...
k_n	...	j	i_n	...

Here, i_1, i_2, \dots, i_n are atomic (i.e. singleton sets of) time intervals, and $i_1 \oplus i_2 \oplus \dots \oplus i_n = i$.

c) There exists an info state H of the following form:

(214)

Info state H	...	u	ι	ε	u'	...
h_1	...	j	i_1	e_1	nt_1	...
h_2	...	j	i_2	e_2	nt_2	...
...
h_n	...	j	i_n	e_n	nt_n	...

Here, for each $e_k \in \{e_1, e_2, \dots, e_n\}$, e_k is a wearing event whose agent is John, and whose theme is nt_k . For each $nt_k \in \{nt_1, nt_2, \dots, nt_n\}$, nt_k is a possibly atomic sum of neckties, and it must be the case that either there exists a $nt_k \in \{nt_1, nt_2, \dots, nt_n\}$ such that nt_k is non-atomic or there exist $nt_l, nt_m \in$

$\{nt_1, nt_2, \dots, nt_n\}$ such that $nt_l \neq nt_m$. Finally, for each $e_k \in \{e_1, e_2, \dots, e_n\}$, the temporal trace of e_k is i_k , i.e. $\tau(e_k) = i_k$

These truth conditions can be informally re-stated as follows: there exists a set of time intervals T which satisfies the relevant frequency condition, such that there is a set of events E which occur at the time intervals in T and each of these events is an event of John wearing one or more neckties, and it must be the case that the number of neckties involved in the events in E is more than one. This captures the dependent plural reading of sentence (203).

Other pluractional adverbials may similarly be assigned translations involving weak distributivity over time interval drefs. For instance, the quantificational adverb *always* can be translated as follows:

$$(215) \quad \text{always}^{\varepsilon, \varepsilon'} \rightsquigarrow \lambda P_{\text{it}}. \lambda P'_{\text{it}}. [\iota, \iota']; \mathbf{max}'([\mathbf{dist}_w(P(\iota))(\iota)]); \\ \mathbf{max}'([\mathbf{dist}_w(P(\iota'); P'(\iota'))(\iota')]); [\iota = \iota']$$

Under this analysis, the translation of *always* is analogous to that of weakly distributive quantificational determiners. It combines with two predicates, which in this case are predicates over time intervals, and compares two maximal time interval drefs: the maximal dref that satisfies the restrictor predicate taken under the weak distributivity operator, and the maximal dref that satisfies both the restrictor and the nuclear scope predicate taken under the weak distributivity operator. Since *always* is a universal quantifier, these drefs must return the same set of time intervals.

To see how this definition works, consider the translation of example (200b), with the indexing in (216):

$$(216) \quad \text{John}^u \text{ always}^{\iota, \iota'} \text{ wears}^\varepsilon \text{ neckties}^{u'} \text{ when he}_u \text{ goes}^{\varepsilon'} \text{ to work.}$$

In this case, the restrictor predicate is provided by the *when*-clause, which is translated as follows:

$$(217) \quad \lambda t_{\text{i}}. [\varepsilon']; [\text{got_to_work}\{\varepsilon'\}], \mathbf{Ag}\{u, \varepsilon'\}; [\tau\{\varepsilon'\} = t]$$

The nuclear scope predicate is encoded by the main clause. Its translation, after exhaustification, is the same as in (209), repeated in (218):

$$(218) \quad \lambda t_i. \lambda I_{st}. \lambda J_{st}. I[\varepsilon, u']J \wedge \text{loud}\{u'\}J \wedge \text{necktie}\{u'\}J \wedge \text{wear}\{\varepsilon\}J \wedge \\ \mathbf{Ag}\{v, \varepsilon\}J \wedge \mathbf{Th}\{u', \varepsilon\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J) \wedge (\tau\{\varepsilon\} = t)J$$

These time interval predicates are then combined with the translation of *always* in (215). After the introduction of the subject, this yields the following DRS as the translation of sentence (216):

$$(219) \quad [u \mid u = \text{John}]; \\ \mathbf{max}'([\mathbf{dist}_w([\varepsilon']; [\text{got_to_work}\{\varepsilon'\}, \mathbf{Ag}\{u, \varepsilon'\}]; [\tau\{\varepsilon'\} = \iota])(\varepsilon')]); \\ \mathbf{max}'([\mathbf{dist}_w(\lambda I_{st}. \lambda J_{st}. I[\varepsilon, \varepsilon', u']J \wedge \text{got_to_work}\{\varepsilon'\}J \wedge \mathbf{Ag}\{u, \varepsilon'\}J \wedge \\ (\tau\{\varepsilon'\} = \iota')J \wedge \text{loud}\{u'\}J \wedge \text{necktie}\{u'\}J \wedge \text{wear}\{\varepsilon\}J \wedge \mathbf{Ag}\{u, \varepsilon\}J \wedge \\ \mathbf{Th}\{u', \varepsilon\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}\{u'\}J) \wedge (\tau\{\varepsilon\} = \iota')J)(\iota')]); [\iota = \iota']$$

Let us consider the truth conditions of this DRS. It will be true with respect to a singleton input info state $I = \{i\}$ iff there exists an output info state $J = \{j\}$ such that the following conditions hold:

a) j differs from i at most with respect to the values of u , ι and ι' , and uj is John:

(220)

Info state J	...	u	ι	ι'	...
j	...	j	i	i'	...

b) ιj , i.e. the set of time intervals i in (220), is the maximal set of time intervals such that there exists an info state of the following form:

(221)

Info state J'	...	u	ι	ε'	...
j'_1	...	j	i_1	e'_1	...
j'_2	...	j	i_2	e'_2	...
...
j'_n	...	j	i_n	e'_n	...

Here, i_1, i_2, \dots, i_n are atomic time intervals, and $i_1 \oplus i_2 \oplus \dots \oplus i_n = i$. Moreover, e'_1, e'_2, \dots, e'_n are going to work events, whose agent is John, and for each $e'_k \in \{e'_1, e'_2, \dots, e'_n\}$, the temporal trace of e'_k is i_k .

c) $\iota'j$, i.e. the set of time intervals i' in (220), is the maximal set of time intervals such that there exists an info state of the following form:

(222)

Info state J'	...	u	ι'	ε'	ε	u'	...
j'_1	...	j	i'_1	e'_1	e_1	nt_1	...
j'_2	...	j	i'_2	e'_2	e_2	nt_2	...
...
j'_n	...	j	i'_n	e'_n	e_n	nt_n	...

Here, i'_1, i'_2, \dots, i'_n are atomic time intervals, and $i'_1 \oplus i'_2 \oplus \dots \oplus i'_n = i'$. Next, e'_1, e'_2, \dots, e'_n are again going to work events, whose agent is John, and for each $e'_k \in \{e'_1, e'_2, \dots, e'_n\}$, the temporal trace of e'_k is i'_k . Furthermore, e_1, e_2, \dots, e_n are wearing event, such that for each $e_k \in \{e_1, e_2, \dots, e_n\}$, the agent of e_k is John, the theme of e_k is nt_k , and the temporal trace of e_k is i'_k . Finally, for each $nt_k \in \{nt_1, nt_2, \dots, nt_n\}$, nt_k is a possibly atomic sum of neckties, and it must be the case that either there exists a $nt_k \in \{nt_1, nt_2, \dots, nt_n\}$ such that nt_k is non-atomic or there exist $nt_l, nt_m \in \{nt_1, nt_2, \dots, nt_n\}$ such that $nt_l \neq nt_m$.

c) The set of time intervals i must be equal to the set of tie intervals i' .

Less formally, the DRS in (219) will be true if for each time interval i such that John goes to works at i , there is an event of John wearing one or more neckties at i ,

and it is the case that John wears more than one necktie at some time interval when he goes to work, or he wears different neckties at at least two such time intervals, i.e. more than one necktie must be involved overall. These truth conditions are compatible with John wearing a single necktie on each occasion of going to work, as long as there are at least two occasions when he wears different neckties. We have thus derived the dependent plural interpretation of sentence (216).

Two further comments are in order. First, given the presence of the weak distributivity operator in the translation of pluractional adverbials, we correctly derive the absence of cumulative readings with numerical DPs in sentences like (223):

(223) John always wears five neckties when he goes to work.

This sentence will be judged true only if on each occasion of John going to work, he wears five neckties. It cannot mean that there is a set of neckties T and a set of events of John going to work E , and these sets are cumulatively related, i.e. in each event in E John wears a necktie in T , and John wears each necktie in T in some event in E . This follows from the fact that the second weak distributivity operator in (215) introduces a plural info state where each event of wearing neckties is stored in a separate assignment (cf. the info state in 222), while the numeral encodes a domain level cardinality condition which is checked against each assignment in a plural info state.

Second, pluractional adverbials sometimes appear to induce strong distributivity, which is evident from the fact that they allow for co-variational readings of singular indefinites in their scope:

(224) John always wears a loud necktie when he goes to work.

As in the case of plural QDs, distributive readings in sentences like (224) can be captured if we allow for the insertion of a covert (generalised) strong distributivity operator into the syntactic structure:

- (225) a. $\delta_s \rightsquigarrow \lambda P_{\sigma t} . \lambda d_{\sigma} . [\mathbf{dist}_s(P(d))(d)]$
 b. $\mathbf{dist}_s(D_t)(d_{\sigma}) := \lambda I_{st} . \exists J_{st} . (\langle d \rangle ; \mathbf{dist}(D))IJ$,
 where $\sigma \in \mathbf{DRefTyp}$.

To conclude, I have demonstrated how we can capture dependent plural readings in the scope of pluractional adverbials by analysing such adverbials as inducing weak distributivity over the values of time interval drefs. This analysis correctly predicts the absence of cumulative readings of numerical DPs in this context.

In the following discussion, I revert to using the simplified version of the system without time intervals to avoid unnecessary cluttering. However, the extended version presented here will again prove useful when we analyse long-distance dependency relations across adjunct clause boundaries, in section 5.3.5.5.

4.7 Bare Plurals in the Scope of Modals

Recall the observation from Ivlieva 2013, discussed in section 1.3.3, that modals, as opposed to plural quantificational DPs and pluractional adverbials, do not license dependent plural readings:

- (226) a. #John should wear yellow t-shirts to the party.
 b. All the boys were wearing yellow t-shirts.
 c. John always wears yellow t-shirts.

In (226a) a bare plural occurs in the scope of a modal. However this sentence does not have a reading on which in every contextually relevant possible world compatible with certain deontic constraints John wears a yellow t-shirt. Instead, this sentence seems to imply that in each, or at least some, of these worlds John wears more than one yellow t-shirt, which makes it pragmatically odd. Sentence (226b), on the other hand, is naturally interpreted as stating that each boy was wearing a single yellow t-shirt. Similarly, (226c) is pragmatically felicitous, and is compatible with John wearing a single yellow t-shirt on each relevant occasion.

One may be tempted to conclude from the data in (226) that modals are to be analysed as inducing strong distributivity over possible worlds, i.e. that they split a plural info state into a set of singleton info states corresponding to each of the relevant possible worlds. This would ensure that the multiplicity condition associated with the bare plural in (226a) is evaluated relative to each possible world separately. However, this analysis makes the wrong predication when it comes to the interaction between modals and other quantificational licensors. Specifically, if modals induce strong distributivity we would expect them to act as interveners for the licensing of dependent plurals by higher quantificational items in examples like (227):

(227) Most of us must now submit copies of our passports to the embassy.

Here, a deontic modal occurs in the scope of a plural quantificational DP, and in turn scopes over a bare plural. Thus, for each individual in the witness set of the subject DP, the modal quantifies over a set of possible worlds related to the actual world via a certain deontic accessibility relation. If modals are strongly distributive quantifiers over possible worlds, we would expect the multiplicity condition associated with the plural DP *copies of our passports* to be evaluated separately for each of these possible worlds, i.e. sentence (227) should mean ‘Most of us must now submit *two or more* copies of our passports to the embassy’. In fact, this sentence allows for a dependent plural interpretation, on which each of the relevant individuals is required to submit a single copy of her passport. This is unexpected on the analysis of modals as strongly distributive quantifiers.

Furthermore, it has been noted that the presence of a modal can trigger a weakening of the multiplicity semantics associated with bare plurals. Consider examples (228a) and (228b), from Zweig 2009 and Ivlieva 2013, respectively (cf. also Grimm 2013, Mathieu 2014 for similar observations):

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

b. You should bring friends to the party.

Zweig (2008, 2009) observes that sentence (228a) does not imply that Sherlock Holmes must necessarily question more than one resident. For instance, it does not follow from (228a) that even if the very first resident Holmes questions supplies him with all the necessarily information, he should nonetheless question another one. Similarly, Ivlieva (2013) notes that sentence (228b) does not require the addressee to necessarily bring more than one friend to the party.

The challenge, then, is to capture the contrast between the semantics of bare plurals in modal contexts and that of dependent plurals licensed by nominal and adverbial quantificational items, as in (226), and at the same time to account for the fact that modals do not act as interveners for the licensing of dependent plurals in examples like (227), and furthermore can trigger weakened, ‘non-exclusive’ (in the terminology of Farkas and de Swart 2010) reading of bare plurals, as in (228a) and (228b). However, before we can attempt to provide an account of these facts we need to extend the formal system to deal with intensional phenomena.

4.7.1 Intensional PCDRT*

Brasoveanu(2007:Ch. 7) presents an extension of PCDRT which is meant to handle phenomena involving intensionality. In this section I develop an intensional version of our system, PCDRT*, largely based on Brasoveanu’s (2007:Ch. 7) *Intensional PCDRT* (IP-CDRT) framework.¹⁷

First, the set of basic types must be expanded to include w , the type for possible worlds, with variables w, w', \dots . Similarly, the standard frame is extended with D_w , the domain for possible worlds, which is disjoint from D_e, D_s , and D_t . D_w must include the actual world w^* .

Next, we introduce drefs for possible worlds, i.e. terms of type sw which are interpreted as functions from assignments to possible worlds. The symbols p, p', \dots

¹⁷I will base this extension on the simpler version of IP-CDRT which does not make use of the dummy world $\#$. For an exposition of IP-CDRT with $\#$, and its application to the analysis of modal subordination, cf. Brasoveanu (2007). I will also use a notation which is slightly different from that in Brasoveanu (2007), but fits better with the conventions that have been used throughout this thesis.

will be used for constants of type sw , and q, q', \dots for variables of this type. Following our usual convention, the type sw will be abbreviated as \mathbf{w} .

Atomic conditions are relativised to possible worlds, e.g.:

$$(229) \text{ a. } \mathit{man}_p\{u\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (\mathit{man}_{pi}(ui)),$$

where $\mathit{man}_{pi}(ui)$ is true iff individual ui is a man in world pi .

$$\text{ b. } \mathit{walk}_p\{\varepsilon\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (\mathit{walk}_{pi}(\varepsilon i)),$$

where $\mathit{walk}_{pi}(\varepsilon i)$ is true iff event εi is a walking event in world pi .

$$\text{ c. } \mathbf{Ag}_p\{u, \varepsilon\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (\mathbf{Ag}_{pi}(ui, \varepsilon i)),$$

where $\mathbf{Ag}_{pi}(ui, \varepsilon i)$ is true iff individual ui is the agent of event εi in world pi .

The translations of lexical items are intensionalised so that the type of noun translations becomes $\mathbf{e}(\mathbf{wt})$, the type of intransitive verb translations becomes $\mathbf{e}(\mathbf{v}(\mathbf{wt}))$, the type of determiner translations becomes $(\mathbf{e}(\mathbf{wt}))((\mathbf{e}(\mathbf{wt}))\mathbf{wt})$ etc., e.g.:

$$(230) \text{ a. } \mathbf{man} \rightsquigarrow \lambda v_e. \lambda q_w. [\mathit{man}_q\{v\}]$$

$$\text{ b. } \mathbf{own} \rightsquigarrow \lambda v_e. \lambda v'_e. \lambda \zeta_v. \lambda q_w. [\mathit{own}_q\zeta, \mathbf{Th}_q\{v, \zeta\}, \mathbf{Ag}_q\{v', \zeta\}]$$

$$\text{ c. } \mathbf{John}^u \rightsquigarrow P_{\mathbf{e}(\mathbf{wt})}. \lambda q_w. [u|u = \mathit{John}]; P(u)(q)$$

$$\text{ d. } \mathbf{they}_u \rightsquigarrow P_{\mathbf{e}(\mathbf{wt})}. \lambda q_w. P(u)(q)$$

$$\text{ e. } \mathbf{a}^u, \mathbf{Indef}^u \rightsquigarrow \lambda P'_{\mathbf{e}(\mathbf{wt})}. \lambda P_{\mathbf{e}(\mathbf{wt})}. \lambda q_w. [u]; P'(u)(q); P(u)(q)$$

$$\text{ f. } \mathbf{most}^{u,u'} \rightsquigarrow \lambda P'_{\mathbf{e}(\mathbf{wt})}. \lambda P_{\mathbf{e}(\mathbf{wt})}. \lambda q_w. \mathbf{max}^u([\mathbf{dist}_w(P'(u)(q); P(u)(q))(u)]); \\ \mathbf{max}^{u'}([\mathbf{dist}_w(P'(u')(q))(u')]); [\mathbf{MOST}\{u', u\}]$$

The translation of the event closure operator must also be modified accordingly:

$$(231) \exists_{ew}^\varepsilon \rightsquigarrow \lambda V_{\mathbf{v}(\mathbf{wt})}. [\varepsilon]; V(\varepsilon)$$

If nothing else is said, a full sentence will receive a translation of type \mathbf{wt} , i.e. that of a (dynamic) proposition, e.g.:

$$(232) \mathbf{a}^u \mathbf{man} \mathbf{is} \mathbf{walking}^\varepsilon \rightsquigarrow \lambda q_w. [u]; [\varepsilon]; [\mathit{man}_q\{u\}]; [\mathit{walk}_q\{\varepsilon\}, \mathbf{Ag}_q\{u, \varepsilon\}]$$

To turn such a proposition into a DRS of type **t**, Brasoveanu (2007) posits the existence of an indicative mood morpheme in the complementizer head **C** which takes a dynamic proposition and applies it to the designated dref for the actual world p^* .¹⁸

$$(233) \quad [\mathbf{ind}_{p^*}]_C \rightsquigarrow \mathbb{P}_{\mathbf{wt.}} \mathbb{P}(p^*),$$

where if I is the input info state for the sentence, $p^*I = \{w^*\}$.

$$(234) \quad [\mathbf{ind}_{p^*}]_C \mathbf{a}^u \mathbf{man} \mathbf{is} \mathbf{walking}^\varepsilon \rightsquigarrow [u]; [\varepsilon]; [\mathbf{man}_{p^*}\{u\}]; [\mathbf{walk}_{p^*}\{\varepsilon\}, \mathbf{Ag}_{p^*}\{u, \varepsilon\}]$$

In other words, the sentence *A man is walking* will be true if there is an individual who is a man in the actual world, and that individual is the agent of a walking event in the actual world.

Finally, we must provide the translations of number features and numerals in the intensional system. They are the following:

$$(235) \quad \text{a. } \#\mathbf{:sg} \rightsquigarrow \lambda P_{\mathbf{et.}} \lambda v_{\mathbf{e.}} \lambda q_{\mathbf{w.}} [\mathbf{atom}\{v\}]; [\mathbf{unique}_q\{v\}]; P(v)(q)$$

$$\text{b. } \#\mathbf{:pl} \rightsquigarrow \lambda P_{\mathbf{et.}} \lambda v_{\mathbf{e.}} \lambda q_{\mathbf{w.}} P(v)(q)$$

$$(236) \quad \text{a. } \mathbf{two} \rightsquigarrow \lambda v_{\mathbf{e.}} \lambda q_{\mathbf{w.}} [\mathbf{2_atoms}\{v\}]$$

The translations of both number features and numerals have been intensionalised by adding an argument of type **w**. Properties that measure the cardinality of a sum (e.g. **atom**, **2_atoms** etc.) are not world-dependent. However, the uniqueness condition is world dependent, in the following way (cf. the definition of uniqueness in Brasoveanu 2007:Ch.7):

¹⁸The use of the term ‘indicative’ may be somewhat misleading in this context, since the presence of the morpheme in question does not seem to coincide with the distribution of the indicative mood in syntax. For instance, many propositional attitude verbs combine with complement clauses in the indicative mood, both in English and in other languages, and yet semantically the meaning of these clauses must be propositional, i.e. their world argument must not be closed off by the indicative morpheme. Instead, the indicative morpheme as defined by Brasoveanu (2007) appears to be restricted to matrix clauses.

An alternative approach would be to allow for the translation of sentences to remain of type **st**, and to define truth with respect to a pair of input info state and reference world. Sentences in a discourse would then be connected via Generalised Sequencing into a complex proposition of type **wt**.

$$(237) \text{ unique}_p\{u\} := \lambda I_{st}. \forall i, i' \in I. (pi = pi' \rightarrow ui = ui')$$

The uniqueness condition relativised to a possible world dref p requires for an individual dref to return the same value for all assignments in the plural info state for which p returns the same values. This way of defining uniqueness will play an important role in our account of the semantics of plurals in the scope of modals.

4.7.2 Analysis

I propose that modals are to be analysed as weakly distributive quantifiers over possible worlds. For the purpose of this discussion, I will adopt a simplified semantics for modals, ignoring e.g. the notion of ordering source (cf. e.g. Kratzer 1981, 1991*b*, etc.). Thus, a universal deontic modal is translated as follows:

$$(238) \text{ should}^p \rightsquigarrow \lambda \mathbb{P}_{\mathbf{wt}}. \lambda q_{\mathbf{w}}. \lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{deont}(qj)(w)\}) \wedge \exists K_{st}. \mathbb{P}(p)HK),$$

where f is a partial function from the domain of assignments \mathcal{D}_s to the set of info states $\wp(\mathcal{D}_s)$, and $R_{deont}(w)(w')$ is true iff world w' is deontically accessible from w .

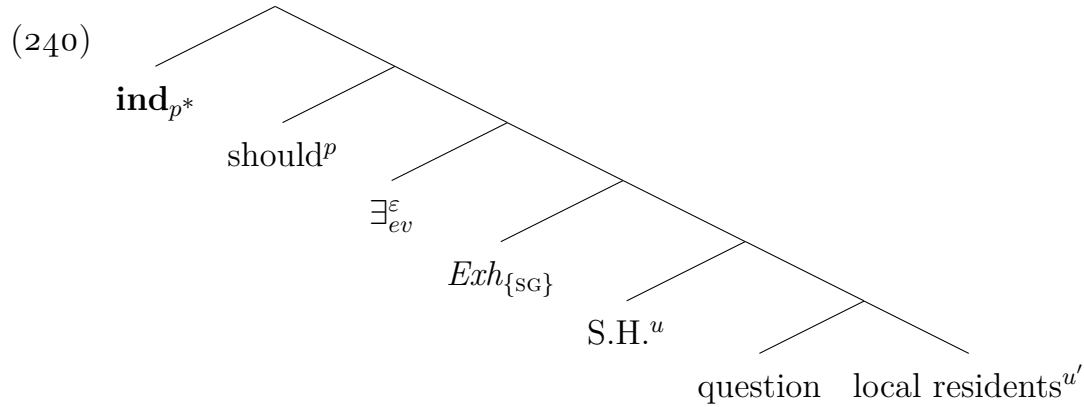
Modals are indexed with a possible world dref p , and combine with a proposition \mathbb{P} , a possible world dref q and the input and output info states I and J . The input info state is not modified, and simply passed on as the output info state. What the modal does is construct an info state H , such that for each assignment j in J , H includes a sub-set of assignments H' , where pH' stores all the possible worlds deontically accessible from qj . Then it applies \mathbb{P} to p and H .¹⁹

¹⁹One may note the similarity between the translation in (238), and way the $\langle \rangle$ relation was defined in section 3.7.1. Recall that the $\langle \rangle$ relation forms the basis for our definition of weak distributivity. The translation in (238), in effect, transports the effects of weak distributivity into the domain of possible world drefs, but without making use of sums of possible worlds. Alternatively, we could have defined the domain for possible worlds \mathbf{D}_w as the powerset of the set possible worlds \mathbf{W} , in parallel to the domains for individuals and events. Then, the translation of modals could be formulated in the familiar way in terms of distributivity of maximality operators. In fact, the reader may recall that this is the approach that I adopted with respect to time intervals in section 4.6. At this point, I don't have any arguments in favour of either of the two options.

As an illustration, take sentence (239), a simplified version of (228a):

(239) Sherlock Holmes should question local residents.

The syntactic structure I assume for this sentence is the following:



The compositional translation of this structure proceeds as follows. The structure up to the event closure operator yields the following proposition in the standard way:

$$(241) \quad \lambda q_{\mathbf{w}}. \lambda I_{st}. \lambda J_{st}. I[\varepsilon, u, u']J \wedge (u = S.H.)J \wedge resident_q\{u'\}J \wedge question_q\{\varepsilon\}J \wedge \mathbf{Ag}_q\{u, \varepsilon\}J \wedge \mathbf{Th}_q\{u', \varepsilon\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}_q\{u'\}J)$$

Note that the non-atomicity and/or non-uniqueness condition on the values of u' is added via the application of the exhaustification operator, which compares the event predicate involving the translation of the bare plural with the alternative event predicate involving the translation of the corresponding singular indefinite.

Combining the proposition in (241) with the translation of the modal in (238), we arrive at the following proposition:

$$(242) \quad \lambda q_{\mathbf{w}}. \lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{deont}(qj)(w)\}) \wedge \exists K_{st}. (H[\varepsilon, u, u']K \wedge (u = S.H.)K \wedge resident_p\{u'\}K \wedge question_p\{\varepsilon\}K \wedge \mathbf{Ag}_p\{u, \varepsilon\}K \wedge \mathbf{Th}_p\{u', \varepsilon\}K \wedge (\neg \mathbf{atom}\{u'\}K \vee \neg \mathbf{unique}_p\{u'\}K)))$$

Finally, this proposition combines with the indicative morpheme indexed with the actual world, yielding the following DRS as the translation of sentence (239):

$$(243) \quad \lambda I_{st}.\lambda J_{st}. I = J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{deont}(p^*j)(w)\}) \wedge \exists K_{st}. (H[\varepsilon, u, u']K \wedge (u = S.H.)K \wedge resident_p\{u'\}K \wedge question_p\{\varepsilon\}K \wedge \mathbf{Ag}_p\{u, \varepsilon\}K \wedge \mathbf{Th}_p\{u', \varepsilon\}K \wedge (\neg \mathbf{atom}\{u'\}K \vee \neg \mathbf{unique}_p\{u'\}K)))$$

Let us consider the truth conditions of this DRS relative to a singleton input info state $I = \{i\}$. It will be true if there is an info state K , constructed in the following way. First, we introduce an info state H , such that for each $h \in H$, h differs from i at most with respect to the value for p , and moreover the set of values for p in H is the set of all possible worlds deontically accessible from the actual world w^* :

(244)

H	...	p^*	p	...
h_1	...	w^*	w_1	...
h_2	...	w^*	w_2	...
...
h_n	...	w^*	w_n	...

Info state K is then generated by applying the proposition in (241) to p and H , which means that K must have the following form:

(245)

K	...	p^*	p	ε	u	u'	...
k_1	...	w^*	w_1	e_1	$H.S.$	r_1	...
k_2	...	w^*	w_2	e_2	$H.S.$	r_2	...
...
k_n	...	w^*	w_n	e_n	$H.S.$	r_n	...

Here, $\{w_1, \dots, w_n\}$ is the set of possible worlds deontically accessible from the actual world w^* . Each event $e_k \in \{e_1, \dots, e_n\}$ is a questioning event in w_k , whose agent is Sherlock Holmes and whose theme is the individual r_k . Consider now the conditions on the values of u' . Each individual $r_k \in \{r_1, \dots, r_n\}$ is a (possibly atomic) sum of local residents. Moreover, it must be the case that either one of the individuals in $\{r_1, \dots, r_n\}$ is non-atomic or is non-unique with respect to some value of p , i.e. at least for some possible world, deontically accessible from the actual world, u' must return a non-atomic sum of individuals.

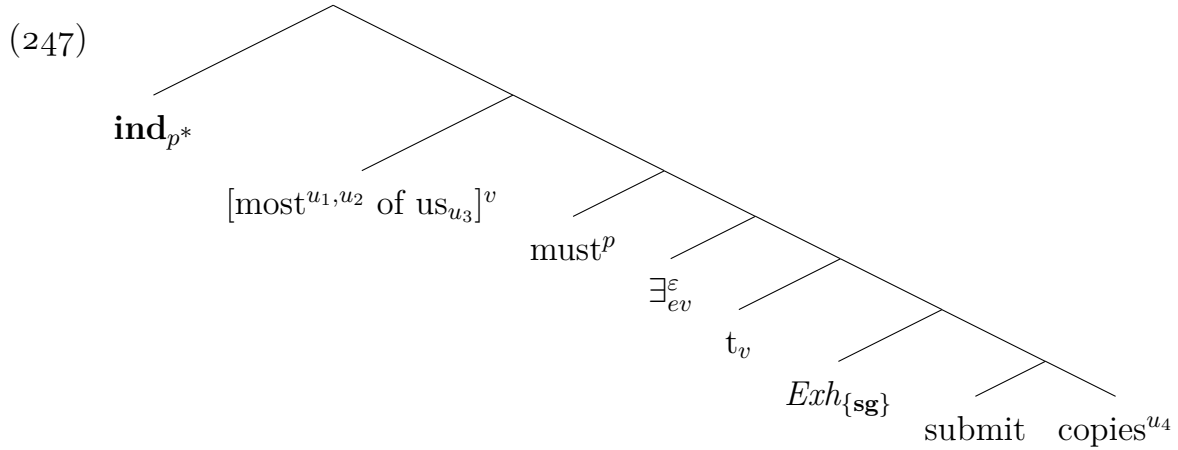
In other words, we predict that sentence (239) will be true if in every possible world, deontically accessible from the actual world, Sherlock Holmes questions one or more local residents, and in at least one of these worlds Holmes questions more than one local resident. Crucially, these truth conditions do not require for Holmes to question multiple local residents in all the deontically accessible worlds. We have thus derived the weakened, non-exclusive interpretation of the bare plural in this example. It is easy to see how the same result will be obtained for the examples in (228).

Let us now go back to the pragmatically odd example in (226a). The truth conditions that will be derived for this sentence in our system are the following: in every possible world, deontically accessible from the actual world, John wears one or more yellow t-shirt to the party, and crucially, in at least one of these worlds John wears more than one yellow t-shirt to the party. Thus, we predict that sentence (226a) can only be uttered in a context where the set of deontically accessible worlds includes those where John wears more than one t-shirt to the party, which would account for the pragmatic oddness of this sentence.

Finally, consider sentence (227), where a modal ‘intervenes’ between a DP licenser and a bare plural, but does not block the dependent plural interpretation. Example (246) is a simplified version of this sentence, with the added indices:

(246) Most ^{u_1, u_2} of us _{u_3} must ^{p} submit ^{ε} copies ^{u_4} .

I assume the following syntactic structure for (246):



Given the intensionalised translation of the QD *most* in (230f), the structure in (247) is translated as the DRS in (248):²⁰

$$\begin{aligned}
 (248) \quad & \mathbf{max}^{u_1}([\mathbf{dist}_w(\lambda I. \lambda J. I = J \wedge (u_1 \leq u_3)J \wedge \\
 & \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \\
 & \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{deont}(p^*j)(w)\}) \wedge \\
 & \exists K_{st}. (H[\varepsilon, u_4]K \wedge copy_p\{u_4\}K \wedge submit_p\{\varepsilon\}K \wedge \mathbf{Ag}_p\{u_1, \varepsilon\}K \wedge \\
 & \mathbf{Th}_p\{u_4, \varepsilon\}K \wedge (\neg \mathbf{atom}\{u_4\}K \vee \neg \mathbf{unique}_p\{u_4\}K))) (u_1)]); \\
 & \mathbf{max}^{u_2}([\mathbf{dist}_w([u_2 \leq u_3])(u_2)]; [\mathbf{MOST}\{u_2, u_1\}]
 \end{aligned}$$

This complex DRS will be true with respect to a singleton input info state $I = \{i\}$ iff there exists an output info state $J = \{j\}$ such that j differs from i at most with respect to the values of u_1 and u_2 , and these values satisfy a number of conditions. First, u_2 must store the maximal sum of individuals that are part of the referent of the personal pronoun *us*, i.e. $u_2j = u_3j$. The dref u_1 must store the maximal sum of individuals such that there is an info state K as in (249):

²⁰For simplicity, I am disregarding the semantics of the first person feature on the personal pronoun *us*.

(249)

K	...	p^*	p	ε	u_1	u_4	...
k_{11}	...	w^*	w_1	e_{11}	x_1	c_{11}	...
k_{12}	...	w^*	w_2	e_{12}	x_1	c_{12}	...
...
k_{21}	...	w^*	w_1	e_{21}	x_2	c_{21}	...
k_{22}	...	w^*	w_2	e_{22}	x_2	c_{22}	...
...
k_{n1}	...	w^*	w_1	e_{n1}	x_n	c_{n1}	...
k_{n2}	...	w^*	w_2	e_{n2}	x_n	c_{n2}	...
...

Here, x_1, x_2, \dots, x_n are atomic individuals which are part of u_3j (i.e. the referent of us) such that $\{x_1 \oplus x_2 \oplus \dots \oplus x_n\} = u_1j$, i.e. the value of u_1 has been split into its atomic parts by the weak distributivity operator which is part of the semantics of the QD *most*. The set $\{w_1, w_2, \dots\}$ is the set of possible worlds deontically accessible from the actual world w^* . Since the modal *must* occurs in the scope of *most* and is too translated as a weakly distributive quantifier, p must return all the values in $\{w_1, w_2, \dots\}$ for each value of u_1 in K . Next, for each $k \in K$, εk is a submitting event in world pk , whose agent is u_1k and whose theme is u_4k . Consider now the conditions on the values of u_4 in K . For each $k \in K$, u_4k is a (possibly atomic) sum of copies, and it must be the case that either at least one of the values of u_4 in K is non-atomic or its values are non-unique with respect to some value of p (i.e. there exist assignments k_l and k_m in K , such that $pk_l = pk_m$ and $u_4k_l \neq u_4k_m$).

Summing up, the DRS in (248) requires for u_1 to store the maximal sum of individuals, such that each of these individuals is part of the referent of the personal pronoun us in (246) and submits one or more copies in every deontically accessible possible world, and it must be the case that either one of these individuals submits more than one copy in some deontically accessible world, or that at least two

individuals submit different sums of copies in some deontically accessible world. The final condition in (248) states that the cardinality of u_1j must be greater than half the cardinality of u_2j , i.e. u_1j must include more than half of the individuals referred to by us in (246).

Note, that the interpretation we have derived for (246) is compatible with a scenario where there is a set of individuals which comprises more than half of us , and each individual in this set is required to submit a single copy e.g. of her own passport. This demonstrates that on the proposed analysis of modals as weakly distributive quantifiers over possible worlds, we are able to account for the fact that they do not act as interveners for the licensing of dependent plurals.

Before I conclude this section, I want to consider another type of context where bare plurals appear to have a non-exclusive interpretation outside of downward entailing contexts. Consider the following examples, due to Farkas and de Swart (2010):

- (250) a. [Speaker walks into basement, and notices mouse droppings]: Arghh, we have mice!
- b. [Speaker walks into unknown house, and notices toys littering the floor]: There are children in this house.

Farkas and de Swart (2010) note that the bare plurals in these examples can have a non-exclusive interpretation, where the speaker does not know how many mice/children are actually involved (cf. also Ivlieva 2013 for a similar observation). They provide a pragmatic account of this fact, couched within a framework which is very different from the one adopted here. We may ask then, how our approach could deal with the non-exclusive readings of bare plurals in examples like (250).

What I would like to suggest, albeit somewhat tentatively, is that these examples can be analysed as involving a covert modal operator, and thus the non-exclusive reading of bare plurals in examples like (250) can be accounted for in the same way as that of bare plurals in examples like (228), discussed above. First, note that the contexts in (250a) and (250b) are exactly the kind of contexts that would

license markers of inferred evidentiality in languages where this category is grammaticalised (cf. Aikhenvald 2004).²¹ Moreover, this kind of evidential meaning has been analysed in terms of quantification over possible worlds, i.e. essentially as a special type of epistemic modal with universal quantificational force (cf. Izvorski 1997, Matthewson et al. 2007, Rullmann et al. 2008). It is thus not implausible that English sentences like (250) involve a covert operator with similar epistemic semantics, and it is the presence of this operator that accounts for the weakened reading of bare plurals in these examples.

To conclude, I have defined an intensionalis version of PCDRT*, based on Brasoveanu's (2007:Ch. 7) Intensional PCDRT, and have proposed an analysis of modals within this framework. The main idea of the analysis is that modals act as weakly distributive quantifiers over possible worlds, however a particular definition of intensionalised uniqueness ensures that they cannot themselves act as licensors of dependent plurals. I have demonstrated how this analysis is able to account for non-exclusive readings of bare plurals in the scope of modals, while at the same time preserving the distinction between these readings and the interpretation of dependent plurals licensed by weak distributivity operators. Furthermore, I have shown that this analysis correctly captures the fact that modals do not act as interveners for the licensing of dependent plurals by other weakly distributive items. Finally, I have also suggested that (at least some) examples of bare plurals allowing a non-exclusive interpretation in non-downward entailing contexts can be attributed to the presence of a covert epistemic modal operator akin to markers of evidentiality found in other languages.

4.8 Conclusion

This chapter has focused on the semantics of various classes of quantificational items, and on their interaction with plurals. I have argued that the contrast be-

²¹In fact, the contexts in (250) most closely resemble the ones that license markers of 'perceived-evidence' evidentiality in language like St'át'imcets, cf. Matthewson et al. 2007, Rullmann et al. 2008.

tween so-called singular and plural quantificational determiners is best accounted for in terms of the proposed distinction between weak and strong distributivity. I demonstrated how this analysis is able to account for the fact that the latter group of QDs, but not the former, is able to license dependent plural readings. Furthermore, I have argued that the Licensing Generalisation proposed in Chapter 1 falls out from the proposed semantics of QDs and number features, combined with an independently established Conservativity Universal, which restricts the possible semantics of natural language determiners. I also showed that the proposed analysis correctly accounts for the absence of cumulative readings between quantificational DPs and plural DPs involving numerals and cardinal modifiers (cf. the Neutrality Generalisation), including cases which are problematic for previous theories of dependent plurals. Next, I focused on the issue of collective predication, and proposed an analysis of the semantics of two groups of collective predicates and their interaction with the two types of QDs. I argued that this analysis is superior to previously proposed alternatives because it accounts for the systematic correlation between the ability of a certain type of quantificational DP to license dependent plurals and its compatibility with a particular class of collective predicates.

I then moved on to examine the semantics of quantificational adverbials, which as we have seen in Chapter 1 pattern with plural QDs in their ability to license dependent plural readings. I proposed an analysis of these items as weakly distributive quantifiers over time intervals, couched within an extended version of the semantic system.

The final section of the chapter was concerned with the interpretation of plurals in the scope of modals. As we discussed in Chapter 1, modals contrast with plural adverbials and plural QDs in that they cannot function as licensors for dependent plurals. However, as has been previously noted in the literature, they do trigger the weakening of the multiplicity semantics associated with bare plurals. I proposed an analysis of modals as weakly distributive quantifiers over possible worlds couched within an intensional version of PCDRT*, and argued that this

analysis correctly accounts for various aspects of the semantic interaction between modals and bare plurals.

Chapter 5

Intervention, Non-Locality, and Scope

5.1 Introduction

In this chapter I discuss some further applications of the analysis developed in Chapters 3 and 4. I address a range of data which are particularly problematic for previous approaches to the semantics of distributivity, grammatical number and dependent plurals. Thus, if the analysis proposed here proves successful, it will constitute an important argument for the general approach developed in this thesis.

First, I will address the issue of intervention, and demonstrate that the proposed theory of distributivity can account for the full range of relevant data, which as I argued in Chapter 2 is problematic both for mereological and disistributive theories of dependent plurals. I further demonstrate how the proposed account can readily accommodate speaker variation observed in this domain.

Next I turn to the phenomenon of long-distance dependent plurals, which as far as I know has not been previously discussed in the literature. I demonstrate that these data are again problematic for existing theories of dependent plurals, but can be accounted for straightforwardly in the semantic framework developed

in this thesis.

Finally, I address the intriguing effect discovered by Partee (1985) and discussed in section 1.4.2, whereby the scopal properties of English bare plurals functioning as dependent plurals differ from those of ‘standard’ bare plurals. I propose an account of this contrast that crucially relies on the notion of weak distributivity as proposed in this thesis. To my knowledge, this is the first attempt at a formal account of this phenomenon.

5.2 Intervention Effects

5.2.1 Accounting for Intervention

Consider again the intervention effects discovered by Zweig (2008, 2009), and discussed in section 1.2.3. I repeat the relevant examples from Zweig 2008, 2009:

- (1) a. Two boys told three girls secrets.
- b. Two boys told a girl secrets.

According to the judgements that Zweig (2008, 2009) reports, sentence (1a) can have a reading on which each of the two boys addressed a different set of three girls, and each boy told one secret to the girls he addressed. In this case the indirect object DP is interpreted distributively with respect to the subject, while the direct object DP is interpreted as a dependent plural licensed by the subject. I will refer to this as the ‘mixed reading’.

Sentence (1b), on the other hand, lacks a mixed reading, i.e. (1b) cannot mean that each boy addressed a different girl, and each boy told the girl he addressed one secret. Instead, it can either mean that both boys addressed the same girl, and told her one or more secrets each, or if the boys addressed different girls, it must be the case that each boy told more than one secret.

Recall, that the contrast between (1a) and (1b) presents a significant problem for both mereological and distributive approaches to dependent plurals (cf. the

discussion in section 2.5.1). However, on the theory of plurality and distributivity proposed here these data receive a natural account.

Starting with with the mixed reading of (1a), it turns out that this is exactly the interpretation that results if a weak distributivity operator is added on top of the VP:

- (2) Two^u boys δ_w told three^{u'} girls secrets^{u''}.

To provide the compositional translation of this example we must start with the translation of the double object verb *tell*:

- (3) $\mathbf{tell} \rightsquigarrow \lambda v_{se}.\lambda v'_{se}.\lambda v''_{se}.\lambda \zeta_{sv}.$ [$\mathbf{tell}\{\zeta\}$, $\mathbf{Th}\{v, \zeta\}$, $\mathbf{Adr}\{v', \zeta\}$, $\mathbf{Ag}\{v'', \zeta\}$],
where \mathbf{Adr} is the thematic relation Addressee.

Both *tell* and \mathbf{Adr} are distributive on the state level:

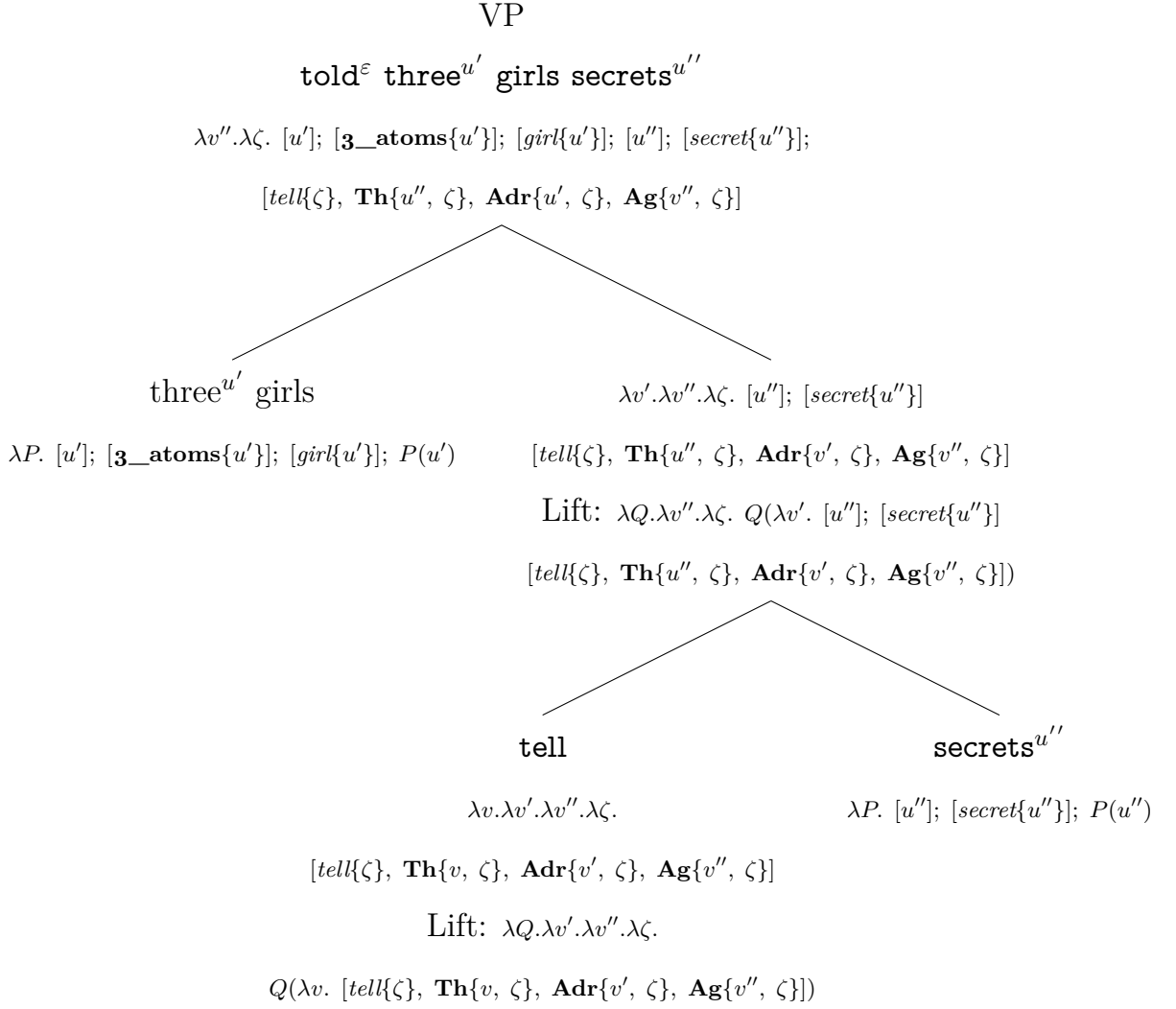
- (4) a. $\mathbf{tell}\{\varepsilon\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (\mathbf{tell}(i_s))$
b. $\mathbf{Adr}\{u\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (\mathbf{Adr}(i_s))$

Now, recall that I adopted (an analogue of Landman's (2000) Lift rules in order to allow for *in situ* interpretation of argument DPs of transitive and intransitive verbs. To extend this possibility to the innermost argument of ditransitive verbs we must add another Lift rule to our inventory:

- (5) a. **Intransitive Lift:** $\lambda v_{se}.\lambda \zeta_{sv}.[...] \Rightarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda \zeta. Q(\lambda v. [...])$
b. **Transitive Lift:** $\lambda v_{se}.\lambda v'_{se}.\lambda \zeta_{sv}.[...] \Rightarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda v'.\lambda \zeta.Q(\lambda v[...])$
c. **Ditransitive Lift:** $\lambda v_{se}.\lambda v'_{se}.\lambda v''_{se}.\lambda \zeta_{sv}.[...] \Rightarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda v'.\lambda v''_{se}.\lambda \zeta.Q(\lambda v[...])$

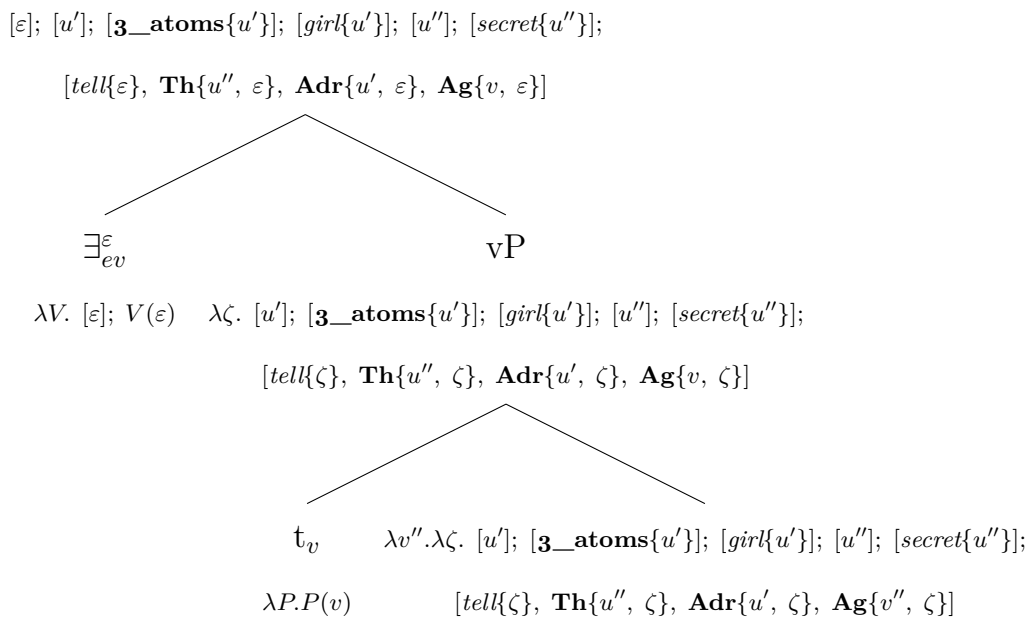
We can now derive the compositional translation for the VP in (2):

(6)

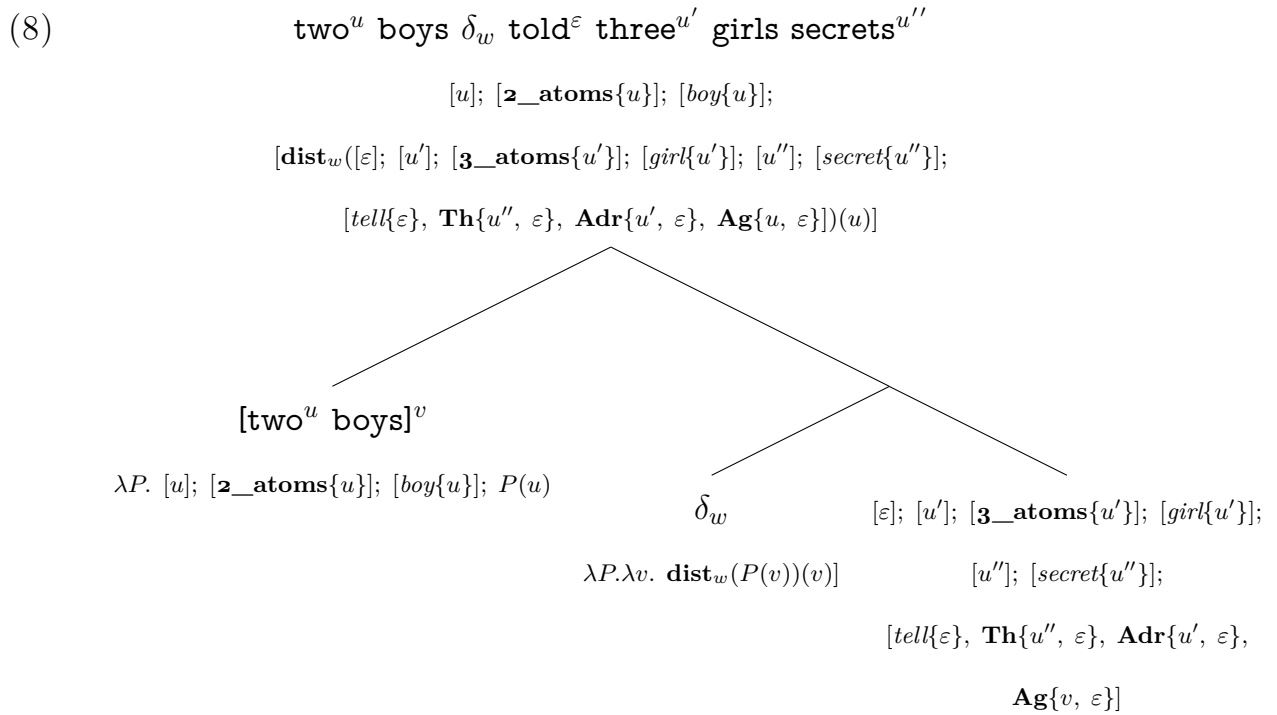


The VP then combines with the subject trace and the event closure operator:

(7)



Finally, combining this vP with the weak distributivity operator δ_w and the raised subject via the Distributive Quantifying-In rule , we arrive at the DRS in (8):



This DRS will be true if there exists an info state H' of the following general form:

(9)

Info state H'	...	u	u'	u''	ε	...
h'_1	...	b_1	g_1	s_1	e_1^{tell}	...
h'_2	...	b_2	g_2	s_2	e_1^{tell}	...

Here, b_1 and b_2 are derived by ‘splitting’ the values of the dref introduced by the subject DP *two boys* into two atomic individuals, i.e. b_1 and b_2 must be two distinct atomic boys. The values for u' , g_1 and g_2 , must both be sums of girls. Furthermore, the condition $\mathbf{3_atoms}\{u'\}$ applies distributively to the assignments in H' , thus the following must hold: $|g_1| = 3$ and $|g_2| = 3$. The values for u'' , s_1 and s_2 , must

both be sums of secrets. Additionally, calculating the multiplicity implicature for the bare plural DP *secrets* gives rise to the following overarching multiplicity condition: $\neg\mathbf{atom}\{u''\}H' \vee \neg\mathbf{unique}\{u''\}H'$. Finally, e_1^{tell} and e_2^{tell} are telling events, such that b_1 told secret(s) s_1 to girls g_1 in e_1^{tell} , and b_2 told secret(s) s_2 to girls g_2 in e_2^{tell} .

Note, that H' constrained in this way is consistent with the situation where each boy addressed a different set of three girls, and each boy told one secret, as long as they told different secrets. This is exactly the mixed reading that we set off to derive.

Why then is this kind of reading not available for (1b)? The key is the global atomicity condition associated with the singular number feature.

Let us calculate the translation of (1b) with the added weak distributivity operator:

(10) Two^{*u*} boys δ_w told ^{ε} a^{*u'*} girl secrets^{*u''*}.

The DRS for (10) is the following:

(11) two^{*u*} boys δ_w told ^{ε} a^{*u'*} girl secrets^{*u''*} \rightsquigarrow $[u]; [\mathbf{2_atoms}\{u\}]; [boy\{u\}];$
 $[\mathbf{dist}_w([\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [girl\{u'\}]; [u'']; [secret\{u''\}];$
 $[tell\{\varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}, \mathbf{Adr}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}](u)]$

This DRS will again be true if there exists an info state H' of the form given in (9), but this time the conditions imposed on this info state are different in a crucial respect. The conditions on the values of u , u'' and ε are the same as before, but the values for u' are subject to a global atomicity requirement (i.e. $\mathbf{atom}\{u'\}H'$ and $\mathbf{unique}\{u'\}H'$). It follows that g_1 and g_2 must represent the same atomic girl.

Hence, (10) will be true only if both boys told one or more secrets to the same girl.

The only way in the current system to derive a reading where the girls vary with the boys for a sentence like (1b) is to interpret the singular DP in the scope of a strong distributivity operator:

$$(12) \quad \text{two}^u \text{ boys } \delta_s \text{ told}^\varepsilon \text{ a}^{u'} \text{ girl secrets}^{u''} \rightsquigarrow [u]; [\mathbf{2_atoms}\{u\}]; [\text{boy}\{u\}]; \\ [\mathbf{dist}_s([\varepsilon]; [u']; [\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\text{girl}\{u'\}]; [u'']; [\text{secret}\{u''\}]); \\ [\text{tell}\{\varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}, \mathbf{Adr}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}](u)]$$

Recall, that all the conditions that occur under the strong distributivity operator are evaluated separately with respect to each atomic sub-part of the distributed dref. This means that (12) will be true in case there are two info stets H' and H'' of the following form:

(13)

Info state H'	...	u	u'	u''	ε	...
h'	...	b_1	g_1	s_1	e_1^{tell}	...
Info state H''	...	u	u'	u''	ε	...
h''	...	b_2	g_2	s_2	e_2^{tell}	...

These two info states are similar to the unified info state in (9) in that b_1 and b_2 are again derived by ‘splitting’ the values of the dref introduced by the subject DP into atomic individuals. However, in this case the global atomicity requirement associated with u' is evaluated separately for H' and H'' , thus g_1 and g_2 must both be atomic, but may be distinct. Hence, in this case each boy can be associated with a different girl.

What about u'' ? I demonstrated in Chapter 3 (cf. section 3.9.2) that the multiplicity implicature gets trapped under the strong distributivity operator. This means, that the multiplicity condition applies separately to the values of u'' for H' and H'' in (13), requiring for the cardinality of both s_1 and s_2 to be greater than one. Consequently, (11) will only be true if each boy told more than one secret.

There is indeed no way in the current system to derive a mixed reading for (1b) because of the conflicting requirements that this reading imposes on the reference of the two object DPs: the singular indirect object DP requires strong distributivity for a distributive reading to be possible, while the bare plural direct object requires weak distributivity to be interpreted as a dependent plural.

5.2.2 Incorporating Dialectal Variation

As was discussed in Chapter 1 (cf. section 1.2.3), the facts about intervention appear to be somewhat more complex than presented in Zweig 2008, 2009. Specifically, there seems to be inter-speaker variation with respect to whether plural numerical DPs act as interveners for the licensing of dependent plurals. The judgements are subtle, and I found that replacing sentences with double objects, as in (1), with examples involving complex DPs makes them somewhat clearer. I repeat the relevant examples here:

- (14) Context: Bill and John were looking for their wives, who had disappeared. Bill talked to Ann, who was his friend and knew his wife well, but didn't know John's wife. John talked to Jane, who was his friend and knew his wife well, but didn't know Bill's wife.

Example: To begin with, they both talked to a / one friend who knew their wives well.

- (15) Context: Bill and John were looking for their wives, who had gone missing. Bill talked to Ann and Bob, who were his friends and knew his wife well, but didn't know John's wife. John talked to Jane, Philip and Kate who were his friends and knew his wife well, but didn't know Bill's wife.

Example: To begin with, they both talked to a few / two or three / several friends who knew their wives well.

Most of my consultants reported a contrast between (14) and (15), ruling out the former, while judging the latter to be acceptable. Some speakers, however, found both examples unacceptable on the intended mixed reading.

As similar contrast in judgements was observed for the examples in (16):

- (16) a. #All the children received a letter written by their fathers.
b. ?All the children received two letters written by their fathers.

While all of my consultants rejected the example in (16a) on the mixed reading where each child received a different letter, the judgement regarding (16b) were

split. Whereas some speakers accepted a mixed reading for this sentence, where each child received a different pair of letters written by her father, others rejected this reading.

I will refer to the first type of judgement as Dialect I, and to the second – as Dialect II. For the speakers of Dialect I only singular indefinites block the relation between a dependent plural and its licenser, while for the speakers of Dialect II both singular and plural numerical DPs act as interveners with respect to dependent plurals.

Dialect I corresponds to the judgements presented in Zweig 2008, 2009, and this is the dialect captured by the present theory, as demonstrated above for the examples in (1). An account of Dialect II, however, requires some modification.

Thankfully, the way the system was set up, and specifically the way the global atomicity condition was divided into two components: domain-level atomicity and state-level uniqueness, opens the way for a straightforward account of this dialectal contrast. Specifically, the contrast between Dialect I and Dialect II can be reduced to the presence of a state-level uniqueness condition in the translation of numerals and cardinal modifiers, e.g.:

- (17) a. Dialect I: **three** $\rightsquigarrow \lambda v_e. [\mathbf{3_atoms}\{v\}]$
 b. Dialect II: **three** $\rightsquigarrow \lambda v_e. [\mathbf{3_atoms}\{v\}]; [\mathbf{unique}\{v\}]$

To see how this works consider again the translation of (2), repeated here for convenience:

- (18) Two^u boys δ_w told three^{u'} girls secrets^{u''}.

For Dialect I, the translation was derived in (8). I repeat it here:

- (19) two^u boys δ_w told ^{ε} three^{u'} girls secrets^{u''} \rightsquigarrow
 $[u]; [\mathbf{2_atoms}\{u\}]; [boy\{u\}];$
 $[\mathbf{dist}_w([\varepsilon]; [u']; [\mathbf{3_atom}\{u'\}]; [girl\{u'\}]; [u'']; [secret\{u''\}]);$
 $[tell\{\varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}, \mathbf{Adr}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}](u)]$

Recall, that this DRS captures the mixed reading of sentence (1a).

In Dialect II, the translation for (18) is slightly different in that it includes a uniqueness condition on u' which is contributed by the translation of the numeral (cf. 17b):¹

$$(20) \quad \text{two}^u \text{ boys } \delta_w \text{ told}^\varepsilon \text{ three}^{u'} \text{ girls secrets}^{u''} \rightsquigarrow \\ [u]; [\mathbf{2_atoms}\{u\}]; [\mathbf{unique}\{u\}]; [\text{boy}\{u\}]; \\ [\mathbf{dist}_w([\varepsilon]; [u']; [\mathbf{3_atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\text{girl}\{u'\}]; [u'']; [\text{secret}\{u''\}]; \\ [\text{tell}\{\varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}, \mathbf{Adr}\{u', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}]](u)$$

Consider again an info state H' which must exist for the DRSs in (19) and (20) to be true:

(21)

Info state H'	...	u	u'	u''	ε	...
h'_1	...	b_1	g_1	s_1	e_1^{tell}	...
h'_2	...	b_2	g_2	s_2	e_2^{tell}	...

The conditions on u and u'' are the same for both dialects: the values for u are atomic and different, the values for u'' are subject to a global non-atomicity requirement, derived as a scalar implicature. Moreover, in both dialects each value of u' must be of cardinality three. There is however an important difference: Dialect I allows for the two values of u' to be distinct, while the uniqueness condition associated with the numeral in Dialect II requires for u' to return the same sum individual for both assignments in H' . This means that (20) will be true only if both boys told secrets to the same three girls, i.e. the mixed reading is blocked.

Numerical DPs in Dialect II can only be interpreted distributively if they occur in the scope of strong distributivity operators. But as we have seen, such operators block dependent plural readings. Hence, mixed readings with numerical DPs intervening between a licenser and a dependent plural are predicated to be unavailable

¹The uniqueness condition is also applied to u in Dialect II, but not Dialect I. However, this difference does not influence the truth conditions because according to our definition of truth, the top level input info state must be singleton.

in Dialect II for exactly the same reason that such readings are ruled out in the presence of singular interveners in both dialects.

How and why did this inter-speaker variation with respect to the interpretation of numerals emerge? I can only speculate at this point, but it seems that what may play an important role is the relative scarcity of evidence for either alternative interpretation in the linguistic input of the language learner. Since both strong and weak distributivity operators can be phonologically null and are freely inserted, the existence of distributive readings of numerical DPs in garden variety sentences such as (22) is consistent with both dialects:

(22) All the boys / three boys ate two pizzas.

In order to firmly establish the presence or absence of a uniqueness condition in the semantics of numerals, the learner would have to encounter a very specific, and arguably rare, type of structure, namely one where the numerical DP acts as an intervener between a licenser and a dependent plural, and moreover encounter this structure in a context which would clearly indicate the presence or absence of a mixed reading.

In the absence of such clear evidence the learners appear to follow one of two strategies: either keep the interpretation of numerals as simple as possible, and thus exclude the uniqueness condition (Dialect I), or generalise the semantics of singular to numerals and other cardinal modifiers, and include the uniqueness condition (Dialect II).²

To conclude, the proposed system is able to account for mixed readings with plural interveners which seem especially challenging for previous approaches to dependent plurals. At the same time, it is flexible enough to incorporate the inter-speaker variation that exists in this domain.

²Note that evidence, albeit indirect, for the existence of a uniqueness condition in the semantics of singular is more readily available, since its presence is crucial for the correct calculation of the multiplicity implicature of dependent plural DPs.

5.3 Long-Distance Dependent Plurals

5.3.1 Introduction

Consider sentence (23), taken from a paper in the *Handbook of Social Comparison* (cf. Krueger 2000):

(23) Solipsists believe that only their own minds exist.

On one reading, this sentence may be taken as stating that generally, each solipsist believes that only his or her own mind exists. This is clearly the intended reading. It turns out, however, that this reading is not easy to derive compositionally.

Let us consider what readings can be assigned to (23) given the standard assumptions on plurality and quantification. Assuming that the subject in (23) is interpreted distributively, i.e. (23) is a statement about the beliefs of individual solipsists (cf. the discussion of ‘collective attitudes’ in section 5.3.2.2), two readings for (23) can be obtained, depending on the interpretation of the plural possessive pronoun *their*. If the pronoun is interpreted as referring to the whole group of solipsists, (23) can be read as stating that each solipsist believes that only the minds of solipsists exist. This is indeed a possible interpretation of (23), but clearly not the intended one.

On the other hand, if the pronoun is interpreted as a variable bound by the subject, (23) can be taken to mean that each solipsist believes that only his or her minds exist. This reading implies that each solipsist has more than one mind. Although (23) may indeed be understood as endorsing this unusual assumption, it does not have to be.

There seems to be no way to compositionally obtain the desired reading of (23), namely the one where each solipsist holds a belief about his or her own unique mind. On brief reflection it becomes clear that the problem lies with the plural marking on the noun *minds*. Interpreting this plural marking in the scope of the distributivity operator which ranges over the subject, immediately leads to readings where each

solipsist holds a belief about more than one mind, be it her own multiple minds or the minds of all fellow solipsists. What is required, on the other hand, is a mechanism to establish a co-distributive relation between the matrix subject and the subject of the complement clause.

The issue here is then the same as for dependent plurals in local contexts, except for the fact that the licensor and the dependent in (23) are separated by a finite clause boundary. I will refer to such cases as involving *long-distance dependent plurals* (LDDP). I will show that such dependencies are insensitive to both complement and adjunct clause boundaries. In this respect they are closer to the relation between a pronoun and its binder than to relations which rely on direct predicate application, movement and/or syntactic agreement. In the next few sections I provide a more detailed discussion of some core properties of such constructions.

5.3.2 Long-Distance Dependent Plurals: The Data

5.3.2.1 LDDPs in Attitude Contexts

A core type of constructions involving LDDPs was illustrated in (23) above. Here, the dependent is located within the complement clause of an attitude predicate (in this case, *believe*), while the licensor is an argument of the attitude verb. Similar examples can be easily constructed, and freely occurring examples of this type are relatively common:³

- (24) a. Chicago Mayor Richard Daley and Houston Mayor Bill White were willing to risk delicacies like pizza and barbecue when **they** bet *their teams* would win this year's World Series.⁴

³The availability of dependent plural readings in examples (24a- 24e) was further confirmed by my English-speaking consultants. For convenience, I highlight the licensor in bold and the dependent in italics in the examples taken from corpora and the Internet.

⁴North Texas Daily (Denton, Tex.), Vol. 90, No. 36, Ed. 1 Friday, October 28, 2005.

- b. **Both Managers Johnny Brady and Charley Givens** expressed confidence that *their teams* would win Thursday's game.⁵
- c. **Everyone** loves to claim that *their teams' mascots* are the best on the planet. It's human nature.⁶
- d. In my favourite play of the compilation, **Ginger (Lucy Eaton) and Doris (Melanie Heslop)** watch their daughters Amber and Ashley performing, desperately trying to convince themselves and each other that *their daughters* will win.⁷
- e. I'm laughing at the fact that **everybody** thinks *their countries* are better than everybody else's.⁸

In all these examples the contextually appropriate reading involves a co-distributive relation between a plural DP in the subject position of an attitude or speech predicate and a plural DP within the clausal complement of that predicate. Thus, since only one team can win the World Series in any particular year, sentence (24a) must be understood as stating that each of the two mayors made a bet about *his own team*. Sentence (24b) appears in a similar context, stating that each coach expressed confidence in his own team in advance of an upcoming game between the two teams. Similarly, in (24c) each person is attributed a claim that *her own team's mascot* is the best on the planet, and in (24e) each person is claimed to believe that *her own country* is better than everybody else's. Sentence (24d) is a fragment of a review of a play about a child beauty pageant. In this context, it is most naturally understood as stating that each of the two female characters was trying to convince herself that *her daughter* would win. Finally, in (24e) the speaker is stating that everyone holds a particular belief about his or her own country, namely that it better than everybody else's.

All the examples in (24) involve possessive DPs as dependents. However, LDDP

⁵The Sunday Morning Star (Wilmington, Del.), Aug 1, 1920.

⁶<http://bleacherreport.com/articles/1954666-definitive-ranking-of-the-cutest-dog-mascots>

⁷<http://gingerhibiscus.com/review-win-lose-draw-at-the-waterloo-east-theatre/>

⁸<https://funnyjunk.com/channel/4chan/B+visits+america/oXsfGbK/45>

relations are possible with other types of plurals as well. Consider the following example from an academic paper on political science (Ajzenstat 1992):

- (25) As Fraser argued, the demands were ideologically incompatible. If the NDP had its way, Canada's constitution would reflect socialist principles. If the Liberal proposal or the Group of 22 was successful, the constitution would enshrine the principles of the economic market.

These groups were demanding that *particular modes of distributive justice*, that is, *particular political ideologies*, be given an advantage through clauses inserted in the constitution.

Here, plural DPs *particular modes of distributive justice* and *particular ideologies* occur within the clausal complement of *demand*, and given the context, are most naturally interpreted as introducing referents that co-vary with the atomic sub-referents of the matrix clause subject, *these groups*. I.e., each of the groups was demanding that one particular mode of distributive justice and one particular ideology be given an advantage. Thus, in this case we are dealing with an LDDP construction where the dependent is a plural noun phrase involving *particular*, which enforces a specific interpretation.

Similarly, in appropriate contexts, bare plurals may also function as long-distance dependents. Consider the following following context: A survey was conducted at the stage of the primary contests in a US presidential election, i.e. there are several potential Republican candidates competing for a nomination from their party, and similarly several potential Democratic candidates seeking the nomination from the Democratic Party. In the survey, participants were asked to name one candidate who they think is most likely to end up winning the presidential race. After the survey, a sociologist divided all the respondents into two groups, characterizing the first group as follows:

- (26) In group A we have (all) the respondents who think that Republican candidates will win.

Here, the bare plural *Republican candidates* in the clausal complement of *think* can be interpreted as dependent on the plural DP *(all) the respondents*, i.e. this sentence is appropriate in the above context where each respondent named one candidate.

We may thus conclude that constructions involving LDDP in attitude contexts, like local dependent plurals, are possible with a variety of plural DPs acting as the dependent: possessives, noun phrase involving *certain/particular*, and bare plurals. Crucially, however, co-distributive readings across finite-clause boundaries are not possible if the plural DP in the subordinate clause contains a numeral or a cardinal modifier like *several*. Thus, in (27a) and (27b), plural DPs in the complement clause cannot be interpreted as co-varying with the plural DPs in the main clause (cf. also the discussion of this point in Beck 2000a, Beck and Sauerland 2001):

- (27) a. #Johnny Brady and Charley Givens expressed confidence that their two teams would win Thursday's game.
- b. #The respondents in group A think that six Republican candidates will win the presidential race.

All the examples considered so far involved dependent DPs which were 'specific' in the sense that their reference was established relative to the actual world, and was independent of the alternative possible worlds introduced by the attitude (or speech) predicate. For instance, in (24a) the managers made a bet concerning their teams in the actual world. The identity of these teams does not change across the doxastic alternatives quantified over by *bet*. Similarly, in (26), each respondent is taken to hold a belief about a specific Republican candidate. However, the dependent DP in LDDP constructions can also be non-specific. Consider the following scenario. An annual shooting contest takes place in Tromsø. John took part in the contest in 1985, and Bill took part in it in 1997. Then someone utters:⁹

⁹This particular context is constructed in such a way as to rule out a potential 'collective attitude' reading, cf. the discussion in section 5.3.2.2.

- (28) John and Bill (both) believed that they would be given faulty guns by the organisers.

Sentence (28) is naturally interpreted as stating that John (in 1985) believed that he would be given a faulty gun, and Bill (in 1997) believed that he would be given a faulty gun, i.e. the bare plural *guns* can be interpreted as dependent on the matrix subject DP *they*. Crucially, this reading does not require for John and Bill to hold beliefs about any particular faulty guns. I will refer to such cases as *narrow-scope LDDPs*. Example (28) shows that narrow-scope LDDPs are possible when the dependent is a bare plural noun phrase. Such readings are, however, blocked if the plural DP in the complement clause contains a numeral or a cardinal modifier such as *several*. Thus, sentence (29) cannot be felicitously uttered in the context described above:

- (29) John and Bill believed that they would be given two faulty guns by the organisers.

5.3.2.2 The Issue of ‘Collective Attitude’

I have stated above that co-distributive readings between a plural DP inside the complement clause of an attitude or speech predicate and another plural in the main clause is blocked if the lower DP contains a numeral or a cardinal modifier. This conclusion was supported by the contrast between examples (24b), (26) and (28) on the one hand, and (27a), (27b) and (29), on the other. However, there are examples which appear to contradict it. Thus, Cable (2012) provides the following example. Suppose Dave said that he caught three fish and Bill said that he caught two fish. Then the following sentence can be read as true, according to Cable (2012):

- (30) The boys said that they caught five fish.

Similarly, Cable (2012) reports that sentence (31) will be true in a scenario where Dave wants to own three houses, without having any specific houses in

mind, while John wants to own two houses, without having any specific houses in mind:

(31) Two men want to own five houses.

These examples appear to involve what can be referred to as ‘long-distance cumulativity’, i.e. a cumulative semantic relation between two plural DPs separated by a clausal boundary.¹⁰ Now, I should note that not all my informants accept the cumulative reading of examples like (30) and (31). However, some do, and if we accept, following Cable (2012), that such ‘long-distance cumulative’ readings are indeed possible, we may be tempted, once again, to treat long-distance dependent plural readings described in the previous section as a sub-class of more general long-distance cumulative readings. Nevertheless, I would like to argue against this move. First, I am not aware of any existing analysis that would account for the cumulative readings of examples like (30) and (31), which means that simply saying that long-distance dependent plurals are a sub-class of long-distance cumulative readings does not bring us closer to an actual analysis of the phenomenon involved. Of course, it may be that a unified analysis of examples like (30) and (31) and those involving long-distance dependent plurals is indeed possible, but hasn’t yet been discovered (at least to my knowledge). However, note that such an analysis would not only need to account for cumulative readings of examples like (30) and (31), but also for the absence of such readings in examples like (27a), (27b) and (29), as well as for the contrast between plural DPs that contain numerals and cardinal modifiers and those that do not, as discussed in the previous section.

I think that these points make an analysis of long-distance dependent plurals in terms of ‘long-distance cumulativity’ as exemplified in (30) and (31) rather

¹⁰Note that it would not suffice to analyse these examples as involving a syntactic cumulativity operator, along the lines of Beck (2000a) and Beck and Sauerland (2001), cf. the discussion in section 3.11.2. Such an analysis would require covert movement of the lower plural DP into the main clause. For (30) this is problematic because the lower DP occurs inside a finite complement clause, and finite clauses are commonly assumed to block covert movement of this sort. In (31) the lower DP has an opaque interpretation, which indicates that it must be interpreted inside the complement clause, below the intensional matrix verb. Cf. also the discussion in section 5.3.4.1 below.

implausible, and I will adopt a different approach. Specifically, I would like to propose that long-distance cumulative readings of examples like (30) and (31) arise due to the existence, as least for some speakers, of a certain type of collective interpretation of attitude and speech predicates. Consider the following Hintikkan analysis of attitude predicates as quantifiers over possible worlds (cf. Hintikka 1986 and much subsequent work):¹¹

$$(32) \quad \llbracket A_{att} \rrbracket = \lambda P_{st}. \lambda x_e. \lambda w_s. \forall w'. R_{att}(x)(w)(w') \rightarrow P(w'),$$

where A_{att} is an attitude or speech act predicate and R_{att} is the relevant accessibility relation.

According to this analysis, attitude and speech act predicates combine with a proposition P , encoding the content of attitude/speech, an individual x (the attitude holder/speaker) and a possible world w , and require for P hold of each possible world related to x and w via a certain accessibility relation R_{att} . Thus, *want* would require P to hold of all possible worlds compatible with what x wants in w . Similarly, *say* would require P to hold of all possible worlds compatible with what x says in w .

Given the interpretation in (32), we may ask what happens if the subject of an attitude/speech predicate denotes a non-atomic individual. One possibility is that attitude/speech predicates are lexically distributive with respect to the attitude holder/speaker argument, in a way similar to how verbs like *bark* are lexically distributive with respect to their agent argument. Then, the interpretation of attitude predicates can be represented in the following way:

$$(33) \quad \textit{Attitude predicates (distributive version)}$$

$$\llbracket A_{att} \rrbracket = \lambda P_{st}. \lambda x_e. \lambda w_s. \forall w'. \exists y_e. (\mathbf{atom}(y) \wedge y \leq x \wedge R_{att}(y)(w)(w')) \rightarrow P(w'),$$

¹¹For simplicity, I will present the analysis in this section in terms of a static semantic system with direct interpretation, in lines with Heim and Kratzer (1998) and von Stechow and Heim (2011). However, this proposal can easily be re-stated in terms of the PCDRT analysis of attitude predicates developed in section 5.3.5.1 below.

where A_{att} is an attitude or speech act predicate and R_{att} is the relevant accessibility relation.

This interpretation ensures that if $\llbracket A_{att} \rrbracket(P)(x)(w)$ is true for a proposition P , an individual x and a world w , then $\llbracket A_{att} \rrbracket(P)(y)(w)$ is true for any y which is an atomic part of x . And conversely, if $\llbracket A_{att} \rrbracket(P)(y_1)(w)$ and $\llbracket A_{att} \rrbracket(P)(y_2)(w)$ are true, then $\llbracket A_{att} \rrbracket(P)(y_1 \oplus y_2)(w)$ is also true.

I propose, that speakers who *do not* allow for cumulative readings of examples like (30) and (31) are those for whom attitude and speech predicates are lexically distributive, in the above sense. For these speakers, sentence (30), for instance, will be true if e.g. Dave said that he and Bill caught five fish and Bill said that he and Dave caught five fish. However, it will not be true in the cumulative scenario described above.

Consider now an alternative interpretation of attitude and speech predicates in (34):

(34) *Attitude predicates (intersective version)*

$$\llbracket A_{att} \rrbracket = \lambda P_{st}. \lambda x_e. \lambda w_s. \forall w'. \forall y_e. (\mathbf{atom}(y) \wedge y \leq x \wedge R_{att}(y)(w)(w')) \rightarrow P(w'),$$

where A_{att} is an attitude or speech act predicate and R_{att} is the relevant accessibility relation.

According to this interpretation, $\llbracket A_{att} \rrbracket(P)(x)(w)$ is true for a proposition P , an individual x and a world w iff P is true for each possible world w' accessible via the relevant accessibility relation from w for all the atomic individuals in x , i.e. P must apply to the intersection of the sets of worlds accessible for the atomic individuals in x . For instance, suppose x is a sum of two atomic individuals y_1 and y_2 . Then, $\llbracket say \rrbracket(P)(x)(w)$ will be true if P is true in all the possible worlds compatible both with what y_1 says in w and with what y_2 says in w . Note that attitude and speech predicates interpreted as in (34) are not lexically distributive.¹²

¹²In a system like Landman's (2000), where all basic predicates are lexically distributive with

I propose that the apparent ‘long-distance cumulative readings’ in examples like (30) and (31) are in fact due to the semantics of attitude and speech predicates as in (34). Consider sentence (30). Given the interpretation of attitude and speech predicates in (34), this sentence will have the following interpretation:

$$(35) \quad \forall w'. \forall y_e. (\mathbf{atom}(y) \wedge y \leq \sigma(*boy) \wedge R_{say}(y)(w^*)(w')) \rightarrow \exists z. (*fish(z) \wedge |z| = 5 \wedge *catch_w(\sigma(*boy))(z)),$$

where w^* is the actual world.

Consider now the ‘cumulative’ scenario discussed in Cable 2012. In this scenario the maximal sum of boys $\sigma(*boy)$ consists of two boys – Dave and Bill. Then, according to (35), sentence (30) will be true if in every world compatible with what Dave said and *at the same time* compatible with what Bill said, Dave and Bill cumulatively caught five fish. For instance, this sentence will be true in the situation described in Cable 2012, where Dave said that he caught three fish and Bill said that he caught two fish.

The same analysis can be applied to example (31). If the verb *want* is interpreted intersectively, this sentence will have the following interpretation:

$$(36) \quad \exists x. *man(x) \wedge |x| = 2 \wedge \forall w'. \forall y_e. (\mathbf{atom}(y) \wedge y \leq x \wedge R_{want}(y)(w^*)(w')) \rightarrow \exists z. (*house(z) \wedge |z| = 5 \wedge *own_w(x)(z)),$$

where w^* is the actual world.

On this interpretation, sentence (31) will be true if there are two men such that in every world compatible with what *both* of these men want in the actual world, they cumulatively own five houses. It follows that this sentence will be true in Cable’s (2012) ‘cumulative’ scenario where Dave wants to own three houses and John wants to own two houses.

Note that the cumulative relations between the sum of boys and the sum of fish in (35) and between the sum of men and the sum of houses in (36) are the stan-

respect to all their arguments, the semantics in (34) can be formulated as a meaning postulate which applies when an attitude or speech predicate combines with a subject DP denoting an impure atom, i.e. a group.

dard local cumulative relations, which are accounted for by the cumulativity of the predicates **catch* and **own*. What Cable (2012) described as ‘long-distance cumulativity’ is captured via an intersective interpretation of the speech and attitude predicates, as in (34).

Furthermore, this analysis of ‘long-distance cumulativity’ immediately explains why such readings do not arise in examples like (27a) and (27b), repeated as (37a) and (37b):

- (37) a. #Johnny Brady and Charley Givens expressed confidence that their two teams would win Thursday’s game.
 b. #The respondents in group A think that six Republican candidates will win the presidential race.

On the intersective interpretation of the predicate *express confidence*, sentence (37a) will have the following interpretation:¹³

- (38) $\forall w'. \forall y_e. (\mathbf{atom}(y) \wedge y \leq JR \oplus CG \wedge R_{e.c.}(y)(w^*)(w')) \rightarrow \exists z_1. \exists z_2. (z_1 = \sigma x. (*team(x) \wedge *poss(JR \oplus CG)(x)) \wedge |z_1| = 2 \wedge z_2 = \sigma x. (*game(x) \wedge *on_Thursday(x)) \wedge \mathbf{atom}(z_2) \wedge *win(z_1)(z_2)),$

where w^* is the actual world.

On this interpretation, sentence (37a) will be true if in all possible worlds compatible with what both Johnny Brady and Charley Givens expressed confidence in in the actual world, *both their teams* win Thursday’s game. Given the context and world knowledge, there are no such worlds, and this reading is ruled out as a case of vacuous quantification.

The ‘cumulative’ reading of (37b) is ruled out for the same reason, given that we know that only one candidate can win a presidential race. Quite generally, the proposed analysis predicts that ‘long-distance cumulative’ readings will be possible only if the attitude/speech content associated with the multiple attitude hold-

¹³For simplicity, I treat the cardinality restrictions associated with the definite DPs as part of the assertion. This issue is immaterial to the main point of discussion.

ers/speakers is mutually compatible. As a further illustration of this point, consider the following example:

- (39) The coaches are confident that their four teams are going to win tomorrow.

Suppose there will be a round of games tomorrow, with multiple teams taking part including the teams of the four contextually relevant coaches, and these four teams will not be playing each other. In this context, sentence (39) has a ‘cumulative’ reading on which each of the coaches is confident that his or her team is going to win its game. This is expected on the proposed analysis because the coaches are associated with mutually compatible attitudes. Suppose, on the other hand, that tomorrow’s round will consist of just two games, with each game involving two teams playing against each other. In this context the ‘cumulative’ reading of (39) is not available. Similarly, the ‘cumulative’ reading is ruled out in a context where tomorrow’s round will involve a single game involving four teams playing against each other, with only one possible winner. Again, this is expected, because in these contexts there are no possible worlds compatible with the attitudes of all the four coaches.

Consider now example (29), repeated as (40):

- (40) John and Bill believed that they would be given two faulty guns by the organisers.

Recall the following scenario, discussed in the previous section: An annual shooting contest takes place in Tromsø. John took part in the contest in 1985, and Bill took part in it in 1997. Sentence (44) is not judged true in this scenario, indicating that it lacks a ‘long-distance cumulative’ interpretation. On the intersective interpretation of *believe*, this sentence should be true if in each possible world compatible with what both John and Bill believe in the actual world, they are (cumulatively) given two faulty guns by the organisers. Note that in this case the attitudes of John and Bill are compatible, in the sense that there are contextually

accessible possible worlds where they are both given faulty guns. I believe that the reason that the ‘cumulative’ reading is ruled out in this case has to do with the temporal relation between the events described in the main and the complement clauses, and the grammatical expression of this relation. The future tense of the subordinate predicate requires for the cumulative event of the organisers giving John and Bill two faulty guns to temporally follow the event of them holding the relevant belief. However, in the above context such a sequence of events is ruled out, since the event of Bill holding the belief cannot precede the event of John getting a faulty gun. This account then predicts that the ‘cumulative’ reading of sentence (44) should be possible in a scenario where John and Bill took part in the same context, e.g. in 1985. This appears to be correct. A formal implementation of this account would require a much more involved theory of tense than I have been assuming, so I will not attempt it here for the sake of brevity. I hope that the informal exposition given above is sufficient to convince the reader that a formal account along these lines is plausible.

To conclude this section, I have considered instances of apparent ‘long-distance cumulative’ readings which involve a plural DP functioning as the subject of an attitude or speech predicate and another plural within the complement clause of that predicate. I have argued that these readings can be captured if we assume a non-distributive (intersective) interpretation for attitude and speech predicates, on which the content proposition is applied to each possible world compatible with the attitude/speech of *all* the atomic individuals in the denotation of the subject. Furthermore, I demonstrated that this analysis is able to account for the fact that ‘long-distance cumulative’ readings are not available in a class of examples discussed in section 5.3.2.1. If the analysis proposed in this section is on the right track, so-called ‘long-distance cumulative’ readings can be reduced to local cumulative relations combined with a particular non-distributive lexical semantics for attitude and speech predicates. Note, that this analysis does not account for long-distance dependent plural (LDDP) interpretations discussed in

section 5.3.2.1, which are available in contexts where ‘long-distance cumulative’ readings are blocked. Moreover, as I demonstrate in the next section, LDDPs may occur in adjunct clauses, while cumulative readings of plural DPs separated by an adjunct clause boundary are not available. This is expected if the availability of ‘long-distance cumulative’ readings is indeed dependent on the lexical semantics of attitude and speech predicates.

5.3.2.3 LDDPs in Adjunct Clauses

LDDPs are not restricted to the complements of attitude predicates, but can also occur in adjunct clauses. An example of this sort is briefly discussed in Schwarzschild (1996:114):

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

Schwarzschild (1996) notes that sentence (41a) can be understood as a paraphrase of (41b). Note, that this reading is compatible with a situation where the students received their grades and left in turn, i.e. one student received her grade and left, then a second student received her grade and left, and so on. Schwarzschild (1996) takes this to indicate that the plural pronoun *their* can be interpreted as a bound variable. Note however, that the whole possessive DP *their grades* in (41a) is plural. In other words, we are dealing with a dependent plural interpretation, where a possessive plural DP within a participial adjunct clause is interpreted as dependent on a plural licenser, *the students*, in the main clause. As in the case of LDDPs in complement clauses, the co-distributive interpretation in sentences like (41a) disappears if we replace the dependent DP with a DP containing a numeral:

- (42) The students left the room immediately after receiving their seven grades.

Sentence (42) can only be understood as stating that the group of students as a whole left after they all received their grades. In contrast to (41a), it cannot

be used to describe a situation where one student received her grade and left first, then a second received her grade and left, and so on.

LDDPs can also occur in finite temporal adjuncts, as the following freely occurring examples demonstrate:

- (43) a. **Most sellers** become buyers as soon as *their homes* sell.¹⁴
- b. Fresh plans for preparation for the next World Cup Competition are made by **most associations** as soon as *their teams* are eliminated.¹⁵
- c. **David Moles and Gord Sellar** were both published in Asimov's before they received *their Campbell nominations*.¹⁶
- d. **They** all won a Super Bowl (or two in the case of the Steelers) and all had ongoing success after they won *their league titles*.¹⁷

Sentence (43a) is most naturally understood as stating that it is mostly true that a seller becomes a buyer as soon as her home sells. It does not imply that each of these sellers must have owned more than one home. Similarly, in (43b) the plural DP *their teams* within a finite temporal clause can be interpreted as dependent on the plural quantificational DP *most associations* in the main clause, i.e. each association can be linked to a single team. In fact, given our world knowledge, this is the most natural reading. Sentence (43c) is naturally understood as stating that each of the two authors was published in Asimov's before he received his Campbell nomination, i.e. the possessive plural *their Campbell nominations* inside the *before*-clause can be interpreted as a dependent plural licensed by the conjoined DP *David Moles and Gord Sellar* in the main clause. Note, that the temporal relation expressed by *before* in this sentence can be evaluated separately for each of the two authors. Thus, this sentence is compatible with a situation where e.g. Gord Sellar was published in Asimov's *after* David Moles received his Campbell

¹⁴<http://teamcoon.com/jack-nimble-jack-quick-jack-go-limbo-stick/>

¹⁵FIFA World Cup 1974 Final Competition. Technical Report. http://resources.fifa.com/mm/document/afdeveloping/technicaldevp/50/09/65/wc_74_tr_312.pdf

¹⁶<http://whatever.scalzi.com/2009/12/29/my-war-or-not-with-the-big-three/>

¹⁷<http://bleacherreport.com/articles/505973-chicago-bears-halloween-special-is-head-coach-lovie-smith-a-mind-snatcher>

nomination, as long as Gord Sellar was published in Asimov's *before* he himself received his Campbell nomination. Similarly, in (43d) the plural pronoun *they* in the main clause refers to a set of teams, and the temporal relation expressed by *after* is evaluated separately for each atomic team in this set. Moreover, the DP *their league titles* inside the *after*-clause is naturally interpreted as dependent on *they*, i.e. each team is associated with one or more league titles.

The form of the dependent in adjunct clauses is not restricted to possessive plurals, e.g.:

- (44) a. All of my Sailor Moon cards, stickers, paper stamps and magnets up to now. **Most of them** came as free gifts when I purchased *certain Sailor Moon items* so I'm not sure which series they belong to.¹⁸
- b. We also found that although the occupancy at the time of the recordings was only 8 people in the 'Fishbowl' and 45 in the center area of the Cocktail Lounge, there were a similiar number of sound spikes in both graphs. **These spikes** occurred mainly when *hard surfaces* were struck or when *chairs* were moved.¹⁹
- c. **Both instances** occurred when *consumers* tried to purchase Adderall from *illegal websites* rather than using legitimate distribution channels.²⁰
- d. The article discusses how **most German women** still leave the work force permanently when they start *families*.²¹

Sentence (44a) has an interpretation on which each of the relevant items came as a free gift when the speaker purchased one Sailor Moon item, i.e. the noun phrase *Sailor Moon items* can interpreted as a dependent plural licensed by the plural quantificational DP *most of them*. Similarly, example (44b) can naturally

¹⁸<http://lunazvezda.livejournal.com/28561.html>

¹⁹http://vitalsigns.ced.berkeley.edu/bld/toolkit_studies/A%20Quiet%20Corner%20to%20Read.pdf

²⁰<http://thechart.blogs.cnn.com/2012/05/30/fda-issues-warning-about-counterfeit-adderall-purchased-online/>

²¹<https://andreasmoser.blog/2010/10/03/quotas-for-women-why-only-in-boardrooms/>

be read as stating that each spike occurred when a hard surface or a chair was moved, i.e. the referents of the bare plural noun phrases *hard surfaces* and *chairs* in the temporal adjunct can co-vary with the referent of *these spikes* in the main clause. Next, the discourse in (44c) does not entail that each of the relevant events involved more than one consumer and more than one illegal website. In fact, it is compatible with a situation where each event involved a single person and a single website. This indicates that the bare plurals *consumers* and *illegal websites* in the adjunct clause can be interpreted as dependent on the DP *both instances* in the main clause. Finally, in (44d) the bare plural *families* inside a temporal adjunct clause is most naturally interpreted as a dependent plural licensed by the quantificational DP *most German women* in the main clause, i.e. each relevant woman is associated with a single family that she starts.

Again, the co-distributive interpretation is blocked if the plural DP in the finite adjunct clause involves a numeral. Compare the following sentences:

- (45) a. Most delegates replied as soon as they received letters of invitation from the committee.
- b. Mary and Jane replied as soon as they received two letters of invitation from the committee.

Sentence (45a), which involves a bare plural noun phrase within the temporal adjunct clause, has a co-distributive interpretation on which for each of the relevant delegates the event of her replying immediately followed the event of her receiving a letter of invitation. Sentence, (45b), on the other hand, lacks a co-distributive interpretation. It can only be understood as stating that the event of Mary and Jane replying immediately followed the event of them getting two letters of invitation.²²

²²LDDPs can also occur in conditional clauses, as the following examples illustrate:

- (i) **The three major parties** have committed to huge increases in apprenticeship numbers if *their parties* win the next election.
- (ii) **The mayors of Kansas City, Mo., and San Francisco** may really be betting honorable things like feeding the homeless and reading to children if *their teams* win the World Series.
- (iii) A woman may have started the America's Cup race, but 150 years later very few women

5.3.3 LDDPs and the Multiplicity Condition

Like dependent plurals in local contexts, LDDPs are associated with an overarching Multiplicity Condition, which requires for more than one object referred to by the dependent plural noun phrase to be involved overall. Thus, sentence (24b), repeated here for convenience, cannot be used to describe a situation where both Johnny Brady and Charley Givens are co-managers of the same team:

- (46) Both Managers Johnny Brady and Charley Givens expressed confidence that their teams would win Thursday's game.

Similarly, sentence (25), repeated as (47), can only be true if at least two different modes of distributive justice and two different political ideologies were involved in the demands:

- (47) These groups were demanding that particular modes of distributive justice, that is, particular political ideologies, be given an advantage through clauses inserted in the constitution.

The same condition applies to LDDS in adjunct clauses. Consider sentence (48), a modified version of example (43a):

- (48) All these sellers became buyers as soon as their homes were sold.

This sentence has a dependent plural interpretation, where each of the relevant sellers became a buyer as soon as her home was sold. It does not require the

are involved in this prestigious sailing competition. Among the handful that are, three are from the Bay Area, and **they** will make history this summer if *their teams* win the America's Cup in Valencia, Spain.

- (iv) Most Americans don't have a strong preference over a divided-party government or one-party majority, at least according to a September Gallup poll, which shows only four out of 10 believe it matters a "great deal" who has control of Congress. **Cynics on both sides of the aisle** hint that this may be a fair assessment, arguing that even if *their parties* take the majority, it may not matter.

For the sake of brevity, I will not provide an explicit account of such examples, and restrict my attention to cases of LDDPs in finite complement and temporal adjunct clauses. The analysis of LDDPs in conditional clauses would be parallel to that of LDDPs in attitude complements, presented below, given that both of these constructions involve a quantifier over possible worlds intervening between the licenser and the dependent.

sellers to have each owned more than one home. However, it does entail that more than one home was involved overall, i.e. this sentence will not be judged true in a situation where all the relevant sellers used to share one home.

Let us now consider the application of the Multiplicity Condition in the context of narrow-scope LDDPs in attitude contexts. Take example (28), repeated as (49):

- (49) John and Bill (both) believed that they would be given faulty guns by the organisers.

We are interested in the narrow-scope dependent plural reading of the bare plural *faulty guns* in this example. On this reading, (49) will be judged true if John and Bill both believed: “I will be given a faulty gun by the organisers”. In this case each of the two men stands in a correspondence with *a multiplicity* of faulty guns - i.e. the faulty guns that each of them is given in the various possible worlds compatible with their beliefs in the actual world.²³ The same is true of the corresponding sentence involving a singular indefinite in place of the bare plural:

- (50) John and Bill (both) believed that they would be given a faulty gun by the organisers.

Here too, on the narrow scope reading of the indefinite, John and Bill are both associated with a multitude of faulty guns that they believe they may be given. So the question arises whether there is any semantic effect of the difference in number marking of the indefinites in (49) and (50). In other words, does the Multiplicity Condition apply to the dependent plural DP narrow-scope LDDP constructions like (49), and if it does, how?

In addressing this question I will pursue the following strategy. If the Multiplicity Condition plays no role in the interpretation of narrow-scope dependent plurals, we expect narrow-scope LDDPs to be acceptable in the same set of contexts as the corresponding narrow-scope singular indefinites. On the other hand,

²³I am here assuming a classical Hintikkan analysis of propositional attitudes in terms of quantification over accessible possible worlds, cf. Hintikka 1986 and the discussion in section 5.3.5.1 below.

if the Multiplicity Condition does apply to narrow-scope dependent plurals we expect there to be contexts where narrow-scope singular indefinites are allowed, while narrow-scope dependent plurals are infelicitous. And if we are able to identify such contexts, they will point to the correct formulation of the Multiplicity Condition for narrow-scope LDDPs.

In light of this, consider the following examples:

- (51) a. Most of the participants want to watch a comedy film.
 b. Most of the participants want to watch comedy films.

Sentence (51a) involves a singular indefinite DP *a comedy film* within the complement clause of *want*, while sentence (51b) has a bare plural *comedy films* in the same position. Now consider the following scenario, which I will refer to as “Scenario A”: a researcher is conducting an experiment with a set of participants. Each participant is placed in a separate room in front of a monitor and told that she will be shown a film. Each participant is asked what kind of film she would like to watch. A research assistant records the answers, and reports them to the researcher. Suppose most of the participants said: “I want to watch a comedy film”. Then, both (51a) and (51b) can be truthfully uttered by the assistant when she reports the answers to the researcher.

Now consider a slightly different scenario, which I will call “Scenario B”: a researcher is again conducting an experiment with a set of participants. But now, all the participants are placed together in the same room in front of a single monitor, and told that they will be shown a film together. Each participant is asked what kind of film she would like to watch. A research assistant records the answers, and again, reports them to the researcher. Suppose that, like in the previous scenario, most of the participants said: “I want to watch a comedy film”. In this scenario, sentence (51a) can be truthfully uttered by the assistant when she reports the answers to the researcher. Sentence (51b), on the other hand, cannot.²⁴

²⁴Sentence (51b) may be used to describe a situation where each participant in the room named a specific comedy film, i.e. if the bare plural *comedy films* is interpreted as taking wide scope

Consider another pair of examples:

- (52) a. Ann and Jane both expect to win a nice prizes.
 b. Ann and Jane both expect to win nice prizes.

Consider the following situation ("Scenario C"): A lottery is being held, where several prizes are to be awarded. Both Ann and Jane think: "I will surely win a nice prize". In this context both sentence in (52) will be judged true.

Now suppose that it was announced that only one prize is to be awarded in the lottery, and both Ann and Jane heard the announcement ("Scenario D"). As in the previous scenario, both Ann and Jane think: "I will surely win a nice prize". In this case sentence (52a) can be truthfully uttered, while sentence (52b) is infelicitous.

We now have a contrast between scenarios A and C, on the one hand, and scenarios B and D, on the other. In the former, both singular and plural indefinites are possible, while in the latter plural indefinites are ruled out. How do we explain this contrast?

Let us start with the examples in (51), and the contrast between scenario A and scenario B. In scenario B, the participants know that they will be shown one film together, and express their preferences with respect to that film. This means, that in all the possible world quantified over by the attitude predicate, for all the participants, there is a single film that all the participants watch. In this case the dependent plural is ruled out. On scenario A, on the other hand, there is no such restriction, because the participants are to be shown films separately, and so their "want"-worlds include those where there is more than one comedy film involved. In this case, the dependent plural is felicitous.

The contrast between scenarios C and D for the examples in (52) is similar. In scenario C, both Ann and Jane can in principle win nice prizes, i.e. there are possible worlds consistent with their expectations where each of them wins a nice prize. In this context both the singular and plural indefinite can be used. In

with respect to *want*. In this case the Multiplicity Condition applies in a straightforward way, requiring for more than one comedy film to have been named overall.

scenario D, on the other hand, Ann and Jane know that only one prize will be awarded, and hence there are no possible worlds consistent with their expectations that involve them being awarded multiple prizes. In this context only the singular indefinite can be used.

Finally, consider again example (28) discussed in section 5.3.2.1, repeated as (53):

- (53) John and Bill (both) believed that they would be given faulty guns by the organisers.

Here, the “believe”-worlds of John and Bill include those where they are a both given faulty guns, i.e. more than one gun is involved. Note, that it is not necessary for *all* of these “believe”-worlds to involve more than one faulty gun being given to John and Bill, i.e. there may be possible worlds compatible with John’s beliefs, but incompatible with Bill’s, or in some of these possible worlds they may actually be given the same faulty gun. What is important, is that there are *at least some* “believe”-worlds where John and Bill are given two faulty guns.

The generalisation may be descriptively stated in the following way:

Multiplicity and Narrow-Scope Dependent Plurals

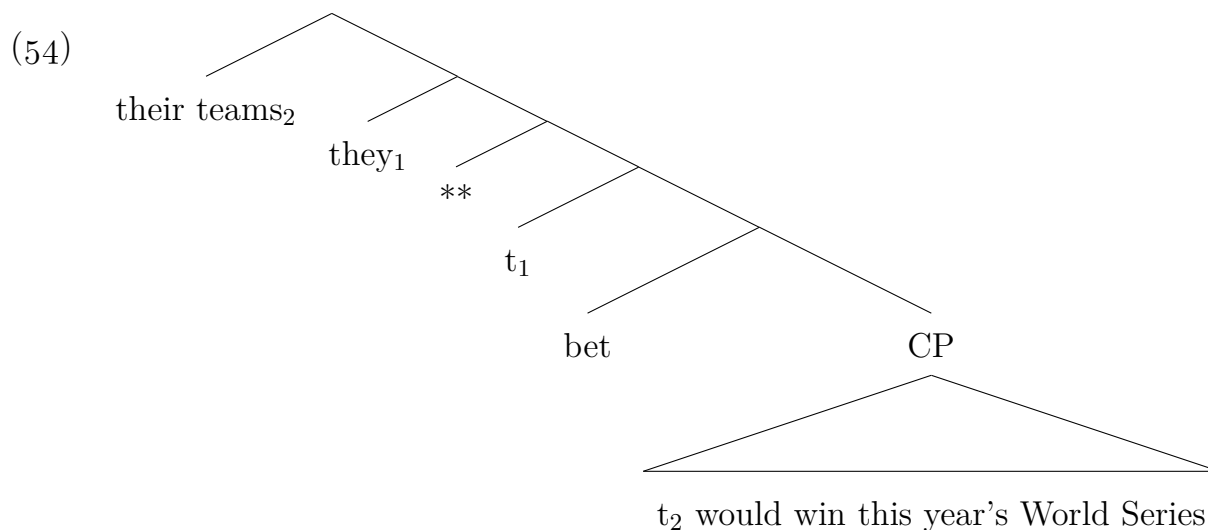
If D is a narrow-scope dependent plural in the complement of an attitude predicate, and L is its licenser, then for at least some of the possible worlds with respect to which D is interpreted there must be more than one of the things referred to by D .

I conclude that the Multiplicity Condition does apply to narrow-scope dependent plurals in propositional attitude contexts, and one of the challenges for an analysis of dependent plurals is to provide a unified account of the Multiplicity Condition in both wide-scope and narrow-scope contexts.

5.3.4 Previous Approaches and LDDPs

5.3.4.1 Mereological Approach and LDDPs

Before presenting an analysis of LDDPs within PCDRT*, I will briefly address the question whether these constructions can be accounted for under previous approaches to dependent plurals. Consider first the mereological approach that takes dependent plural readings to be a sub-type of cumulative readings. Given that long-distance dependent plurals and their licensors are syntactically and semantically related to different predicates, we cannot rely on lexical cumulativity to account for the observed co-distributive readings. The only remaining option is to involve syntactic cumulativity operators, discussed in section 3.11.2 in Chapter 3 (cf. Beck 2000a, Beck and Sauerland 2001). Under this approach, sentences with LDDPs would be analysed as involving a covert ******-operator, inserted in the main clause, which would cumulatively relate the two plural DPs involved in the co-distributive relation. For this analysis to work both plural DPs would need to be covertly quantifier-raised to positions above the cumulativity operator, e.g.:



However, this analysis faces both theoretical and empirical problems. First, the raising of the plural DP from within the complement clause of an attitude predicate violates a well-known generalisation which states that quantifier raising across finite-clause boundaries is blocked, or at least problematic. Thus, in (55) the quantifier cannot take scope over the matrix subject, indicating that it cannot

be covertly raised across the boundary of the finite complement clause:

(55) A coach bet that every team would win this year's World Series.

The same restriction applies to quantifiers in adjunct clauses, accounting for the fact that the DP involving *every* in (56) cannot be interpreted as scoping above the singular indefinite in the main clause:

(56) A student left the room immediately after receiving every grade.

Thus, if we adopt the cumulative analysis we will need to make additional assumptions to explain how dependent DPs are able to covertly raise out of complement and adjunct clauses in constructions involving LDDPs.

Moreover, the analysis illustrated in (54) makes incorrect empirical predictions. First, if this analysis is correct we expect that long-distance cumulative readings should also be available in examples where the lower plural DP contains a numeral. We have seen that this is not the case, cf. examples (27), (29), (42), and (45b). Second, this analysis predicts that the dependent plural DP in LDDP constructions will necessarily take wide scope with respect to the attitude predicate, because as pointed out above, it has to (covertly) move out of the complement clause to combine with the distributivity operator. In fact, narrow-scope readings of long-distance dependent plurals are possible, as illustrated in (28). I think these facts are sufficient to reject the analysis of LDDPs based on syntactic cumulativity operators.

Note that these comments equally apply to Ivlieva's (2013) mixed theory, since it too relies on the mechanism of cumulative predication to account for the co-distributive relation between a dependent plural and its licensor.

5.3.4.2 Distributive Approach and LDDPs

Let us now consider whether the distributivity-based approach to dependent plurals (as proposed by e.g. Kamp and Reyle 1993 and Spector (2003), cf. the discussion in Chapter 2) would be more successful in accounting for LDDP constructions.

Recall that under this approach, plural DPs (the dependents) can have a number-neutral interpretation in the scope of other plurals (the licensors). It turns out that this approach, too, faces difficulties when it comes to LDDPs. The first problem has to do with the issue of locality. Kamp and Reyle (1993) impose an explicit locality restriction on the relation between the dependent and the licensor, taking the domain of locality to be the clause. The existence of long-distance dependent plurals contradicts this assumption.

Spector (2003) does not explicitly address the issue of locality, but given that in his system the relation between the dependent and the licensor is stated in terms of grammatical features, it is natural to expect that this relation should be subject to the locality restrictions typical for syntactic relations in general. Specifically, we would not expect the relation between a dependent plural and its licensor to cross the boundaries of finite complement CPs, and even less so the boundaries of adjunct clauses, which are commonly considered to be islands with respect to syntactic operations. In fact, as we have seen, the relation between a dependent plural and its licensor is not subject to such locality constraints.

A more serious complication for the distributivity-based approaches has to do with the semantics of LDDP constructions. We have seen that in constructions involving a local relation between a dependent plural and its licensor the plural marking on the dependent is associated with an overarching Multiplicity Condition, which is unexpected under the distributive approaches which assume that the dependent is number neutral (cf. the discussion in Chapter 2). The same point applies to LDDPs, which are also associated with an overarching Multiplicity Condition, as we have seen above.

I conclude that both the mereological and the distributive approaches to dependent plurals fail to provide a satisfactory account of LDDPs.

5.3.5 The Proposal

In this section I will present an analysis of constructions involving of long-distance dependent plurals, discussed above. I will begin with LDDPs in attitude complements, which will require us to return to the intensional version of PCDRT* laid out in section 4.7.1. I will then move on to an analysis of LDDPs in temporal adjunct clauses.

5.3.5.1 The Semantics of Attitude Predicates

The analysis of attitude predicates will be framed within the intensional variant of PCDRT* which was introduced in section 4.7.1. Recall that in the intensional system the set of basic types is expanded to include type w for possible worlds and the translations of all lexical items are intensionalised. Following the classical Hintikkan tradition, I will assume that the semantics of attitude predicates involves quantification over the possible worlds compatible with certain aspects of the mental state of the attitude holder. Importantly, I will model this quantification in terms of weak distributivity, in the sense that the relevant set of possible worlds will be encoded as the values a dref within a plural info state which serves as input for the complement DRS. This analysis is parallel to our treatment of modal predicates in section 4.7.2.

The translation for *believe* is the following:

$$(57) \quad \mathbf{believe}^p \rightsquigarrow \lambda \mathbb{P}_{\mathbf{wt}}. \lambda v_e. \lambda \zeta_v. \lambda q_w. \lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{believe}(vj)(\zeta j)(qj)(w)\}) \wedge \exists K_{st}. \mathbb{P}(p)HK),$$

where f is a partial function from the domain of assignments \mathcal{D}_s to the set of info states $\wp(\mathcal{D}_s)$, and $R_{believe}(x)(e)(w)(w')$ is true iff world w' is compatible with what x believes in event e in world w .

Propositional attitude predicates like *believe* take six arguments: a dynamic proposition \mathbb{P} of type \mathbf{wt} , which corresponds to the translation of the complement

clause, a dref v , which encodes the attitude holder, an event dref ζ , which encodes the believing event, a possible world dref q , and the input and output info states, I and J . Moreover, the verb is indexed with a dref over possible worlds, p in (57), which is used to store the possible worlds defined by the accesability relation. I model attitude predicates as tests, i.e. no change is introduced into the output info state as compared to the input. Instead, a new plural info state H is constructed, such that each assignment j in the input/output info state corresponds to a subset of assignments H' in H , for which the dref p stores all the possible worlds that are compatible with what vj , the attitude holder, believes in event ζj in world qj , i.e. the reference world for the *believe* predicate. The proposition \mathbb{P} is then applied to the dref p and the info state H .

To see how this translation works, consider the following simple example:

(58) Mary ^{u} believes ^{p, ε} that John ^{u'} is sleeping ^{ε'} .

Assuming that the complementizer is semantically vacuous, the complement clause will be translated in the following way:

(59) that John ^{u'} is sleeping ^{ε'} $\rightsquigarrow \lambda q_{\mathbf{w}}. [u' \mid u' = John]; [\varepsilon']; [sleep_q\{\varepsilon'\}, \mathbf{Ag}_q\{u', \varepsilon'\}]$

This dynamic proposition together with the matrix subject are combined with the translation of the attitude predicate *believe*, and after the application of event closure we end up with the following proposition:

(60) $\lambda q_{\mathbf{w}}. \lambda I_{st}. \lambda J_{st}. ([\varepsilon]; [u \mid u = Mary])IJ \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{believe}(uj)(\varepsilon j)(qj)(w)\}) \wedge \exists K_{st}. ([u' \mid u' = John]; [\varepsilon']; [sleep_p\{\varepsilon'\}, \mathbf{Ag}_p\{u', \varepsilon'\}])HK)$

This is then combined with the indicative morpheme indexed with the actual world dref, with the translation in (61), resulting in the DRS in (62):

(61) $\mathbf{ind}_{p^*} \rightsquigarrow \mathbb{P}_{\mathbf{wt}}. \mathbb{P}(p^*)$

$$(62) \quad \lambda I_{st}. \lambda J_{st}. ([\varepsilon]; [u \mid u = \text{Mary}])IJ \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{believe}(uj)(\varepsilon j)(p*j)(w)\}) \wedge \exists K_{st}. ([u' \mid u' = \text{John}]; [\varepsilon']; [sleep_p\{\varepsilon'\}, \mathbf{Ag}_p\{u', \varepsilon'\}])HK)$$

Let us analyse the truth conditions for this DRS with respect to a singleton input info state I . The DRS in (62) will be true iff the following conditions hold:

a) There exists an info state J , such that $I[\varepsilon, u]J$, and u returns the individual *mary* for every assignment in J . Since I is a singleton, $I[u]J$ entails that J is also a singleton.

(63)

Info state J , s.t. $I[u]J$	...	ε	u	...
j	...	e_1	<i>mary</i>	...

b) There exists an info state H , such that each assignment j in J is mapped onto a (non-proper) subset of H which stores as values of p all the possible worlds compatible with what uj believes in the event εj in the actual world p^* , and H is the union of such sub-sets. Since J is a singleton, and uj is *mary*, H must store as values of p all the possible worlds compatible with what *mary* believes in e_1 :

(64)

Info state H	...	ε	u	p	...
h_1	...	e_1	<i>mary</i>	w_1	...
h_2	...	e_1	<i>mary</i>	w_2	...
h_3	...	e_1	<i>mary</i>	w_3	...
...

Here $\{w_1, w_2, w_3, \dots\}$ is the set of all possible worlds w such that $R_{believe}(\text{mary})(e_1)(p^*)(w)$.

b) Finally, there exists an info state K , such that $H[\varepsilon', u']K$, and for every assignment k in K , $u'k$ returns *john*, $\varepsilon'k$ is a sleeping event in world pk , and $u'k$ is the agent of $\varepsilon'k$ in world pk :

(65)

Info state K , s.t. $H[u']K$	...	ε	u	p	ε'	u'	...
k_1	...	e_1	<i>mary</i>	w_1	e'_1	<i>john</i>	...
k_2	...	e_1	<i>mary</i>	w_2	e'_2	<i>john</i>	...
k_3	...	e_1	<i>mary</i>	w_3	e'_3	<i>john</i>	...
...	

Since p stores all the possible worlds compatible with Mary's beliefs in the event e_1 in the actual world p^* it follows that (62) will be true iff there is an event of John sleeping in every doxastic alternative to p^* for Mary in the believing event e_1 . We have thus derived (a version of) the classical Hintikkan semantics for *believe*.

5.3.5.2 Possible World Anaphoricity

Before turning to the analysis of long-distance dependent plurals, I would like to take a closer look at the way the semantics of definite DPs may interact with quantification over possible worlds. Percus (2000) observed that definite DPs and verbs display a peculiar contrast with respect to their interpretation in the scope of propositional attitude verbs (and other situation/possible world quantifiers):²⁵²⁶

(66) Mary thinks that my brother is Canadian.

This sentence is ambiguous. On one reading, (66) will be true if in every doxastic alternative to the actual world for Mary, the person who is my brother in the actual world is Canadian in that alternative world. For instance, if I have a brother called Allon, (66) can be taken as stating that Mary thinks that Allon

²⁵Percus (2000) discusses these issues in terms of *situations*, and the *world of situations*. Since our current system does not make use of situations, I will talk about the relevant readings in terms of possible worlds. As far as I can see, this distinction is orthogonal to the main point under discussion.

²⁶Percus (2000) also addresses the semantics of quantificational determiners, which exhibit similar effects in conditionals. I will restrict the discussion to definites, which will be relevant for our analysis of LDDPs, however the system can be easily extended to capture the facts related to quantificational DPs.

is Canadian. This interpretation is compatible with Mary not even knowing that Allon is my brother, or that I indeed have a brother. Thus, on this reading the DP *my brother* is interpreted with respect to the actual world (the ‘transparent reading’), while the predicate *is Canadian* is interpreted with respect to the alternative worlds compatible with Mary’s beliefs in the actual world.

On another reading, (66) will be true if in every doxastic alternative to the actual world for Mary, the person who is my brother *in that alternative world* is Canadian in that alternative world. For instance, suppose Mary erroneously believes that Pierre is my brother. Then, (66) will be judged true if Mary also believes that Pierre is Canadian. In this case both the DP *my brother* and the predicate *is Canadian* are interpreted with respect to Mary’s doxastic alternatives for the actual world (the ‘opaque reading’ of the DP).

Percus (2000) observes that one reading that we do *not* get for (66) is the one where the DP *my brother* is interpreted with respect to Mary’s belief-worlds, while the predicate *is Canadian* is interpreted with respect to the actual world. If such a reading did exist, (66) would be judged true whenever there is an individual who is actually Canadian, and Mary believes that this individual is my brother, even if she erroneously believes that he is *not Canadian*. This reading is clearly absent.

Thus, definite DPs and verbal predicates display an interesting contrast in the scope of attitude predicates: while the world variable associated with a definite DP can be bound either by the attitude predicate or by a higher binder (the **ind** morpheme in our system), the world variable associated with the verb must be bound by the closest binder, i.e. the attitude predicate. Percus (2000) dubs this observation *Generalisation X*.²⁷

To allow for a transparent reading of definite DPs in the scope of attitude predicates, I will assume that definite and possessive determiners are anaphoric to possible world drefs, i.e. these determiners carry an index which refers back to

²⁷Percus’s (2000) actual formulation is the following:

Generalisation X. The situation pronoun that a verb selects for must be coindexed with the nearest λ above it.

a previously introduced dref over possible worlds. This dref is then used as the reference world for the restrictor predicate the determiner combines with. The relevant translations are as follows:

$$(67) \quad \begin{array}{l} \text{a. } \mathbf{the}_p^u \rightsquigarrow \lambda P_{\mathbf{e}(\mathbf{wt})} \cdot \lambda P'_{\mathbf{e}(\mathbf{wt})} \cdot \lambda q_w \cdot \mathbf{max}^u(P(u)(p)); P'(u)(q) \\ \text{b. } \mathbf{'s}_p^u \rightsquigarrow \\ \lambda P_{\mathbf{e}(\mathbf{wt})} \cdot \lambda Q_{(\mathbf{e}(\mathbf{wt}))(\mathbf{wt})} \cdot \lambda P'_{\mathbf{e}(\mathbf{wt})} \cdot \lambda q_w \cdot \mathbf{max}^u(Q(\lambda v. \lambda q'. [Poss\{v, u, q'\}]))(p); P(u)(p)); \\ P'(u)(q) \end{array}$$

The definite determiner takes two intensionalised predicates of type $\mathbf{e}(\mathbf{wt})$ as arguments, and returns a dynamic proposition of type \mathbf{wt} . Crucially, the restrictor predicate is interpreted with respect to the possible world dref that the determiner is indexed with, p in (67a), while the nuclear scope predicate is applied to the possible world variable that represents the argument of the resulting proposition, q . It is the latter variable that will be bound by an attitude predicate if it takes the resulting proposition as argument.

The analysis of the possessive determiner is similar. It combines with an intensionalised predicate of type $\mathbf{e}(\mathbf{st})$, which corresponds to the restrictor, an intensionalised DP translation of type $(\mathbf{e}(\mathbf{wt}))(\mathbf{wt})$, corresponding to the possessor DP, and another intensionalised predicate of type $\mathbf{e}(\mathbf{wt})$, corresponding to the nuclear scope constituent, and returns a proposition of type \mathbf{wt} . In this case, both the possession relation introduced in the translation of the determiner, and the restrictor predicate are interpreted with respect to the possible world dref that the determiner is indexed with. On the other hand, the nuclear scope predicate is applied to the possible world dref which must be bound by a higher binder, e.g. the **ind** morpheme or an attitude predicate.

The following two indexing configurations capture the two readings of (66) discussed above:

$$(68) \quad \begin{array}{l} \text{a. Mary thinks}^p \text{ that my}_{p^*} \text{ brother is Canadian.} \\ \text{b. Mary thinks}^p \text{ that my}_p \text{ brother is Canadian.} \end{array}$$

The transparent reading of the DP obtains when its determiner is indexed with the actual world $dref\ p^*$, which by assumption is always accessible in the input info state, as in (68a). In this case the predicate *my brother* will be evaluated with respect to the actual world. The opaque reading, on the other hand, arises if the determiner is indexed with the possible world $dref$ introduced by the attitude predicate, p in (68b). In this case *my brother* will be evaluated with respect to all the alternative values for p that correspond to Mary's doxastic alternatives for the actual world.

5.3.5.3 Wide-Scope Dependent Plurals

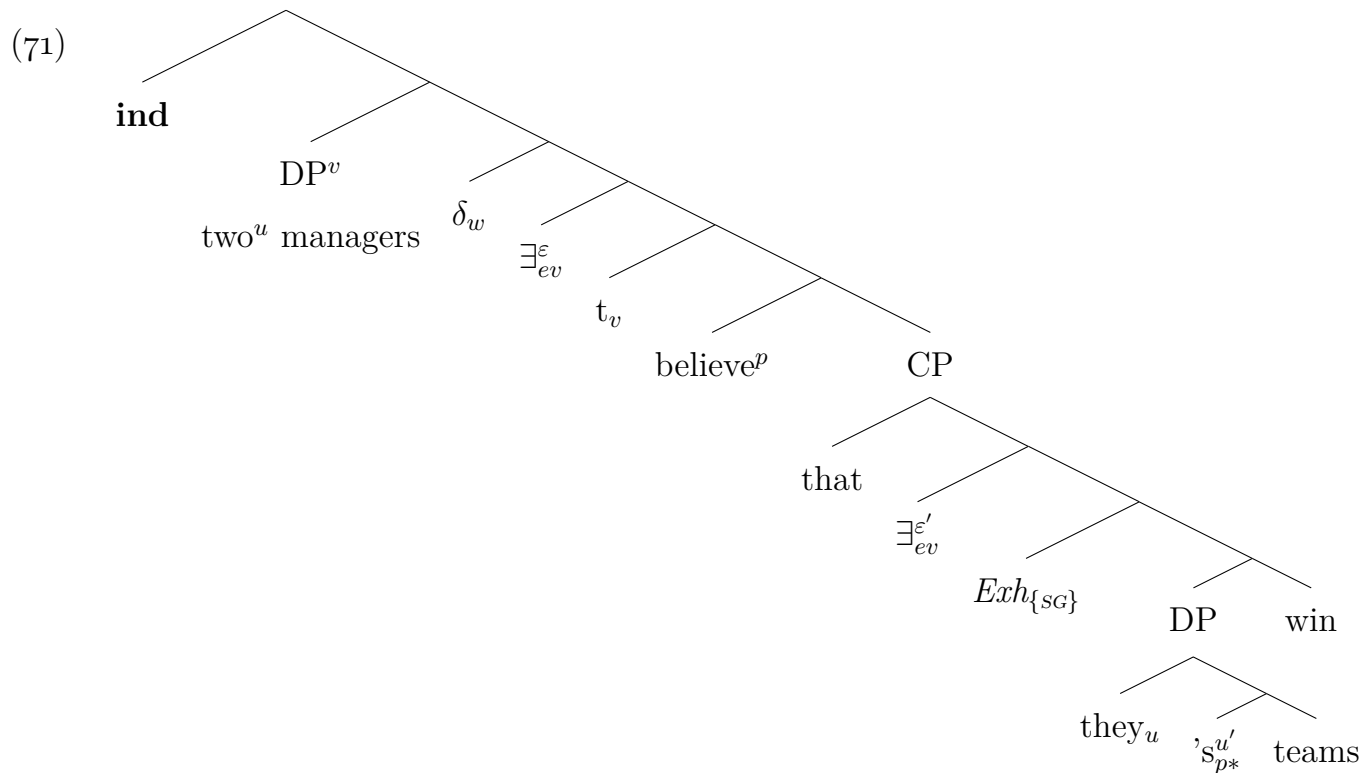
Consider now sentence (69), on the dependent plural reading:

(69) Two managers believe that their their teams are going to win.

Before we can perform a compositional translation of (69) we need to establish the indexing:

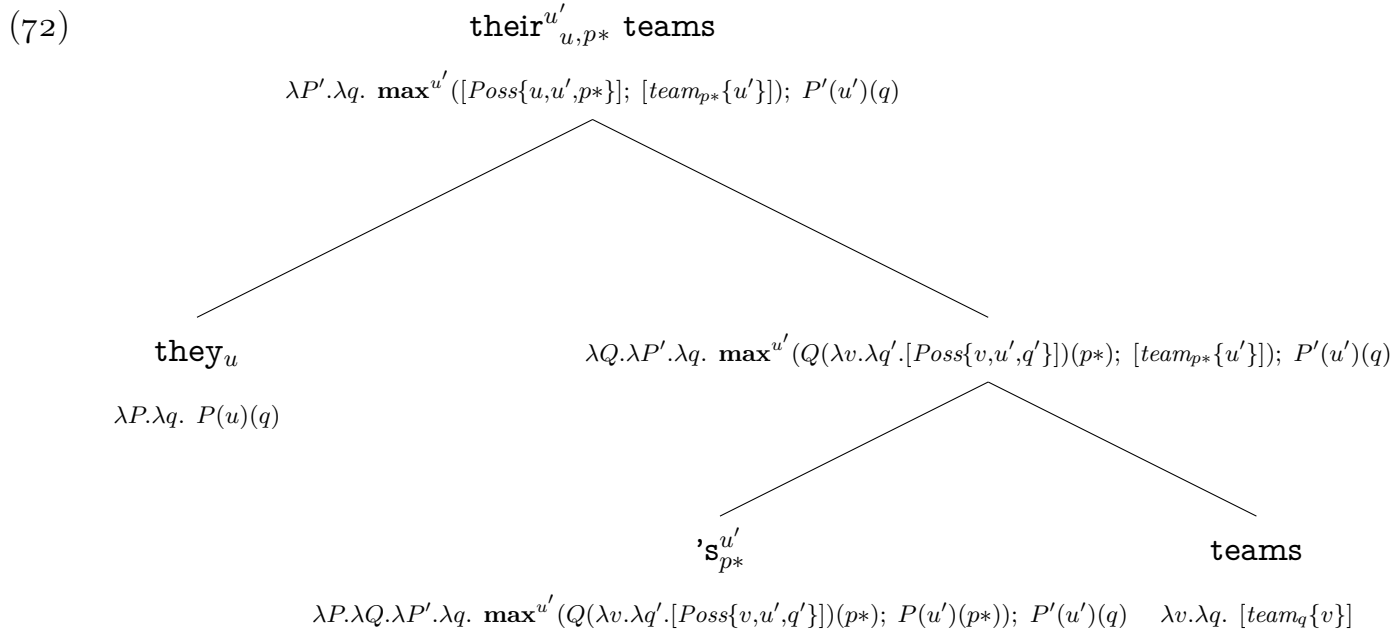
(70) Two ^{u} managers believe ^{p, ε} that their ^{u', p^*} teams are going to win ^{ε'} .

As before, the dependent plural reading will arise if we assume that this sentence involves a weak distributivity operator inserted below the licenser, in this case the main clause subject. The (greatly simplified) syntactic structure that I will assume for (70) is the following:



Note that the determiner of the DP *their teams* is indexed with the actual world dref p^* , not the dref introduced by the attitude predicate, i.e. p . This is meant to capture the fact that each manager holds a belief about the object that is her team in the actual world. Recall also that we analyse possessive pronouns as the surface realisation of the combination of pronouns with the possessive determiner, which is spelled-out in the structure in (71).

Consider first the translation of the complement clause. The complement clause subject is translated as follows:



Combining this translation with that of the complement predicate in (71), we arrive at the following intensionalised event predicate:

$$(73) \quad \lambda \zeta_v.\lambda q_w. \mathbf{max}^{u'}([\text{Poss}\{u,u',p^*\}]; [\text{team}_{p^*}\{u'\}]); [\text{win}_q\{\zeta\}, \mathbf{Ag}_q\{u',\zeta\}] \\ := \lambda \zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. \mathbf{max}^{u'}([\text{Poss}\{u,u',p^*\}]; [\text{team}_{p^*}\{u'\}])IJ \wedge \text{win}_q\{\zeta\}J \wedge \\ \mathbf{Ag}_q\{u',\zeta\}J$$

At this point the exhaustification operator applies, yielding the following strengthened event predicate (cf. section 3.10.2 in Chapter 3 for a detailed discussion of how exhaustification applies to definite plurals):

$$(74) \quad \lambda \zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. \mathbf{max}^{u'}([\text{Poss}\{u,u',p^*\}]; [\text{team}_{p^*}\{u'\}])IJ \wedge \text{win}_q\{\zeta\}J \wedge \\ \mathbf{Ag}_q\{u',\zeta\}J \wedge \neg \mathbf{max}^{u'}([\text{Poss}\{u,u',p^*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p^*}\{u'\}]; [\text{team}_{p^*}\{u'\}])IJ$$

After the application of the event closure operator we arrive at the following proposition as the translation of the complement clause in (71), assuming that the complementizer is semantically vacuous:

$$(75) \quad \lambda q_w.\lambda I_{st}.\lambda J_{st}.\exists K_{st}. I[\varepsilon']K \wedge \mathbf{max}^{u'}([\text{Poss}\{u,u',p^*\}]; [\text{team}_{p^*}\{u'\}])KJ \wedge \\ \text{win}_q\{\varepsilon'\}J \wedge \mathbf{Ag}_q\{u',\varepsilon'\}J \wedge \\ \neg \mathbf{max}^{u'}([\text{Poss}\{u,u',p^*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p^*}\{u'\}]; [\text{team}_{p^*}\{u'\}])KJ$$

To understand this translation better, take sentence (76):

$$(76) \quad \text{Their}_{u,p^*}^{u'} \text{ teams won}_{\varepsilon'}.$$

Its translation would be the proposition in (75) combined with the translation of the indicative morpheme as given in (61), i.e.:

$$(77) \quad \lambda I_{st}. \lambda J_{st}. \exists K_{st}. I[\varepsilon'] K \wedge \mathbf{max}^{u'}([Poss\{u, u', p^*\}]; [team_{p^*}\{u'\}]) K J \wedge win_{p^*}\{\varepsilon'\} J \wedge \\ \mathbf{Ag}_{p^*}\{u', \varepsilon'\} J \wedge \\ \neg \mathbf{max}^{u'}([Poss\{u, u', p^*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p^*}\{u'\}]; [team_{p^*}\{u'\}]) K J$$

This DRS will be true with respect to a singleton input info state I iff there exists a singleton output info state J , which differs from I at most with respect to the values of ε' and u' , and a number of conditions hold. First, $u'j$ is the maximal sum of teams in the actual world p^* such that they stand in a possessive relation with the sum of individuals uj (the referent of the possessive pronoun *their*) in p^* . Next, $\varepsilon'j$ is a winning event in p^* whose agent in p^* is the sum of teams $u'j$. Finally, it must not be the case that $u'j$ is the maximal atomic sum of teams in p^* that stands in a possessive relation with uj in p^* , i.e. it must not be the case that the sum of individuals uj possess a single team. Given our set of Axioms, and specifically Axiom 4 which ensure that we can find an appropriate assignment to relate any individual to any dref, it follows that the DRS in (77) will true if there exists a maximal sum of teams in the actual world that the referents of *their* possess, this sum is non-atomic, and this sum of teams won in the actual world.

Going back to the structure in (71), our next step is to combine the proposition in (75) with the translation of the attitude predicate in (57). This results in the following term:

$$(78) \quad \lambda v_e. \lambda \zeta_v. \lambda q_w. \lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \\ \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge \\ pH' = \{w : R_{believe}(vj)(\zeta j)(qj)(w)\}) \wedge \exists K_{st}. \exists K'_{st}. (H[\varepsilon']K' \wedge \\ \mathbf{max}^{u'}([Poss\{u, u', p^*\}]; [team_{p^*}\{u'\}]) K' K \wedge win_p\{\varepsilon'\} K \wedge \mathbf{Th}_p\{u', \varepsilon'\} K \wedge$$

$$\neg \mathbf{max}^{u'}([\mathit{Poss}\{u, u', p*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p*}\{u'\}]; [\mathit{team}_{p*}\{u'\}])K'K))$$

This predicate is then combined with the subject trace and the event closure operator to yield the following proposition:

$$(79) \quad \lambda q_{\mathbf{w}}.\lambda I_{st}.\lambda J_{st}. I[\varepsilon]J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \\ \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{believe}(vj)(\varepsilon j)(qj)(w)\}) \wedge \\ \exists K_{st}.\exists K'_{st}. (H[\varepsilon']K' \wedge \mathbf{max}^{u'}([\mathit{Poss}\{u, u', p*\}]; [\mathit{team}_{p*}\{u'\}])K'K \wedge \mathit{win}_p\{\varepsilon'\}K \wedge \\ \mathbf{Th}_p\{u', \varepsilon'\}K \wedge \\ \neg \mathbf{max}^{u'}([\mathit{Poss}\{u, u', p*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p*}\{u'\}]; [\mathit{team}_{p*}\{u'\}])K'K))$$

Next, we need to combine this proposition with the weak distributivity operator and the raised subject. Intensionalised translations of the distributivity operators are as follows:

$$(80) \quad \text{a. } \delta_w, \text{ all } \rightsquigarrow \lambda P_{\mathbf{e}(\mathbf{wt})}.\lambda v_{\mathbf{e}}.\lambda q_{\mathbf{w}}. [\mathbf{dist}_w(P(v)(q))(v)] \\ := \lambda P_{\mathbf{e}(\mathbf{wt})}.\lambda v_{\mathbf{e}}.\lambda q_{\mathbf{w}}.\lambda I_{st}.\lambda J_{st}. I = J \wedge \exists H_{st}. [J\langle v \rangle H \wedge \exists H'_{st}. (P(v)(q))HH'] \\ \text{b. } \delta_s, \text{ each } \rightsquigarrow \lambda P_{\mathbf{e}(\mathbf{wt})}.\lambda v_{\mathbf{e}}.\lambda q_{\mathbf{w}}. [\mathbf{dist}_s(P(v)(q))(v)] \\ := \lambda P_{\mathbf{e}(\mathbf{wt})}.\lambda v_{\mathbf{e}}.\lambda q_{\mathbf{w}}.\lambda I_{st}.\lambda J_{st}. I = J \wedge \exists H_{st}. [J\langle v \rangle H \wedge \exists H'_{st}. (\mathbf{dist}(P(v)(q)))HH']$$

Combining the proposition in (79) with the translation of the weak distributivity operator and the raised subject via the Distributive Quantifying-In rule yields the following proposition:

$$\begin{aligned}
(81) \quad & \lambda q_w. \lambda I_{st}. \lambda J_{st}. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge manager_q\{u\}J \wedge \exists L_{st}. [J\langle u \rangle L \wedge \\
& \exists L'_{st}. L[\varepsilon]L' \wedge \exists H_{st}. \exists f_{s(st)}. (L' = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall l'_s. \forall H'_{st}. (f(l') = \\
& H' \rightarrow \forall h'_s \in H'. (l'[p]h') \wedge pH' = \{w : R_{believe}(ul')(\varepsilon l')(ql')(w)\}) \wedge \\
& \exists K_{st}. \exists K'_{st}. (H[\varepsilon']K' \wedge \mathbf{max}^u([Poss\{u, u', p*\}]; [team_{p*}\{u'\}])K'K \wedge win_p\{\varepsilon'\}K \wedge \\
& \mathbf{Th}_p\{u', \varepsilon'\}K \wedge \\
& \neg \mathbf{max}^u([Poss\{u, u', p*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p*}\{u'\}]; [team_{p*}\{u'\}])K'K))]
\end{aligned}$$

Finally, combining this proposition with the indicative morpheme yields the following DRS as the translation of (71):

$$\begin{aligned}
(82) \quad & \lambda I_{st}. \lambda J_{st}. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge manager_{p*}\{u\}J \wedge \exists L_{st}. [J\langle u \rangle L \wedge \\
& \exists L'_{st}. L[\varepsilon]L' \wedge \exists H_{st}. \exists f_{s(st)}. (L' = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall l'_s. \forall H'_{st}. (f(l') = \\
& H' \rightarrow \forall h'_s \in H'. (l'[p]h') \wedge pH' = \{w : R_{believe}(ul')(\varepsilon l')(p * l')(w)\}) \wedge \\
& \exists K_{st}. \exists K'_{st}. (H[\varepsilon']K' \wedge \mathbf{max}^u([Poss\{u, u', p*\}]; [team_{p*}\{u'\}])K'K \wedge win_p\{\varepsilon'\}K \wedge \\
& \mathbf{Th}_p\{u', \varepsilon'\}K \wedge \\
& \neg \mathbf{max}^u([Poss\{u, u', p*\}]; [\mathbf{atom}\{u'\}]; [\mathbf{unique}_{p*}\{u'\}]; [team_{p*}\{u'\}])K'K))]
\end{aligned}$$

Let us analyse the truth conditions of this DRS in detail. As always, we evaluate this DRS with respect to a singleton input info state I . First, we introduce the dref corresponding to the main clause subject, i.e. the output info state $J = \{j\}$ must be such that it differs from I at most with respect to the values of u , and uj returns a sum of individuals of cardinality two who are managers in the actual world, $w*$:

(83)

Info state J , s.t. $I[u]J$	...	$p*$	u	...
j	...	$w*$	$m_1 \oplus m_2$	...

Next, we introduce a new info state L , where the atomic sub-individuals in uj are split as values of u for the assignments in L

(84)

Info state L	...	p^*	u	...
l_1	...	w^*	m_1	...
l_2	...	w^*	m_2	...

Then we introduce the event dref ε , which encodes the believing events:

(85)

Info state L'	...	p^*	u	ε	...
l'_1	...	w^*	m_1	e_1	...
l'_2	...	w^*	m_2	e_2	...

The next step is to introduce an info state H such that each assignment l' in L' corresponds to a subset of assignments H' in H , such that each h' in H' differs from l' at most with respect to the value of the possible worlds dref p , and the set of values of p for H' is the set of doxastic alternatives for ul' in event $\varepsilon l'$ in the actual world:

(86)

Info state H	...	p^*	u	ε	p	...
h_1	...	w^*	m_1	e_1	w_1	...
h_2	...	w^*	m_1	e_1	w_2	...
...
h'_1	...	w^*	m_2	e_2	w'_1	...
h'_2	...	w^*	m_2	e_2	w'_2	...
...

Here, the set of possible worlds $\{w_1, w_2, \dots\}$ represents the set of doxastic alternatives that manager m_1 has in event e_1 in the actual world, while the set of possible worlds $\{w'_1, w'_2, \dots\}$ represents the set of doxastic alternatives that manager m_2 has in event e_2 in the actual world.

The next step is to introduce the event dref ε' , encoding the winning events. This is done by postulating the existence of another info state, K' , which differs from H at most with respect to the values for ε' :

(87)

Info state K'	...	p^*	u	ε	p	ε'	...
k'_1	...	w^*	m_1	e_1	w_1	e'_1	...
k'_2	...	w^*	m_1	e_1	w_2	e'_2	...
...
k''_1	...	w^*	m_2	e_2	w'_1	e''_1	...
k''_2	...	w^*	m_2	e_2	w'_2	e''_2	...
...

Finally, we introduce an info state K , which differs from K' at most with respect to the values of u' , and for each k in K , $u'k$ returns the maximal sum of teams possessively related to the individual uk in the actual world w^* , εk is a winning event in world pk , and the sum of teams $u'k$ is the agent of εk in world pk . Furthermore, it is not the case that u' returns the same atomic individual for all the assignments in K .²⁸

²⁸Given the definition of intensionalised uniqueness discussed in section 4.7.1, the values of u' must either be non-atomic for some assignments in K , or u' must return different values for some assignments k_1 and k_2 in K , where $p^*k_1 = p^*k_2$. Since p^* returns the same value, the actual world w^* , for any assignment, it follows that either some values of u' for the assignments in K are non-atomic, or u' returns different values for some assignments in K .

(88)

Info state K	...	p^*	u	ε	p	ε'	u'	...
k_1	...	w^*	m_1	e_1	w_1	e'_1	t_1	...
k_2	...	w^*	m_1	e_1	w_2	e'_2	t_1	...
...
k'_1	...	w^*	m_2	e_2	w'_1	e''_1	t_2	...
k'_2	...	w^*	m_2	e_2	w'_2	e''_2	t_2	...
...

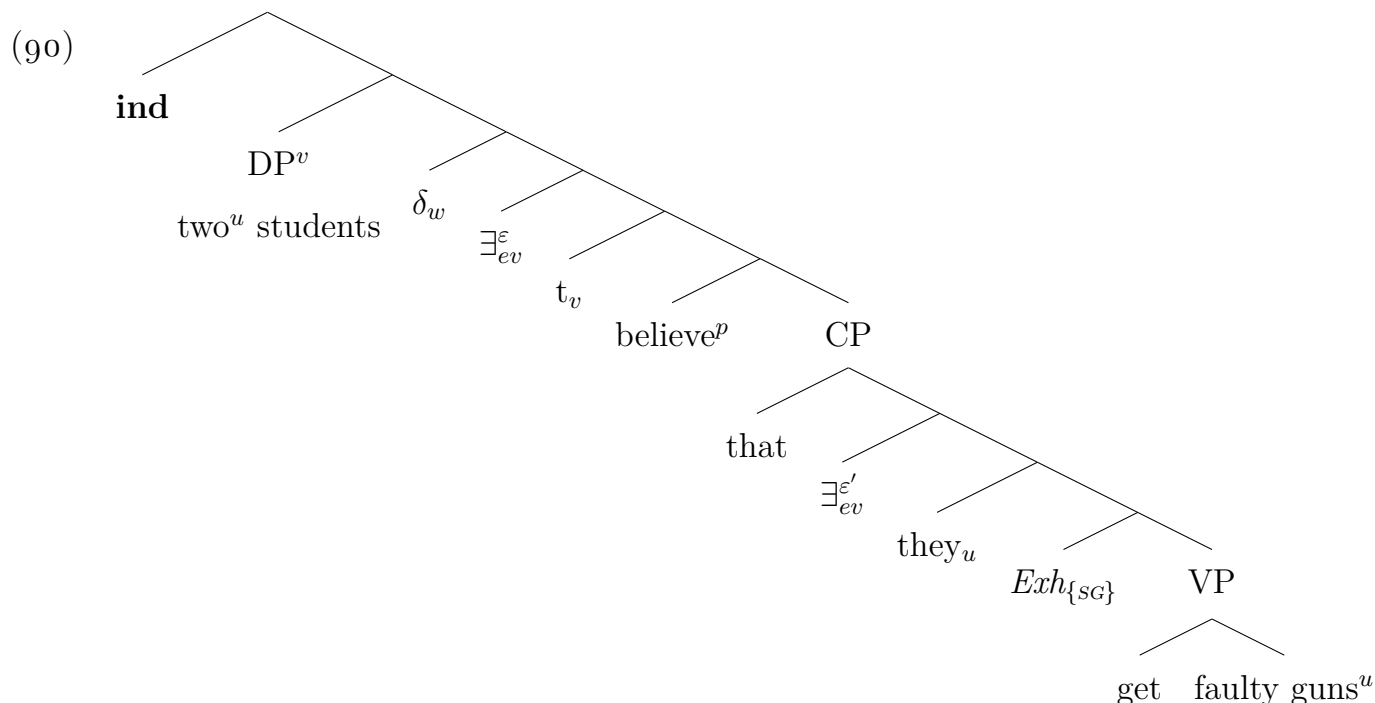
Postulating the existence of info state K which conforms to the conditions stated above is equivalent to saying that there exist two managers in the actual world w^* , m_1 and m_2 , and two events e_1 and e_2 such that in all the possible worlds which are doxastic alternatives for m_1 in event e_1 in the actual world, there is a winning event whose agent is the maximal sum of teams t_1 that stands in a possessive relation with m_1 in the actual world. And similarly, in all the possible worlds which are doxastic alternatives for m_2 in event e_2 in the actual world, there is a winning event whose agent is the maximal sum of teams t_2 that stands in a possessive relation with m_2 in the actual world. Moreover, it must not be the case that t_1 and t_2 are both atomic and identical, i.e. more than one team must be involved overall. These truth conditions capture the long-distance dependent plural reading of sentence (69).

5.3.5.4 Narrow-Scope Dependent Plurals

Let us now turn to narrow-scope LDDPs in attitude contexts. I will demonstrate that the system developed here is able to derive adequate truth-conditions for these constructions. Take example (89), which is a simplified version of example (50), discussed above:

(89) Two students believed that they would get faulty guns.

Here, again, the dependent plural interpretation arises in the presence of a weak distributivity operator inserted below the licenser. Thus, I will assume the following simplified syntactic structure for (89), omitting e.g. the tense morphemes:



The translation of this structure differs from that in (71) in one crucial respect: while in (71) the possessive plural in the complement clause was indexed with the actual world dref, the bare plural indefinite in (90) will be interpreted relative to the possible worlds introduced by the attitude predicate.

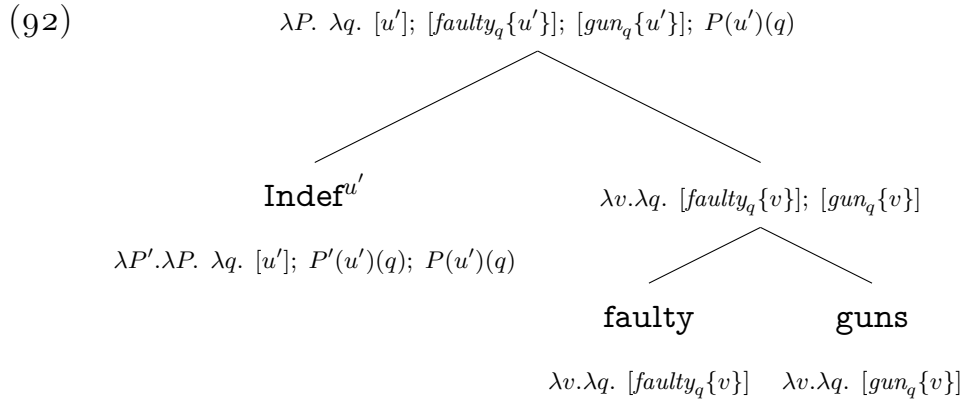
Consider first the interpretation of the bare plural direct object in the complement clause. I have been assuming that bare plurals involve a silent indefinite determiner, *Indef*.²⁹ The intensionalised translation of this determiner was given in section 4.7.1, and is repeated in (91):

$$(91) \quad \text{Indef}^u \rightsquigarrow \lambda P'_{\mathbf{e}(\mathbf{wt})} \cdot \lambda P_{\mathbf{e}(\mathbf{wt})} \cdot \lambda q_{\mathbf{w}} \cdot [u]; P'(u)(q); P(u)(q)$$

Unlike the definite article and the possessive determiner, *Indef* does not carry a possible world index, and thus the possible world arguments of both its restrictor and nuclear scope predicates will be bound by the closest binder:³⁰

²⁹Cf. section 5.4.3 of this chapter, where I modify this assumption. Importantly, however, the proposed modification will not impact the main points discussed in this section.

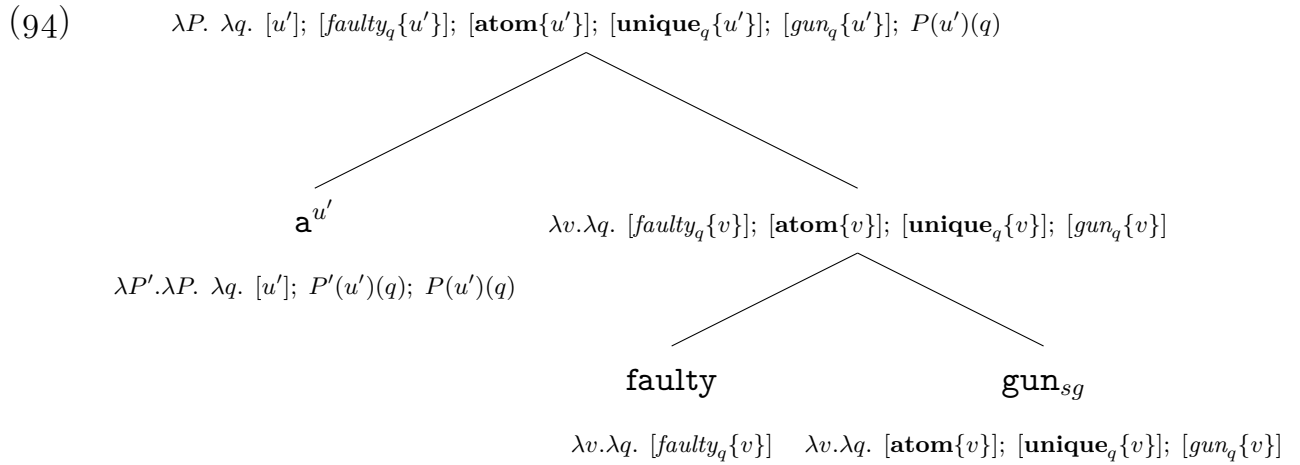
³⁰The system would need to be expanded to account for wide- and intermediate-scope readings



The translation of the complement clause proceeds along familiar lines, and yields the following proposition:

$$(93) \quad \lambda q_w. \lambda I_{st}. \lambda J_{st}. I[\varepsilon', u']J \wedge faulty_q\{u'\}J \wedge gun_q\{u'\}J \wedge get_q\{\varepsilon'\}J \wedge \mathbf{Th}_q\{u', \varepsilon'\}J \wedge \mathbf{Ag}_q\{u, \varepsilon'\}J \wedge (\neg \mathbf{atom}\{u'\}J \vee \neg \mathbf{unique}_q\{u'\}J)$$

Note that the non-atomicity/non-uniqueness condition in (93) is added when the exhaustification operator applies to the VP, and is derived via negation of the stronger alternative involving a singular indefinite with the following translation:



The proposition in (93) is then combined with the attitude predicate, and after that the translation proceeds along the same lines as already discussed in the previous section. At the end we arrive at the following DRS as the translation of (90):

of indefinites, cf. Abusch (1994), Reinhart (1997), Winter (1997), Schwarzschild (2002), a.o. One way to do this would be to allow determiners translated as skolemised choice functions, following the proposal in Kratzer (1998). I will leave the implementation of this approach in PCDRT* for the future.

$$(95) \quad \lambda I_{st}.\lambda J_{st}. I[u]J \wedge \mathbf{2_atoms}\{u\}J \wedge student_{p*}\{u\}J \wedge \exists L_{st}. [J\langle u \rangle L \wedge \exists L'_{st}. L[\varepsilon]L' \wedge \exists H_{st}.\exists f_{s(st)}. (L' = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall l'_s.\forall H'_{st}. (f(l') = H' \rightarrow \forall h'_s \in H'. (l'[p]h') \wedge pH' = \{w : R_{believe}(ul')(\varepsilon l')(p * l')(w) \}) \wedge \exists K_{st}. (H[\varepsilon', u']K \wedge faulty_p\{u'\}K \wedge gun_p\{u'\}K \wedge get_p\{\varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge (\neg \mathbf{atom}\{u'\}K \vee \neg \mathbf{unique}_p\{u'\}K)))]$$

If we analyse the truth conditions of this DRS in the same way as we analysed the truth conditions of (82) in the previous section, we will end up with an info-state of the following form:

$$(96)$$

Info state K	...	$p*$	u	ε	p	ε'	u'	...
k_1	...	$w*$	s_1	e_1	w_1	e'_1	g_1	...
k_2	...	$w*$	s_1	e_1	w_2	e'_2	g_2	...
...
k'_1	...	$w*$	s_2	e_2	w'_1	e''_1	g'_1	...
k'_2	...	$w*$	s_2	e_2	w'_2	e''_2	g'_2	...
...

Here, s_1 and s_2 are atomic individuals, who are students in the actual world $w*$. The set of possible worlds $\{w_1, w_2, \dots\}$ represents the set of doxastic alternatives that student s_1 has in event e_1 in the actual world. Similarly, the set of possible worlds $\{w'_1, w'_2, \dots\}$ represents the set of doxastic alternatives that student s_2 has in event e_2 in the actual world. Moreover, for each $k \in K$, $u'k$ (i.e. $g_1, g_2, \dots, g'_1, g'_2, \dots$) is a (possibly atomic) sum of faulty guns in world pk , εk (i.e. $e'_1, e'_2, \dots, e''_1, e''_2, \dots$) is a getting event in pk , whose theme is $u'k$ and whose agent is uk (i.e. s_1 or s_2). Moreover, it must be the case that either the value of u' is non-atomic for some assignment in K , or there exist at least two assignments k_m and k_n in K , such that $pk_m = pk_n$ and $u'k_m \neq u'k_n$. The latter disjunct follows from the definition of intensionalised uniqueness, repeated in (97), and the fact that the (non-)uniqueness condition in (95) is evaluated with respect to p :

$$(97) \quad \mathbf{unique}_p\{u\} := \lambda I_{st}. \forall i, i' \in I. (pi = pi' \rightarrow ui = ui')$$

Given our axioms, an info state K satisfying the conditions listed above exists in a model M iff there exist two atomic individuals s_1 and s_2 who are students in the actual world and two events e_1 and e_2 in the actual world, such that the following conditions hold:

a) for every doxastic alternative w that s_1 has in e_1 there exists a (possibly atomic) sum of individuals g which are faulty guns in w , and an event e' , which is a getting event in w and whose agent is s_1 and whose theme is a g ;

b) for every doxastic alternative w for s_2 in e_2 there exists a (possibly atomic) sum of individuals g which are faulty guns in w and an event e' which is a getting event in w and whose agent is s_2 and whose theme is a g ;

c) either one of the sums of faulty guns g in (a) or (b) is non-atomic, or there is a possible world w which is in the set of doxastic alternatives that s_1 has in e_1 and in the set of doxastic alternatives that s_2 has in e_2 , and there exist two distinct sums of faulty guns g_1 and g_2 in w such that s_1 gets g_1 and s_2 gets g_2 in w .

Conditions (a) and (b) are compatible with each of the students believing that she would get one faulty gun. We are thus able to capture the co-distributive relation between the bare plural *faulty guns* and the matrix clause subject *two students* in sentence (89). Now, recall that narrow-scope dependent plurals are associated with a variant of the Multiplicity Condition, which was informally stated in section 5.3.3. This requirement is formally derived in condition (c), which follows from the familiar non-atomicity/non-uniqueness condition associated with bare plurals and the adopted definition of intensionalised uniqueness. I thus conclude that the proposed system adequately accounts for the semantics of narrow-scope LDDPs.

5.3.5.5 LDDPs in Temporal Adjunct Clauses

Given our assumptions on the the semantics of weak distributivity and dependent plurals, the analysis of LDDPs in temporal adjuncts is fairly straightforward, but

requires us to return to the extended version of the semantic system presented in section 4.6. In that section, I extended the set of basic types to include type i for sets of time intervals, and introduced the temporal trace function τ , which maps events to singleton sets of time intervals.

Consider now sentence (98), which is a simplified version of example (43d) discussed above:

(98) They _{u} all had ^{ε} ongoing success after they _{u} won ^{ε'} their _{u'} league titles.

I will assume the following semantics for *after*:

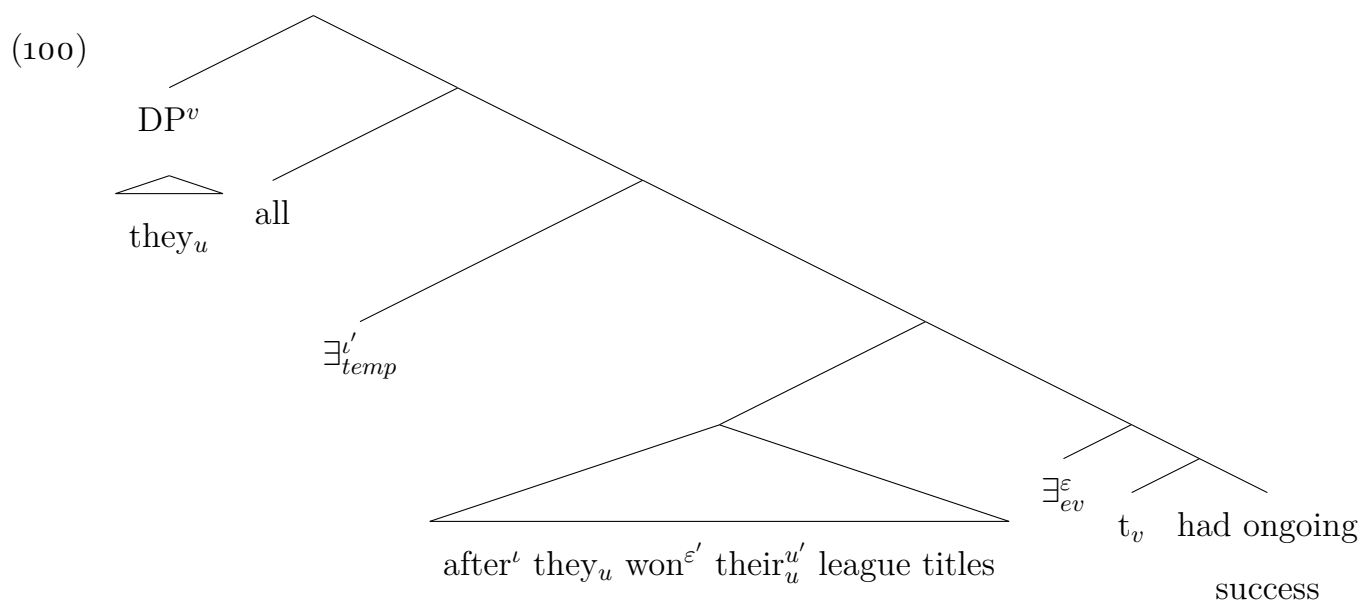
(99) a. $\mathbf{after}^t \rightsquigarrow \lambda T_{it}. \lambda T'_{it}. \lambda t_i. [t]; T(t); T'(t); [t \prec t]$

b. $t \prec t' := \lambda J_{st}. \forall j \in J. t_j \prec t'_j$,

where \prec is the precedence relation between time intervals.

Thus, *after* combines with two predicates of time interval drefs, T and T' , and introduces a new time interval dref t which satisfies T . It returns a predicate which applies to time interval drefs satisfying T' and characterises time intervals that follow the time intervals returned by t .

Syntactically, I will assume that temporal adjuncts attach below the time closure operator in the main clause, e.g.:



Recall, that in section 4.6 we modified the translation of the event closure operator in the following way:

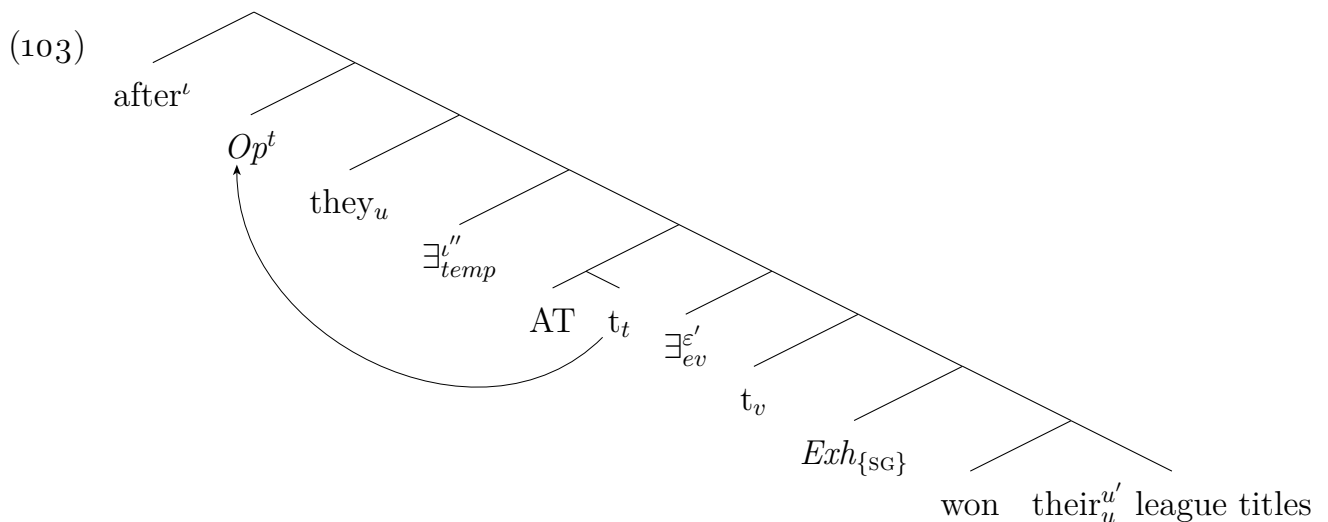
$$(101) \quad \exists_{ev}^\varepsilon \rightsquigarrow \lambda V_{vt}. \lambda t_i. [\varepsilon]; V(\varepsilon); [\tau\{\varepsilon\} = t]$$

Thus, the event closure operator introduces a new event dref, and returns a predicate of time interval drefs. This means that the adjunct clause in (100) combines with a constituent translated as a predicate of time interval drefs, as required given the translation in (99a).

The time variable is then closed via the application of the time closure operator \exists_{temp} , translated as follows:

$$(102) \quad \exists_{temp}^\iota \rightsquigarrow \lambda T_{it}. [t]; T(t)$$

With respect to the internal structure of temporal adjuncts, I will adopt a version Larson’s (1990) and von Stechow’s (2002) proposal, and assume that they involve a covert temporal prepositional phrase hosting an operator which moves to the periphery of the clause:



The operator Op combines with its sister constituent via the Quantifying-In rule, which we generalise to apply to traces of all dref types, as in (104):

(104) *Quantifying-In (QIn) (general form)*

If $DP^d \rightsquigarrow \alpha$, $B \rightsquigarrow \beta$ and DP^d and B are daughters of C , where d is a variable of type σ such that $\sigma \in \mathbf{DRefTyp}$, then $C \rightsquigarrow \alpha(\lambda d.\beta)$, provided that this is a well-formed term.

The operator *Op* itself is semantically vacuous:

(105) $Op \rightsquigarrow \lambda T_{\mathbf{it}}. \lambda t_{\mathbf{i}}. T(t)$

This means that the sister of *as soon as* in (103) is translated as a predicate of time interval drefs (type **it**), which is what we need given the translation in (99a).

Finally, the covert temporal preposition *AT* is translated as follows:

(106) $AT \rightsquigarrow \lambda t_{\mathbf{i}}. \lambda T_{\mathbf{it}}. \lambda t'_{\mathbf{i}}. T(t); [t = t']$

We now have all we need to calculate the translation of sentence (98). Given the structure in (103), the temporal clause will be translated as follows:

(107) $\lambda T'_{\mathbf{it}}. \lambda t_{\mathbf{i}}. \lambda I_{st}. \lambda J_{st}. \exists H_{st}. \exists H'_{st}. I[\iota, \iota'', \varepsilon']H \wedge$
 $\mathbf{max}^{u'}([Poss\{u, u'\}]; [league_title\{u'\}])HH' \wedge$
 $\neg \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [Poss\{u, u'\}]; [league_title\{u'\}])HH' \wedge$
 $won\{\varepsilon'\}H' \wedge \mathbf{Ag}\{u, \varepsilon'\}H' \wedge \mathbf{Th}\{u', \varepsilon'\}H' \wedge (\tau\{\varepsilon'\} = \iota'')H' \wedge$
 $(\iota = \iota'')H' \wedge T'(t)H'J \wedge (\iota \prec t)J$

Here, the event dref ε' is introduced by the event closure operator inside the temporal clause, and encodes the winning events. The agents of these events are the individuals returned by u , and their themes are the individuals returned by u' . The latter are the maximal sums of league titles that the individuals returned by u have. Application of the exhaustification operator further strengthens the conditions imposed on u' , specifically it cannot be the case that u' return the same atomic individual for each assignment in the current info state (cf. the discussion of exhaustification in the case of definite plurals in section 3.10.2). Next, the time interval dref ι'' , introduced by the time closure operator, encodes the temporal traces of the winning events returned by ε' . Silent operator movement from the

within the temporal PP to a peripheral position below *after* creates a predicate of time interval drefs. This predicate is applied to the time interval dref ι , introduced by *after*, and the semantics of the covert temporal preposition AT (cf. 106) ensures that ι returns the same values as ι'' . The expression in (107) must further be combined with a predicate of time interval drefs T' and with a time interval dref t , such that T' applies to t , and the time intervals returned by ι precede those returned by t , i.e. the temporal traces of the winning events must precede the temporal intervals determined by T' .

The predicate T' is derived as the translation of the constituent that the adjunct clause combines with in (100):

$$(108) \quad \lambda t_i. \lambda I_{st}. \lambda J_{st}. I[\varepsilon]J \wedge \text{have_ongoing_success}\{\varepsilon\}J \wedge \mathbf{Ag}\{v, \varepsilon\}J \wedge (\tau\{\varepsilon\} = t)J$$

The translation of the adjunct clause in (107) combines with (108) via Functional Application, yielding the predicate over time interval drefs in (109):

$$(109) \quad \lambda t_i. \lambda I_{st}. \lambda J_{st}. \exists H_{st}. \exists H'_{st}. I[\iota, \iota'', TE\varepsilon']H \wedge \mathbf{max}^{u'}([\text{Poss}\{u, u'\}]; [\text{league_title}\{u'\}])HH' \wedge \neg \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [\text{Poss}\{u, u'\}]; [\text{league_title}\{u'\}])HH' \wedge \text{won}\{\varepsilon'\}H' \wedge \mathbf{Ag}\{u, \varepsilon'\}H' \wedge \mathbf{Th}\{u', \varepsilon'\}H' \wedge (\tau\{\varepsilon'\} = \iota'')H' \wedge (\iota = \iota'')H' \wedge H'[\varepsilon]J \wedge \text{have_ongoing_success}\{\varepsilon\}J \wedge \mathbf{Ag}\{v, \varepsilon\}J \wedge (\tau\{\varepsilon\} = t)J \wedge (\iota \prec t)J$$

Following the structure in (100), (109) combines with the time closure operator, the weak distributivity operator *all* and the subject pronoun, yielding the following DRS as the translation for sentence (98):

$$\begin{aligned}
(110) \quad & [\mathbf{dist}_w(\lambda I_{st} \lambda J_{st} \exists H_{st} \exists H'_{st} I[\iota, \iota', \iota'', \varepsilon'] H \wedge \\
& \mathbf{max}^{u'}([Poss\{u, u'\}]; [league_title\{u'\}]) H H' \wedge \\
& \neg \mathbf{max}^{u'}([\mathbf{atom}\{u'\}]; [\mathbf{unique}\{u'\}]; [Poss\{u, u'\}]; [league_title\{u'\}]) H H' \wedge \\
& won\{\varepsilon'\} H' \wedge \mathbf{Ag}\{u, \varepsilon'\} H' \wedge \mathbf{Th}\{u', \varepsilon'\} H' \wedge (\tau\{\varepsilon'\} = \iota'') H' \wedge \\
& (\iota = \iota'') H' \wedge H'[\varepsilon] J \wedge have_ongoing_success\{\varepsilon\} J \wedge \mathbf{Ag}\{u, \varepsilon\} J \wedge \\
& (\tau\{\varepsilon\} = \iota') J \wedge (\iota \prec \iota') J)(u)]
\end{aligned}$$

Let us consider this DRS more closely. Suppose, that the subject pronoun in (98) refers to a sum of three teams, i.e. for an input state $I = \{i\}$, $ui = t_1 \oplus t_2 \oplus t_3$:

(111)

Info state I	...	u	...
i	...	$t_1 \oplus t_2 \oplus t_3$	...

The weak distributivity operator introduces a new info state, call it K , where the atomic individuals in ui are stored as values of u for separate assignments:

(112)

Info state K	...	u	...
k_1	...	t_1	...
k_2	...	t_2	...
k_3	...	t_3	...

Next, four new drefs are introduced, ι, ι', ι'' and ε' , yielding the info state H :

(113)

Info state H	...	u	ι	ι'	ι''	ε'	...
h_1	...	t_1	i_1	i'_1	i''_1	e'_1	...
h_2	...	t_2	i_2	i'_2	i''_2	e'_2	...
h_3	...	t_3	i_3	i'_3	i''_3	e'_3	...

The maximality operator in (110) introduces another dref, u' :

(114)

Info state H'	...	u	ι	ι'	ι''	ε'	u'	...
h'_1	...	t_1	i_1	i'_1	i''_1	e'_1	lt_1	...
h'_2	...	t_2	i_2	i'_2	i''_2	e'_2	lt_2	...
h'_3	...	t_3	i_3	i'_3	i''_3	e'_3	lt_2	...

Here, lt_1 , lt_2 and lt_3 are the maximal sums of league titles that teams t_1 , t_2 and t_3 have, respectively. Moreover, it must not be the case that lt_1 , lt_2 and lt_3 are all atomic and equal, i.e. more than one team title must be involved. Next, e'_1 , e'_2 and e'_3 are winning events, such that for each $e'_k \in \{e'_1, e'_2, e'_3\}$, team t_k is its agent, league title lg_k is its theme, and time interval i''_k is its temporal trace. Moreover, for each assignment in H , ι returns the same value as ι'' , i.e. $i_1 = i''_1$, $i_2 = i''_2$ and $i_3 = i''_3$. It follows that i_1 , i_2 and i_3 encode the temporal traces of the winning events e'_1 , e'_2 and e'_3 , respectively.

Finally, the event dref ε is added, yielding a plural info state J of the following form:

(115)

Info state J	...	u	ι	ι'	ι''	ε'	u'	ε	...
j_1	...	t_1	i_1	i'_1	i''_1	e'_1	lt_1	e_1	...
j_2	...	t_2	i_2	i'_2	i''_2	e'_2	lt_2	e_2	...
j_3	...	t_3	i_3	i'_3	i''_3	e'_3	lt_2	e_3	...

All the conditions which apply to info state H in (114), apply to info state J in (115). Plus, e_1 , e_2 and e_3 must be events of having ongoing success, and for each $e_k \in \{e_1, e_2, e_3\}$, team t_k is the agent of e_k and i'_k is the temporal trace of e_k . Finally, for each $k \in \{1, 2, 3\}$, time interval i_k must precede time interval i'_k . Recall, that i_1 , i_2 and i_3 are the temporal traces of the ‘winning’ events e'_1 , e'_2 and e'_3 , whereas i'_1 , i'_2 and i'_3 are the temporal traces of the ‘having ongoing success’

events e_1 , e_2 and e_3 . Thus, each ‘having ongoing success’ event must occur later than the corresponding ‘winning’ event.

The DRS in (110) will be true relative to the input info state in (111) iff there exists an input state J as in (115), satisfying the above conditions. These conditions can be expressed less formally in the following way: For each team t , there is an event of t having ongoing success which follows an event of t winning the maximal sum of league titles that t has. Each team may have one or more league titles, as long as more than one league title is involved overall. These truth conditions correspond to the dependent plural interpretation of sentence (98). Other examples of long-distance dependent plurals occurring within temporal adjunct clauses, discussed in section 5.3.2.3, can be analysed in a similar way.

To conclude, I have illustrated how, within the proposed semantic framework, we can account for dependent plural readings in examples like (98), where the dependent occurs within a temporal adjunct clause, while the licenser occupies a position in the main clause. The proposed analysis correctly accounts both for the co-distributive semantic relation between the licenser and the dependent, and the overarching Multiplicity Condition associated with the dependent.

Summing up the discussion of long-distance dependent plurals, I have argued that the relation between a dependent plural and its licenser can traverse the boundaries of complement and adjunct clauses. The fact that a plural DP in the main clause can license a dependent plural within a finite complement or adjunct clause is problematic for theories of dependent plurals that rely on syntactic mechanisms. This includes both Spector’s (2003) feature-checking-based distributive approach, as well as all the versions of the mereological approach and Ivlieva’s (2013) mixed approach, where the licenser and the dependent need to occur in a local configuration for a cumulative relation to be established (e.g. via a syntactic cumulativity operator). In the present framework, on the other hand, long-distance dependent plurals can be accounted for thanks to the fact that the licensing relation is established via semantic mechanisms, i.e. via the propagation of information encoded in

plural info states. I have put forward an analysis of dependent plurals occurring in the complement clauses of attitude predicates, capturing the semantic properties of both wide-scope and narrow-scope dependent plurals. I have also illustrated how the proposed system can account for long-distance dependent plurals occurring inside temporal adjunct clauses.

5.4 An Account of Partee's Generalisation

5.4.1 The Data

The aim of this section is to show how the proposed approach to the semantics of number and distributivity allows us to make sense of a puzzle regarding the scope of bare plurals in English noted by Partee (1985), which I have referred to as Partee's Generalisation.

Let us first review the relevant data:

- (116) a. Miles wants to meet a policeman. $want > \exists, \exists > want$
 b. Miles wants to meet policemen. $want > \exists, * \exists > want$
 c. All the boys want to meet policemen. $want > \exists, \exists > want$

Carlson (1977, 1980) famously observed that in English bare plurals contrast with singular indefinites with respect to their scopal properties. Thus, sentence (116a) is ambiguous: it can either mean that Miles wants to meet some policeman or other, or that there is a specific policeman that Miles wants to meet. This ambiguity can be captured if we assume that the singular indefinite *a policeman* can either be interpreted within the scope of the intensional verb *want* (the narrow-scope reading of the indefinite), or outside that scope (the wide-scope reading of the indefinite). Sentence (116b), on the other hand, lacks this ambiguity. It can only be interpreted as stating that meeting any group of policemen would satisfy Miles' wish, not that there is a specific group of policemen that he want to meet. Thus, the bare plural DP *policemen* in (116b) can only take narrow scope with

respect to the intensional verb.

Partee (1985) added a third element to this paradigm. She noticed that when a bare plural functions as a dependent plural licensed by an item in the main clause, the wide scope reading becomes possible. Thus, (116c) is again ambiguous between a narrow-scope reading of the indefinite, on which each boy wants to meet some policeman or other, and a narrow-scope reading, where for each boy there is a specific policeman that he wants to meet.

Moreover, Partee (1985) shows that this pattern remains valid for a wide range of contexts, e.g.:

- (117) a. Max is looking for a book on Danish cooking. *look for* > \exists , \exists > *look for*
 b. Max is looking for books on Danish cooking. *look for* > \exists , $*\exists$ > *look for*
 c. All the R.A.'s are looking for books on Danish cooking. *look for* > \exists ,
 \exists > *look for*
- (118) a. Jimmy must find a congressman before noon. *must* > \exists , \exists > *must*
 b. Jimmy must find congressmen before noon. *must* > \exists , $*\exists$ > *must*
 c. All the aides must find congressmen before noon. *must* > \exists , \exists > *must*
- (119) a. Bill believes a fascist to have robbed the bank. *believe* > \exists , \exists > *believe*
 b. Bill believes fascists to have robbed the bank. *believe* > \exists , $*\exists$ > *believe*
 c. All the detectives believe fascists to have robbed the bank. *believe* > \exists ,
 \exists > *believe*

We thus observe a contrast between bare plurals that function as dependent plurals, and those that do not. The former pattern with singular indefinites in being able to take wide scope with respect to a range of scope-inducing operators, while the latter are confined to narrow scope.³¹ As discussed in Chapter 2, this contrast is deeply mysterious from the point of view of existing theories of dependent plurals.

³¹Furthermore, it appears that the pattern we observe in (116)-(119) is not confined to English. Alexander Pfaff (p.c.) informs me that a similar contrast exists in German. For instance, sentences (i) and (iii) allow for both a narrow-scope and wide-scope reading of the indefinite in the complement clause, while sentence (ii) allows for only a narrow scope interpretation:

In the following sections I will propose an account of these data based on the theory of grammatical number and distributivity developed in this thesis. The exposition will proceed in three steps. First, I briefly summarise Carlson's (1977, 1980) classic account of bare plurals as kind-referring expressions. I then demonstrate how a version of this approach can be implemented in PCDRT*. Finally, I introduce the core assumption of the proposed analysis according to which plural DPs can optionally combine with a null cardinality head *Card*, and demonstrate how this assumption can account for the contrast between dependent and non-dependent bare plurals, noted in Partee 1985.

5.4.2 Kind-based Account of Bare Plurals

The kind-based approach to the semantics of English bare plurals was originally proposed by Carlson (1977, 1980), and was later developed and modified by e.g., Vergnaud & Zubizarreta (1992), Krifka (1995), Chierchia (1998), Zamparelli (2000) a.o. It is based on the notion of *kind*, which is taken to be a sub-sort of individuals (Vergnaud & Zubizarreta 1992 use the term *type* for a similar notion, Krifka 1995 introduces a distinction between kinds and concepts, where kinds are 'well established' or 'conventional' concepts). Specifically, Carlson (1977, 1980) takes bare plurals like *policemen* or *books on Danish cooking* to be proper names of kinds, in parallel to nouns phrases like *Mary* and *France* which are analysed as proper names of particular individual (or *objects*, in Carlson's terminology). Carlson assumes that while particular individuals are spatially bounded, but not temporally bounded (i.e. they can exist at multiple times, but only in one place at any given time), kinds are not spatially bounded.

-
- (i) Peter mochte einen polizist treffen.
'Peter wants to meet a policeman.'
 - (ii) Peter mochte polizisten treffen.
'Peter wants to meet policemen.'
 - (iii) Alle studenten mochten polizisten treffen.
'All the students want to meet policemen.'

The kind interpretation of bare plurals is most transparent in combination with predicates like *be widespread* and *be extinct*. Compare the following examples:

- (120) a. This kind of lizard is widespread / extinct.
 b. Monitor lizards are widespread / extinct.
 c. #Jane and Jack are widespread / extinct.

Examples (120a) and (120b) show that the predicates *be widespread* and *be extinct* naturally combine with noun phrases that make explicit reference to kinds, as well as with bare plurals. However, they do not combine with noun phrases denoting (sums of) particular individuals, as evident from (120c). Carlson (1977, 1980) assumes that the translation of *be widespread* and *be extinct* involves predicates that apply directly to kinds, e.g.:³²

- (121) a. **be widespread** $\rightsquigarrow \lambda x_k. \textit{widespread}(x)$,
 where x_k is a variable ranging over kinds.
 b. **Monitor lizards are widespread** $\rightsquigarrow \textit{widespread}(ml)$,
 where ml is the kind ‘monitor lizard’.

In contrast to *be widespread* and *be extinct*, VPs like *be sick* (physically) or *be available* do not introduce ‘kind-level’ predicates. Instead, their translation involves predicates that apply to *stages of individuals*, which Carlson takes to be a type of entity which is both spatially and temporally bounded. Particular individuals are related to their stages by the realisation-relation **R**. Thus, the individual *Jake* is realised by a set of Jake-stages, which can be viewed as “temporally-bounded portions of Jake’s existence”. The same realisation-relation **R** is taken to link kinds to stages that are manifestations of those kinds.

Now, predicates introduced by stage-level verbs and adjectives cannot be directly applied to individuals (particular or kind) denoted by their argument DPs.

³²The notation that I will use in this section is slightly different from Carlson’s original notation, and is closer to the one used throughout this thesis. Moreover, I omit some details which are irrelevant for our purposes.

Instead this relation is mediated by the realisation-relation \mathbf{R} and existential closure. As an example, take the stage-level predicate *be hungry*. Its translation is given in (122a). As illustrated in (122b)-(122c), this predicate can be combined with DPs denoting particular or kind individuals, and in both cases the combination is translated via the relation \mathbf{R} and existential closure over stages.

(122) a. **be hungry** $\rightsquigarrow \lambda x_i. \exists y_s. \mathbf{R}(y, x) \ \& \ hungry(y)$,

where x_i is a variable ranging over individuals (particular and kind), y_s is a variable ranging over stages, and \mathbf{R} is the realisation-relation.

b. **John is hungry** $\rightsquigarrow \exists y_s. \mathbf{R}(y, j) \ \& \ hungry(y)$

c. **Monitor lizards are hungry** $\rightsquigarrow \exists y_s. \mathbf{R}(y, ml) \ \& \ hungry(y)$

Thus, in Carlson's system, existential closure is built into the interpretation of stage-level predicates.

The verbs that combine with bare plurals in (116)-(119) are translated in a similar way, e.g.:³³

(123) **meet** $\rightsquigarrow \lambda Q_{(et)t}. \lambda x_i. Q(\lambda y_i. \exists w_s. \exists z_s. \mathbf{R}(z, x) \ \& \ \mathbf{R}(w, y) \ \& \ meet(z, w))$,

where x_i and y_i are variables ranging over individuals (particular and kind), w_s and z_s are variables ranging over stages, and \mathbf{R} is the realisation-relation.

Consider now the contrast between (116a) and (116b). By assumption, the bare plural *policemen* in (116b) is translated as a proper name of the corresponding kind, call it p , as in (124a). The singular indefinite *a policeman*, on the other hand, is treated as an existential quantifier, as in (124b):

(124) a. **policemen** $\rightsquigarrow \lambda Q_{et}. Q(p)$

b. **a policeman** $\rightsquigarrow \lambda Q_{et}. \exists x. policeman(x) \ \& \ Q(x)$

³³Note that Carlson does not adopt lifting rules, and takes all noun phrases to be uniformly translated as expressions of type $(et)t$. Hence transitive verbs are assigned the complex type $((et)t)(et)$ to allow for *in situ* interpretation of the direct object.

This difference between bare plurals and singular indefinites accounts for their contrasting properties with respect to scope. Take the sentences in (116a) and (116b). Let us assume that these sentences can be assigned two underlying structures: either the indefinites are interpreted *in situ*, within the scope of the intensional verb, or they are covertly quantifier-raised above the intensional verb. If the indefinites stay *in situ*, the translations of (116a) and (116b) can be represented as (125a) and (125b) respectively:

(125) a. $want(\hat{\exists}x. policeman(x) \ \& \ \exists w_s. \exists z_s. \mathbf{R}(z, m) \ \& \ \mathbf{R}(w, x) \ \& \ meet(z, w))(m)$

b. $want(\hat{\exists}w_s. \exists z_s. \mathbf{R}(z, m) \ \& \ \mathbf{R}(w, p) \ \& \ meet(z, w))(m),$

where m is the individual referred to by *Miles*.

The translation in (125a) says that what Miles wants is for there to exist an individual x who is a policeman, and two stages, w and z , such that z is a stage of Miles himself and w is a stage of x , and z meets w . The translation in (125b) is very similar. It says that the content of Miles' wish is that there exist two stages, w and z , such that z is a stage of Miles himself and w is a stage of the kind *policemen*, and z meets w . Given some intuitive constraints on the relation between kinds, individuals and stages (namely, that any stage of the kind p is also a stage of some individual who is a policeman, and, conversely, any stage of a policeman-individual is also a stage of the kind p), these translations turn out to be equivalent, reflecting the low-scope reading of the indefinites.

Now, suppose the indefinites in (116a) and (116b) can covertly raise out of the complement clause to a position above the main clause subject. Then, we will have the following translation for sentence (116a):

(126) $\exists x. policeman(x) \ \& \ want(\hat{\exists}w_s. \exists z_s. \mathbf{R}(z, m) \ \& \ \mathbf{R}(w, x) \ \& \ meet(z, w))(m)$

This translation corresponds to the wide-scope readings of the indefinite. It says that there is an individual x who is a policeman, and Miles wants for two stages w and z to exist, such that z is a stage of Miles himself and w is a stage of x , and z meets w . In other words, Miles wants to meet a specific policeman.

Now, consider the translation of (116b), assuming that the bare plural raises above the intensional verb. The sister of the raised DP will be translated as the predicate in (127) obtained by lambda-abstraction over the base position position of the plural:

$$(127) \quad \lambda x. \text{want}(\wedge \exists w_s. \exists z_s. \mathbf{R}(z, m) \ \& \ \mathbf{R}(w, x) \ \& \ \text{meet}(z, w))(m)$$

This predicate is then combined with the translation of the bare plural in (124a), which once again yields (125b). Thus, quantifier raising the bare plural does not lead to a wide-scope interpretation. It is easy to see why: bare plurals in Carlson's system do not themselves introduce existential quantification. Instead, the quantificational force is associated with the stage-level predicate the bare plural combines with, and thus in sentences like (125b) the perceived scope of the bare plural will always remain low. This analysis straightforwardly extends to the contrast between the (a) and (b) sentences in (117)-(119).

Subsequent researchers proposed various modifications to Carlson's original proposal. For instance, Chierchia's (1998) influential paper follows Carlson in treating bare plurals as directly referring to kinds, but does not make use of stages. Instead it assumes a more standard interpretation for predicates such as *be hungry* and *meet* as applying directly to particular individuals, e.g.:

$$(128) \quad \mathbf{meet} \rightsquigarrow \lambda x_o. \lambda y_o. \text{meet}(y, x),$$

where x_o and y_o are variables ranging over objects (i.e. particular individuals).

The combination of object-level predicates with bare plurals denoting kinds is interpreted via a special type-shifting rule, which Chierchia calls *Derived Kind Predication* (DKP):

(129) *Derived Kind Predication*

If P applies to objects and k denoted a kind, then

$$P(k) = \exists x. \cup k(x) \wedge P(x),$$

where $\cup k$ is the predicate that is true of all and only the objects that realise k .

Thus, in Chierchia's system existential quantification is associated with the DKP rule, rather than incorporated into the semantics of the predicate. Nonetheless, the account of the facts related to scope is basically the same as in Carlson's system: assuming that DKP applies locally, i.e. at the point where the bare plural combines with the lexical predicate, it is predicted that bare plurals will only have narrow scope in examples like (116b)-(119b). In the following, I will adopt Chierchia's modifications of Carlson's approach.

Carlson's and Chierchia's proposals are also similar in that they assume that the basic interpretation of a nominal root is as a property of particular individuals, and the kind interpretation is derived from the property interpretation. On the other hand, Krifka (1995) suggests that nominal roots are directly interpreted as names of kinds, and it is the property interpretation that is derived (see also Zamparelli 2000, Kratzer 2007). In this, I will follow Krifka's (1995) proposal.

5.4.3 Bare Plurals and Kinds in PCDRT*

To implement the notion of bare plurals as kind-referring expressions in the current framework, I will extend the set of basic types to include k , the type for kinds, with constants $\kappa_1, \kappa_2, \dots$, and variables k_1, k_2, \dots . I will not make use of stages, and instead follow Chierchia (1998) in relying solely on the distinction between kinds and individuals. This is partly due to simplicity, and partly to the fact that it is not clear whether the individual-level/stage-level contrast is indeed relevant for the distinction between predicates that allow for existential readings of bare plurals and predicates that do not (cf. Kiss 1998, Dobrovie-Sorin 1995).

For simplicity, I will assume that nominal roots directly refer to kinds:³⁴

$$(130) \quad \sqrt{dog} \rightsquigarrow \mathbf{dog}_k$$

Since the plural number feature is by assumption semantically vacuous, the bare plural ends up referring to a kind. The singular, on the other hand, transforms the kind referring nominal root into a predicate over individual drefs, which allows for the application of the atomicity and uniqueness conditions. This is done with the help of the **Inst** relation (parallel to Carlson's 'realises'-relation R) which relates kinds and individuals that instantiate those kinds:

$$(131) \quad \text{a. } \#:\mathbf{sg} \rightsquigarrow \lambda k_k. \lambda v_e. \lambda q_w. [\mathbf{Inst}_q\{v, k\}]; [\mathbf{atom}\{v\}]; [\mathbf{unique}\{v\}]$$

$$\text{b. } \mathbf{Inst}_w\{u, \kappa\} := \lambda I_{st}. \forall i \in I. \mathbf{Inst}_{wi}(ui, \kappa),$$

where $\mathbf{Inst}_{wi}(ui, \kappa)$ must be read as stating that the individual ui is an instantiation of the kind κ in world wi .

Thus, a noun root combined with the singular number head would be translated as follows:

$$(132) \quad \#:\mathbf{sg} + \sqrt{dog} \rightsquigarrow \lambda v_e. \lambda q_w. [\mathbf{Inst}_q\{v, \mathbf{dog}_k\}]; [\mathbf{atom}\{v\}]; [\mathbf{unique}_q\{v\}]$$

Similarly, numerals and cardinal modifiers such as *several* combine with a kind-referring plural NP and return a predicate of individual drefs, adding a cardinality condition:

$$(133) \quad \mathbf{two} \rightsquigarrow \lambda k_k. \lambda v_e. \lambda q_w. [\mathbf{Inst}_q\{v, k\}]; [\mathbf{2_atom}\{v\}]$$

³⁴In fact, a more empirically adequate system would involve nouns introducing drefs over kinds since, as discussed extensively in Carlson 1977, 1980, kind-referring expressions can serve as antecedents for anaphoric pronouns. Then, nominal roots could be translated as in (i) or alternatively as in (ii), in parallel to the indefinite-like and pronoun-like analyses of proper names in Brasoveanu 2007:

$$(i) \quad \sqrt{dog}^\kappa \rightsquigarrow \lambda P_{(sk)t}. [\kappa_{sk} \mid \kappa = Dog_{sk}]; P(\kappa)$$

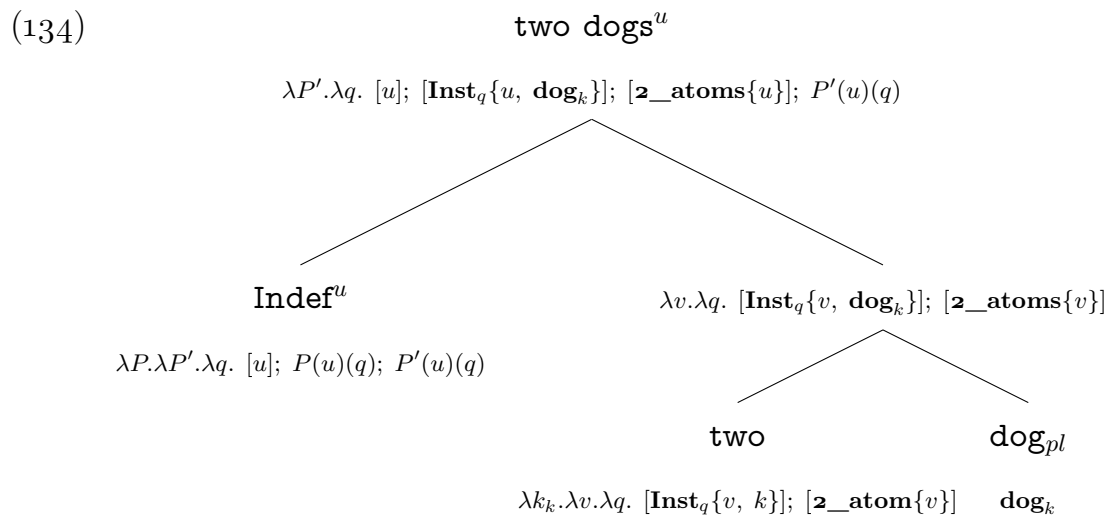
$$(ii) \quad \sqrt{dog}_{Dog} \rightsquigarrow \lambda P_{(sk)t}. P(Dog_{sk})$$

Here, κ_{sk} represents a nonspecific dref over kinds, and Dog_{sk} represents a specific kind-dref that returns the kind \mathbf{dog}_k for any assignment.

I will adopt the translation in (130) for the sake of simplicity. However, nothing would go wrong if we adopt the translations in (i) or (ii), modifying the translations of higher nominal heads accordingly.

In general, I will assume that the function of syntactic elements carrying cardinality information is to shift reference from kinds to individuals.

Singular DPs and DPs with numerals can then combine with indefinite determiners (*a* and its phonologically covert counterpart *Indef*) to yield the familiar semantics of existential quantifiers over individuals:

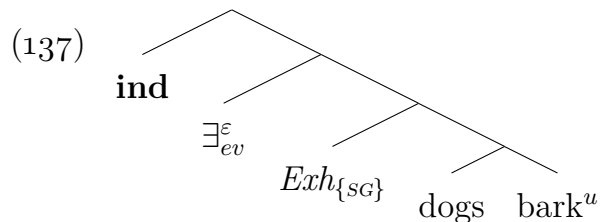


Crucially, bare plurals cannot directly combine with *Indef* due to a type mismatch. Instead, I will assume that a subset of predicates are able to combine directly with kind-referring expressions, introducing new individual drefs in their translations, which accounts for existential readings of bare plurals. Thus, predicates such as *bark*, can be shifted from the standard translation of type $\mathbf{e}(\mathbf{v}(\mathbf{wt}))$, as in (135a), to a translation of type $k(\mathbf{v}(\mathbf{wt}))$, as in (135b):

- (135) a. $\mathbf{bark} \rightsquigarrow \lambda v_e.\lambda \zeta_v.\lambda q_w. [bark_q\{\zeta\}, \mathbf{Ag}_q\{v, \zeta\}]$
 b. $\mathbf{bark}^u \rightsquigarrow \lambda k_k.\lambda \zeta_v.\lambda q_w. [u]; [\mathbf{Inst}_q\{u, k\}]; [bark_q\{\zeta\}, \mathbf{Ag}_q\{u, \zeta\}]$

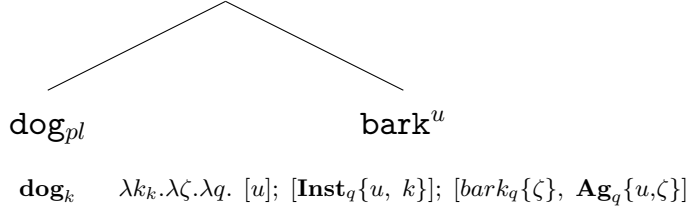
Consider the sentence in (136), with the structure in (137):

- (136) Dogs are barking.



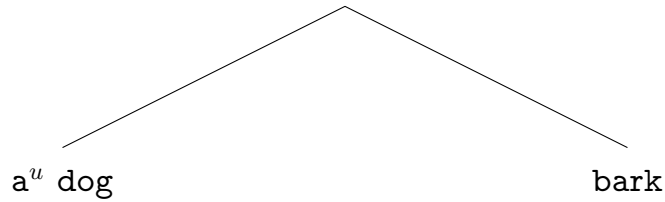
The combination of verb *bark* with the bare plural *dogs* will be translated as follows, with *bark* assigned the translation in (135b):

$$(138) \quad \lambda\zeta.\lambda q. [u]; [\mathbf{Inst}_q\{u, \mathbf{dog}_k\}]; [bark_q\{\zeta\}, \mathbf{Ag}_q\{u, \zeta\}]$$



Next, the exhaustification operator applies, comparing the translation in (138) to that of the corresponding structure involving a singular indefinite. Since the singular indefinite *a dog* is translated as an existential quantifier over individuals, in this case *bark* will be assigned the translation in (135a) to avoid type mismatch:

$$(139) \quad \lambda\zeta.\lambda q. [u]; [\mathbf{Inst}_q\{u, \mathbf{dog}_k\}]; [\mathbf{atom}\{u\}]; [\mathbf{unique}_q\{u\}]; [bark_q\{\zeta\}, \mathbf{Ag}_q\{u, \zeta\}]$$



$$\lambda P.\lambda q. [u]; [\mathbf{Inst}_q\{u, \mathbf{dog}_k\}]; [\mathbf{atom}\{u\}]; [\mathbf{unique}_q\{u\}]; P(u)(q) \quad \lambda v.\lambda\zeta.\lambda q. [bark_q\{\zeta\}, \mathbf{Ag}_q\{v, \zeta\}]$$

The event predicate in (139) is stronger than that in (138), and thus we derive the following strengthened event predicate in the standard way:

$$(140) \quad \lambda\zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \mathbf{Inst}_q\{u, \mathbf{dog}_k\}J \wedge bark_q\{\zeta\}J \wedge \mathbf{Ag}_q\{u, \zeta\}J \wedge (\neg \mathbf{atom}\{u\}J \vee \neg \mathbf{unique}_q\{u\}J)$$

Applying the event closure operator and the indicative morpheme to this event predicate we arrive at the following DRS as the translation of structure (137):

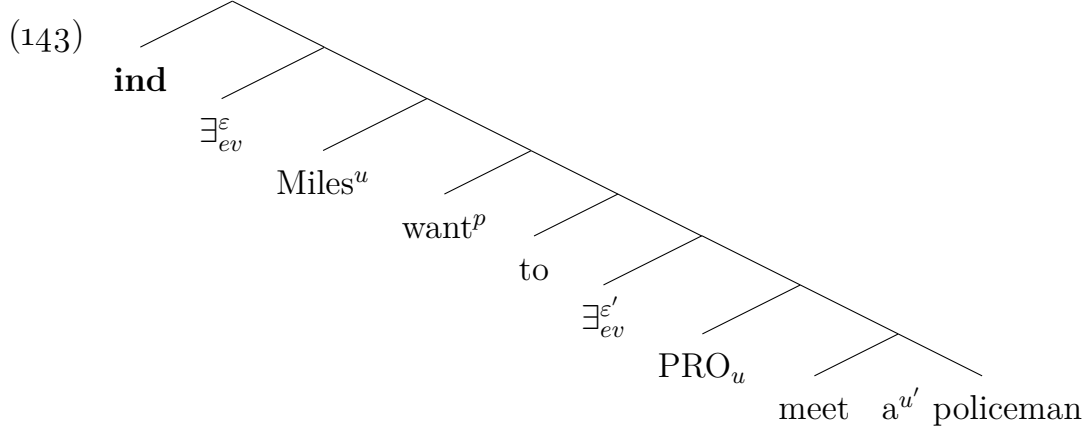
$$(141) \quad \lambda I_{st}.\lambda J_{st}. I[u, \varepsilon]J \wedge \mathbf{Inst}_{p*}\{u, \mathbf{dog}_k\}J \wedge bark_{p*}\{\varepsilon\}J \wedge \mathbf{Ag}_{p*}\{u, \varepsilon\}J \wedge (\neg \mathbf{atom}\{u\}J \vee \neg \mathbf{unique}_{p*}\{u\}J)$$

As expected, this DRS will be true if there is an event of more than one dog barking.

Consider now the contrast between (116a) and (116b), repeated as (142a) and (142b):

- (142) a. Miles wants to meet a policeman. $want > \exists, \exists > want$
 b. Miles wants to meet policemen. $want > \exists, * \exists > want$

The narrow scope reading of (142a) is derived if the indefinite stays *in situ*:



Assuming that *want* has the translation in (144), parallel to the translation of *believe* in (57), PRO is interpreted in the same way as abound pronouns, and *to* is semantically vacuous, the structure in (143) is translated as the DRS in (145):

- (144) $want^p \rightsquigarrow \lambda \mathbb{P}_{wt}. \lambda v_e. \lambda \zeta_v. \lambda q_w. \lambda I_{st}. \lambda J_{st}. I = J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{want}(vj)(\zeta j)(qj)(w)\}) \wedge \exists K_{st}. \mathbb{P}(p)HK),$

where f is a function of type $(s(st))$, and $R_{want}(x)(e)(w)(w')$ is true if world w' is compatible with what x wants in event e in world w .

- (145) $\lambda I_{st}. \lambda J_{st}. I[u, \varepsilon]J \wedge (u = Miles)J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{want}(uj)(\varepsilon j)(p*j)(w)\}) \wedge \exists K_{st}. (H[u', \varepsilon']K \wedge \mathbf{Inst}_p\{u', \mathbf{policeman}_k\}K \wedge \mathbf{atom}\{u'\}K \wedge \mathbf{unique}_p\{u'\}K \wedge \mathbf{meet}_p\{\varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))$

This DRS will be true iff there exists an info state K of the following form:

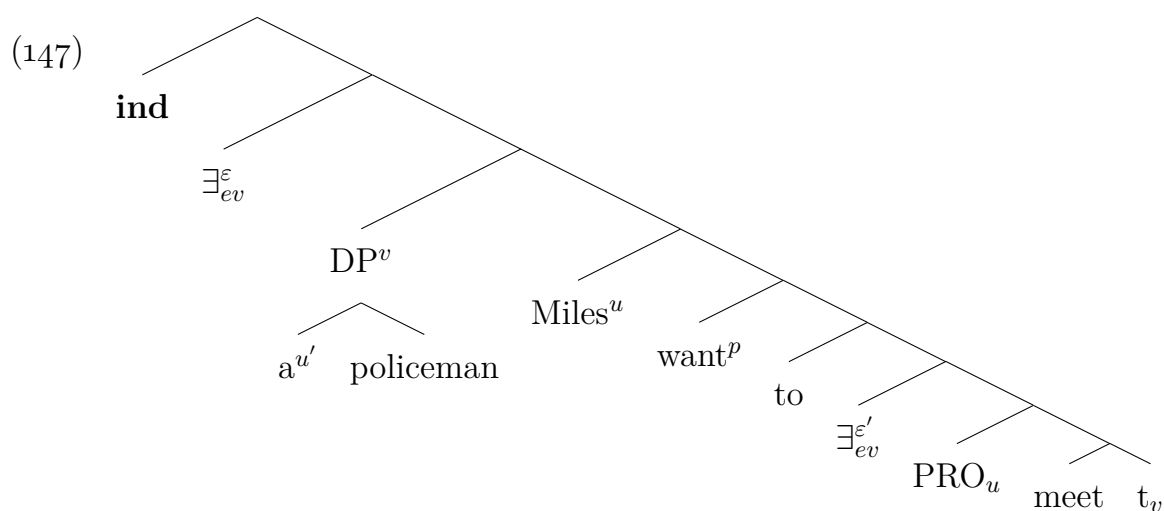
(146)

Info state K	...	p^*	u	ε	p	ε'	u'	...
k_1	...	w^*	m	e	w_1	e'_1	p_1	...
k_2	...	w^*	m	e	w_2	e'_2	p_2	...
...

Here, m represents Miles and e is a wanting event in the actual world w^* . Next, the set of values of p (i.e. $\{w_1, w_2, \dots\}$) is the set of possible worlds compatible with what Miles wants in e . For each $k \in K$, $u'k$ (i.e. p_1, p_2, \dots) is an atomic individual that is an instantiation of the kind **policeman** in world pk and $\varepsilon'k$ (i.e. e'_1, e'_2, \dots) is a meeting event in world pk whose agent is Miles and whose theme is $u'k$.

Restating these truth condition in a more familiar way, the DRS in (145) will be true if there is an event e in the actual world such that in every possible world w compatible with what Miles wants in e there is an atomic policeman-individual p and John meets p in w . This captures the narrow scope interpretation of the indefinite in (142a).

The wide-scope interpretation arises if the indefinite DP quantifier-raises to a position in the main clause:³⁵



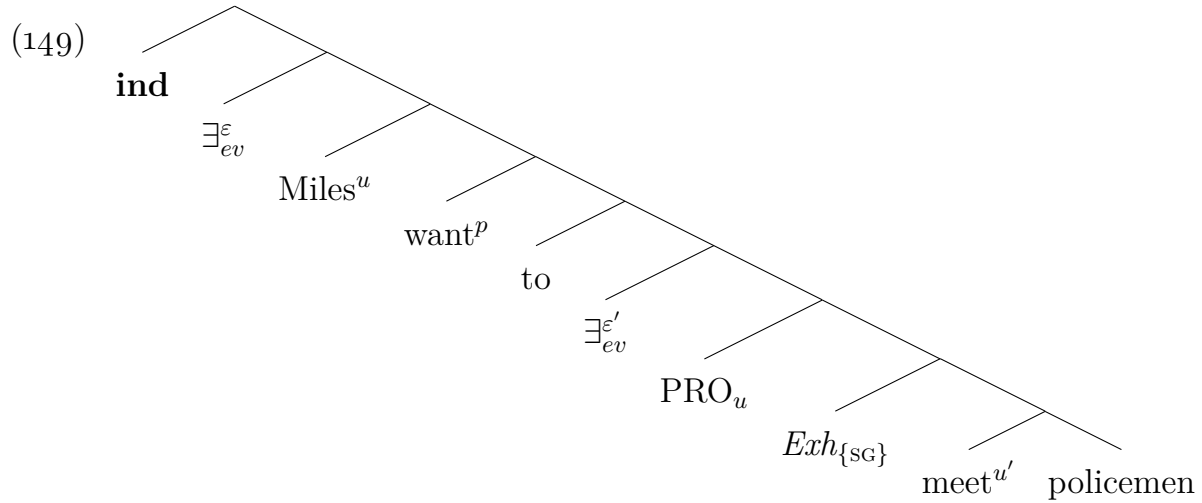
This structure receives the following translation:

³⁵Alternative, we could assume that the indefinite determiner can have a choice-functional interpretation, thus accounting for the wide-scope reading, cf. Kratzer (1998) and footnote 30.

$$\begin{aligned}
(148) \quad & \lambda I_{st}.\lambda J_{st}. I[u, u'\varepsilon]J \wedge \mathbf{Inst}_{p*}\{u', \mathbf{policeman}_k\}J \wedge \mathbf{atom}\{u'\}J \wedge \mathbf{unique}_{p*}\{u'\}J \wedge \\
& (u = \mathbf{Miles})J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \\
& \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge \\
& pH' = \{w : R_{want}(uj)(\varepsilon j)(p * j)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathbf{meet}_p\{\varepsilon'\}K \wedge \\
& \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))
\end{aligned}$$

This DRS will be true iff there exists an info state K as in (146), expect that for every $k \in K$, $u'k$ must return the same atomic individual who is an instantiation of the kind **policeman** in the actual world. I.e. there must be an atomic policeman individual in the actual world such that John meets him in every world compatible with John's wishes in e . Thus, the DRS in (148) captures the wide-scope reading of the singular indefinite in (142a).

Let us now turn to sentence (142b). Consider first the structure in (149), with the the bare plural remaining *in situ*:



Since, by assumption, the bare plural is translated as the kind **policeman**, the translation of *meet* must be shifted to type $k(\mathbf{e}(\mathbf{v}(\mathbf{wt})))$ for the structure to be interpretable:

$$(150) \quad \mathbf{meet}^{u'} \rightsquigarrow \lambda k_k.\lambda v_e.\lambda \zeta_v.\lambda q_w. [u']; [\mathbf{Inst}_q\{u', k\}]; [\mathbf{meet}_q\{\zeta\}, \mathbf{Th}_q\{u', \zeta\}, \mathbf{Ag}_q\{v, \zeta\}]$$

Then, the compositional translation of (149) will result in the following DRS, which corresponds to the narrow-scope readings of the bare plural:

$$\begin{aligned}
(151) \quad & \lambda I_{st}.\lambda J_{st}. I[u, \varepsilon]J \wedge (u = Miles)J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \\
& \cup \mathbf{Ran}(f) \wedge \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge \\
& pH' = \{w : R_{want}(uj)(\varepsilon j)(p*j)(w)\}) \wedge \exists K_{st}. (H[u', \varepsilon']K \wedge \mathbf{Inst}_p\{u', \mathbf{policeman}_k\}K \wedge \\
& meet_p\{\varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K \wedge (\neg \mathbf{atom}\{u'\}K \vee \neg \mathbf{unique}_p\{u'\}K)))
\end{aligned}$$

This DRS will be true iff there exists an info state K as in (146), except for the conditions on the values of u' : for each $k \in K$, $u'k$ must return a (possibly non-atomic) sum of individuals which is an instantiation of the kind **policeman** in world pk , and it must be the case that either u' returns a non-atomic sum of individuals for some assignment $k \in K$, or there are at least two assignments $k_1, k_2 \in K$, such that $pk_1 = pk_2$ and $u'k_1 \neq u'k_2$, i.e. there must be a possible world among the worlds compatible with what Miles wants in e where Miles meets more than one policeman.³⁶

I will assume that the alternative configuration, where the kind-denoting bare plural quantifier-raises above the attitude predicate, is blocked by something like Fox's (1998) *Scope-Economy Constraint*:

$$(152) \quad \textit{Scope-Economy}$$

Scope Shifting Operations can't be semantically vacuous.

This constraint blocks quantifier-raising if it doesn't produce a distinct scopal interpretation. Since the bare plural does not have proper quantificational force, quantifier-raising it above the intensional verb would not produce a distinct scopal

³⁶We may ask whether these truth-conditions are in fact too weak, and instead we want (142b) to be interpreted as stating that Miles meets more than one policeman in *every* possible world compatible with his wishes. The weaker interpretation that we derive for sentences like (142a) is due to the way we define intensionalised uniqueness, cf. (97). The answer to this question is somewhat unclear to me. Note, that the truth conditions for the DRS in (151) are compatible with a context where Miles indeed wants to meet more than one policeman. The question is whether sentence (142b) can also be used in a context where Miles wants to meet one or more policemen, with some of his wish-worlds involving a single policeman, and some - several policemen. For sentence (142b) the judgements seem to be uncertain. Recall, however, that the adopted definition of intensionalised uniqueness derives welcome results with respect to the interpretation of bare plurals in the scope of modals, cf. 4.7, and of narrow-scope LDDPs, cf. 5.3.5.4. I leave a more detailed investigation of this issue for the future.

configuration, and is thus ruled out.³⁷

We can now turn to Partee's observation, and the scopal contrast between bare plural noun phrases that function as dependent plurals, and those that do not.

5.4.4 The Proposal: *Card*

The core assumption that I will make in order to account Partee's Generalisation is that English possesses a phonologically null functional element, *Card(inal)*, with the following semantics:

$$(153) \quad \textit{Card} \rightsquigarrow \lambda k_k. \lambda v_e. \lambda q_w. [\mathbf{Inst}_q\{v, k\}]; [\mathbf{atom}\{v\}]$$

Like numerals and singular number, *Card* combines with kind-referring expressions, and returns a predicate over individuals which specifies the individual's cardinality. In the case of *Card*, the cardinality condition is simply that of atomicity. Thus, *Card* is minimally different from the singular in that it lacks the uniqueness condition, and minimally different from the numerals in that it encodes a simple atomicity condition.³⁸

Let us now see what this assumption entails for the semantics of bare plurals. Take, once again, sentence (154):

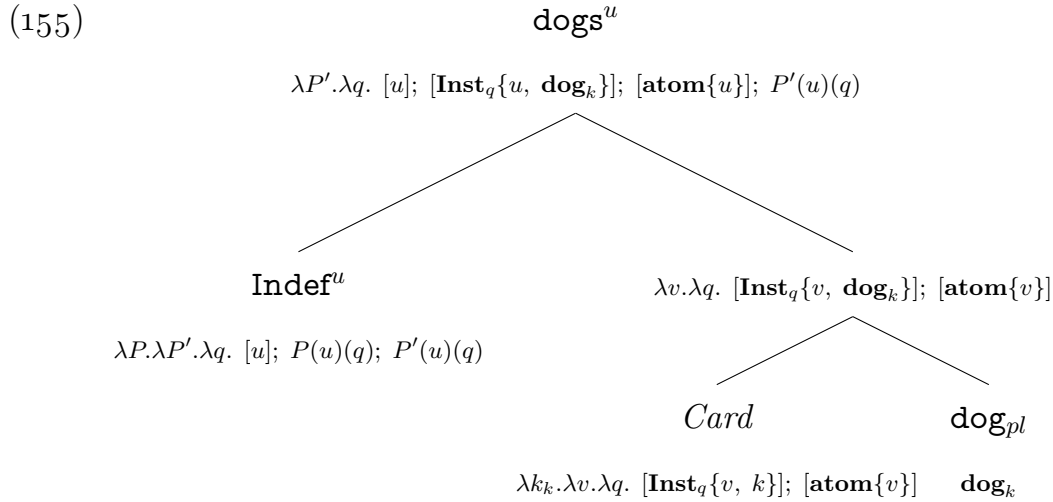
$$(154) \quad \text{Dogs are barking.}$$

The bare plural in this sentence can now correspond to two alternative structures. It may involve the combination of a kind-referring root and a semantically vacuous plural feature, as discussed above. Alternatively, however, it can now be assigned a more elaborated underlying structure, illustrated in (155):

³⁷Alternatively, if wide-scope readings of indefinites are analysed in terms of a choice-functional interpretation of the indefinite determiner, the lack of a wide-scope reading of the bare plural in (142b) directly follows from its inability to combine with *Indef*, see above.

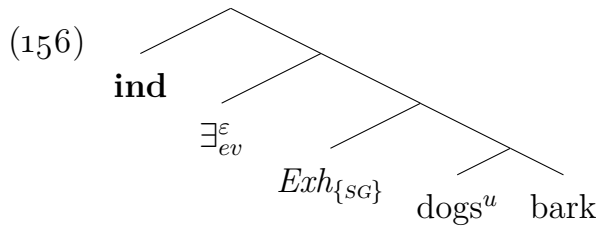
³⁸The numeral *one*, which can also plausibly be associated with an atomicity condition, only combines with singular NPs in English, which as we have argued are already translated as predicates of individuals due to the presence of the singular feature. This indicates that *one* has a semantics distinct from other numerals, e.g.:

(i) *one* $\rightsquigarrow \lambda P_{e(\mathbf{wt})}. \lambda v_e. \lambda q_w. [\mathbf{atom}\{v\}]; P(v)(q)$



Here, the plural noun first combines with *Card* yielding a predicate over individuals with the added atomicity condition. This predicate is then able to combine with the indefinite determiner, avoiding a type mismatch.

Consider now the interpretation of (154), with the structure in (156), assuming that the bare plural has the more elaborated structure in (155):



The verb in this case will be assigned the non-shifted translation in (135a) above, and the combination of the verb with the plural subject will produce the following event predicate:

$$(157) \quad \lambda \zeta_v.\lambda q_w. [u]; [\mathbf{Inst}_q\{u, \mathbf{dog}_k\}]; [\mathbf{atom}\{v\}]; [\mathbf{bark}_q\{\zeta\}, \mathbf{Ag}_q\{u, \zeta\}]$$

The exhaustivity operator will then compare this predicate with the alternative derived for the corresponding structure involving a singular indefinite. I repeat this alternative predicate in (158):

$$(158) \quad \lambda \zeta_v.\lambda q_w. [u]; [\mathbf{Inst}_q\{u, \mathbf{dog}_k\}]; [\mathbf{atom}\{v\}]; [\mathbf{unique}_q\{v\}]; [\mathbf{bark}_q\{\zeta\}, \mathbf{Ag}_q\{u, \zeta\}]$$

The event predicate in (158) involves a uniqueness condition applied to the values of u that is absent from (157), which makes it a stronger alternative. Ex-

haustification thus involves the negation of the stronger alternative, yielding the following strengthened predicate:

$$(159) \quad \lambda\zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. I[u]J \wedge \mathbf{Inst}_q\{u, \mathbf{dog}_k\}J \wedge \mathbf{atom}\{u\}J \wedge \mathit{bark}_q\{\zeta\}J \wedge \mathbf{Ag}_q\{u, \zeta\}J \wedge \neg\mathbf{unique}_q\{u\}J$$

Combining this predicate with the event closure operator and the indicative morpheme, we end up with the DRS in (160) as translation of (156):

$$(160) \quad \lambda I_{st}.\lambda J_{st}. I[u, \varepsilon]J \wedge \mathbf{Inst}_{p^*}\{u, \mathbf{dog}_k\}J \wedge \mathbf{atom}\{u\}J \wedge \mathit{bark}_{p^*}\{\varepsilon\}J \wedge \mathbf{Ag}_{p^*}\{u, \varepsilon\}J \wedge \neg\mathbf{unique}_q\{u\}J$$

Consider the truth-conditions of this DRS. Recall, that our definition of truth requires us to evaluate a DRS with respect to a singleton input info state. The DRS in (160) will be true with respect to an info state $I = \{i\}$ iff there exists an output info state $J = \{j\}$, such that j differs from i at most with respect to the values of u and ε , and a number of conditions hold. First, the individual uj must be an instantiation of the kind **dog** in the actual world, and must be atomic. Next, εj must be a barking event in the actual world, whose agent is uj . Finally, the non-uniqueness condition in (160) requires for u to return different individuals for some two assignments in J . Given that J is singleton, this final condition cannot be satisfied. It follows that the DRS in (160) is false in any model.

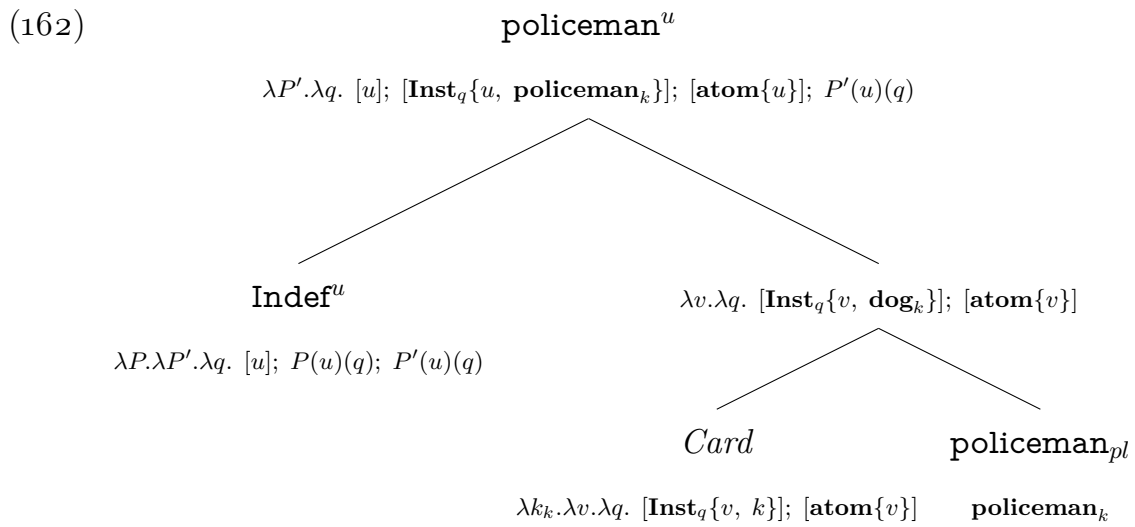
Thus, adopting the analysis in (155) for the bare plural in sentence (154) leads to a DRS which is necessarily false. Recall however, that there is an alternative structure for this sentence, discussed in the previous section, where the bare plural is translated directly as a kind-referring expression, and here our compositional translation delivers the required truth conditions.

Consider now the contrast between (161a) and (161b), which illustrates Partee's Generalisation:

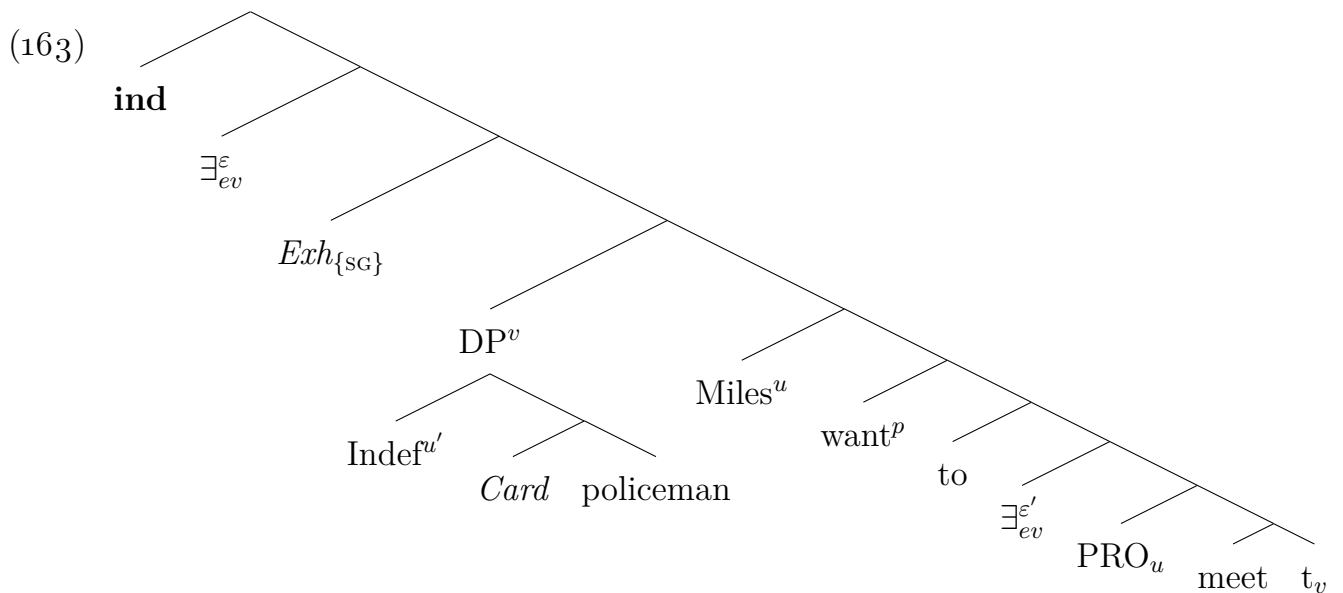
$$(161) \quad \text{a. Miles wants to meet policemen. } \mathit{want} > \exists, * \exists > \mathit{want}$$

$$\text{b. Three boys (all) want to meet policemen. } \mathit{want} > \exists, \exists > \mathit{want}$$

In the previous section, I showed how the wide-scope reading is blocked for kind-referring bare-plurals in examples like (161a). It should be clear that the same conclusion extends to examples like (161b), involving dependent plurals: since quantifier-raising of the kind-referring bare plural fails to produce a distinct scopal interpretation it will be ruled out by Scope-Economy. However, we now have the option of analysing the bare plural in these examples as a true indefinite involving a covert cardinality head, *Card*, and an indefinite determiner, as in (162):



Consider first sentence (161a). We need to ensure that adopting the analysis in (162) does not produce an undesired wide-scope interpretation for this sentence. Potentially, such an interpretation may arise if the bare plural indefinite quantifier-raises into the main clause, as in (163):



Here, the structure below the exhaustification operator is translated as follow:

$$(164) \quad \lambda\zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. I[u, u']J \wedge \mathbf{Inst}_q\{u', \mathbf{policeman}_k\}J \wedge \mathbf{atom}\{u'\}J \wedge \\ (u = \mathit{Miles})J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \\ \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{want}(uj)(\zeta j)(qj)(w)\}) \wedge \\ \exists K_{st}. (H[\varepsilon']K \wedge \mathit{meet}_p\{\varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))$$

The exhaustification operator then compares this event predicate to the following alternative generated by replacing the plural indefinite with its singular counterpart:

$$(165) \quad \lambda\zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. I[u, u']J \wedge \mathbf{Inst}_q\{u', \mathbf{policeman}_k\}J \wedge \mathbf{atom}\{u'\}J \wedge \\ \mathbf{unique}_q\{u'\}J \wedge (u = \mathit{Miles})J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \\ \cup \mathbf{Ran}(f) \wedge \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge \\ pH' = \{w : R_{want}(uj)(\zeta j)(qj)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathit{meet}_p\{\varepsilon'\}K \wedge \\ \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))$$

The alternative in (165) is stronger since it involves a uniqueness condition on the values of u' , which is absent in (164). Hence, strengthening applies, resulting in the event predicate in (166), where the uniqueness condition is negated:

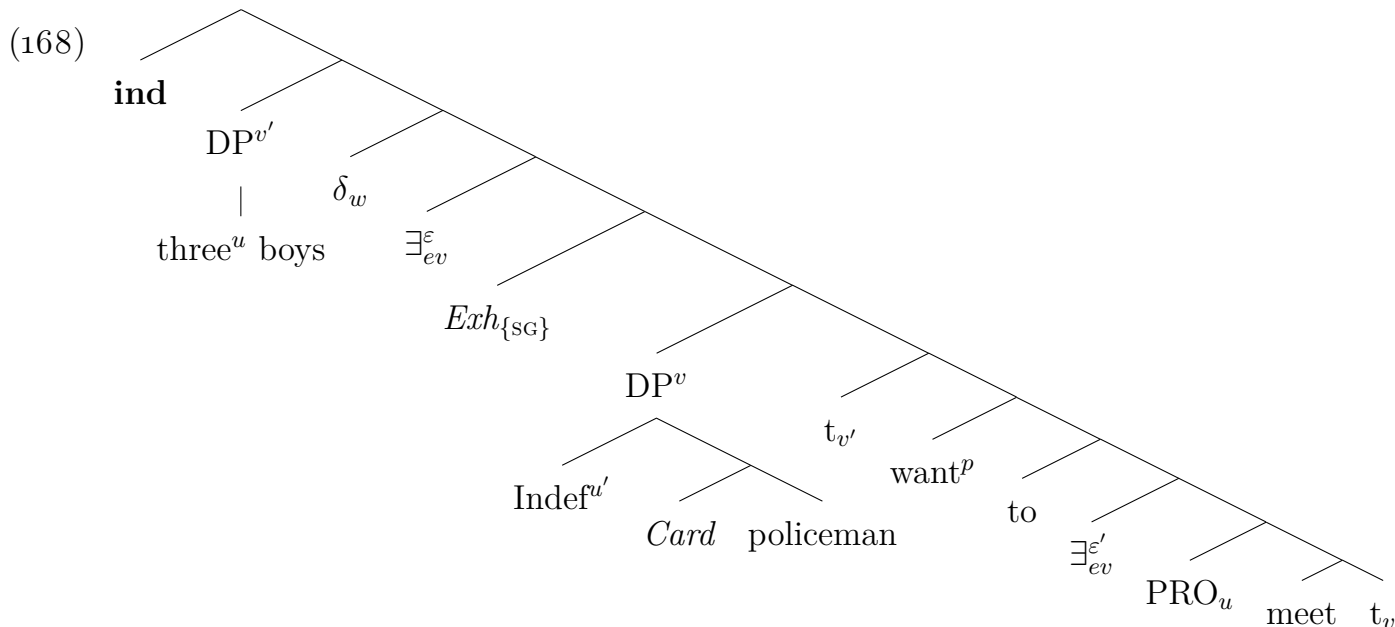
$$(166) \quad \lambda\zeta_v.\lambda q_w.\lambda I_{st}.\lambda J_{st}. I[u, u']J \wedge \mathbf{Inst}_q\{u', \mathbf{policeman}_k\}J \wedge \mathbf{atom}\{u'\}J \wedge \\ \neg \mathbf{unique}_q\{u'\}J \wedge (u = \mathit{Miles})J \wedge \exists H_{st}.\exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \\ \cup \mathbf{Ran}(f) \wedge \forall j_s.\forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge \\ pH' = \{w : R_{want}(uj)(\zeta j)(qj)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathit{meet}_p\{\varepsilon'\}K \wedge \\ \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))$$

After this strengthened event predicate combines with event closure and the indicative morpheme, we arrive at the following DRS as the translation of (163):

$$\begin{aligned}
(167) \quad & \lambda I_{st}. \lambda J_{st}. I[u, u', \varepsilon]J \wedge \mathbf{Inst}_{p*}\{u', \mathbf{policeman}_k\}J \wedge \mathbf{atom}\{u'\}J \wedge \neg \mathbf{unique}_{p*}\{u'\}J \wedge \\
& (u = \mathbf{Miles})J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \\
& \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge \\
& pH' = \{w : R_{want}(uj)(\varepsilon j)(p * j)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathbf{meet}_p\{\varepsilon'\}K \wedge \\
& \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))
\end{aligned}$$

Does this DRS correspond to an (undesired) wide-scope reading of the bare plural? It turns out that it does not. In fact this DRS is necessarily false, for the same reason as the DRS in (160) is necessarily false, as discussed above. Our definition of truth requires us to check the truth of a DRS relative to a singleton input info-state. Furthermore, the \sqsubseteq -relation preserves the cardinality of the info state, which means that the output info state J for the DRS in (167) is also singleton. However, this DRS requires the values of u' to be non-unique with respect to J , which is impossible, given that J must be singleton. Thus, we see that postulating $Card$ does not lead to undesired wide-scope readings of bare plurals in examples like (161a).

Consider now example (161b), with the structure in (168):



The crucial difference between this structure and that in (163) is that here the raised bare plural indefinite occurs in the scope of a weak distributivity operator. Generally, weak distributivity increases the cardinality of the current info state,

and as will see, this will allow the non-uniqueness condition associated with the bare plural to apply in a non-contradictory way.

The translation of (168) below the distributivity operator is the same as that of the corresponding structure in (163), except that the translation of *Miles* is replaced by that of the subject trace:

$$(169) \quad \lambda q_w. \lambda I_{st}. \lambda J_{st}. I[u', \varepsilon]J \wedge \mathbf{Inst}_q\{u', \mathbf{policeman}_k\}J \wedge \mathbf{atom}\{u'\}J \wedge \neg \mathbf{unique}_q\{u'\}J \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{want}(vj)(\varepsilon j)(qj)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathit{meet}_p\{\varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K))$$

Note, that the restriction on the values of u' has been strengthened in the same way as before, with the addition of a non-uniqueness condition. The proposition in (169) combines with the weak distributive operator and the raised subject via the Distributive Quantifying-In rule, yielding the following proposition:

$$(170) \quad \lambda q_w. \lambda I_{st}. \lambda J_{st}. I[u]J \wedge \mathbf{Inst}_q\{u, \mathbf{boy}_k\}J \wedge \mathbf{3_atoms}\{u\} \wedge \exists L_{st}. [J\langle u \rangle L \wedge \exists L'_{st}. (L[u', \varepsilon]L' \wedge \mathbf{Inst}_q\{u', \mathbf{policeman}_k\}L' \wedge \mathbf{atom}\{u'\}L' \wedge \neg \mathbf{unique}_q\{u'\}L' \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{want}(uj)(\varepsilon j)(qj)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathit{meet}_p\{\varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K)))]$$

Combining this proposition with the indicative morpheme, we arrive at the following DRS as the translation of the structure in (168):

$$(171) \quad \lambda I_{st}. \lambda J_{st}. I[u]J \wedge \mathbf{Inst}_{p*}\{u, \mathbf{boy}_k\}J \wedge \mathbf{3_atoms}\{u\} \wedge \exists L_{st}. [J\langle u \rangle L \wedge \exists L'_{st}. (L[u', \varepsilon]L' \wedge \mathbf{Inst}_{p*}\{u', \mathbf{policeman}_k\}L' \wedge \mathbf{atom}\{u'\}L' \wedge \neg \mathbf{unique}_{p*}\{u'\}L' \wedge \exists H_{st}. \exists f_{s(st)}. (J = \mathbf{Dom}(f) \wedge H = \cup \mathbf{Ran}(f) \wedge \forall j_s. \forall H'_{st}. (f(j) = H' \rightarrow \forall h'_s \in H'. (j[p]h') \wedge pH' = \{w : R_{want}(uj)(\varepsilon j)(p*j)(w)\}) \wedge \exists K_{st}. (H[\varepsilon']K \wedge \mathit{meet}_p\{\varepsilon'\}K \wedge \mathbf{Ag}_p\{u, \varepsilon'\}K \wedge \mathbf{Th}_p\{u', \varepsilon'\}K)))]$$

Let us examine the truth conditions of this DRS. Following our definition of truth, we start with a singleton input info state $I = \{i\}$, and introduce a singleton

output info state $J = \{j\}$, which differs from I at most with respect to the value for u :

(172)

Info state J , s.t. $I[u]J$	...	p^*	u	...
j	...	w^*	$b_1 \oplus b_2 \oplus b_3$	...

Here, uj must return a sum of individuals of cardinality 3, which is an instantiation of the kind **boy** in the actual world w^* .

Next, we introduce a new info state L , where the atomic sub-individuals in uj are split as values of u for the assignments in L :

(173)

Info state L	...	p^*	u	...
l_1	...	w^*	b_1	...
l_2	...	w^*	b_2	...
l_3	...	w^*	b_3	...

Then we introduce the event dref ε , which encodes the wanting events, and u' , which represent the referents of the indefinite plural:

(174)

Info state L'	...	p^*	u	ε	u'	...
l'_1	...	w^*	b_1	e_1	p_1	...
l'_2	...	w^*	b_2	e_2	p_2	...
l'_2	...	w^*	b_3	e_3	p_3	...

Given the conditions on u' in (168), for each $l' \in L'$, $u'l'$ must be an instantiation of the kind **policeman** in the actual world w^* , must be atomic, and it must not be the case that all the values of u' for L' are the same, i.e. $\neg(p_1 = p_2 = p_3)$. Note, how due to the semantics of the weak distributivity operator, the non-uniqueness condition in this case applies to a non-singleton info state, and is thus non-contradictory.

The next steps are familiar from our discussion of attitude predicates in section 5.3.5.1. We introduce an info state H such that each assignment l' in L' corresponds to a subset of assignments H' in H , such that each h' in H' differs from l' at most with respect to the value of the possible worlds dref p , and the set of values of p for H' is the set of want-alternatives for $u l'$ in event $\varepsilon l'$ in the actual world:

(175)

Info state H	...	p^*	u	ε	u'	p	...
h_1	...	w^*	b_1	e_1	p_1	w_1	...
h_2	...	w^*	b_1	e_1	p_1	w_2	...
...
h'_1	...	w^*	b_2	e_2	p_2	w'_1	...
h'_2	...	w^*	b_2	e_2	p_2	w'_2	...
...
h''_1	...	w^*	b_3	e_3	p_3	w''_1	...
h''_2	...	w^*	b_3	e_3	p_3	w''_2	...
...

Here, $\{w_1, w_2, \dots\}$ is the set of possible worlds compatible with what boy b_1 wants in event e_1 in the actual world; $\{w'_1, w'_2, \dots\}$ is the set of possible worlds compatible with what boy b_2 wants in event e_2 in the actual world; and $\{w''_1, w''_2, \dots\}$ is the set of possible worlds compatible with what boy b_3 wants in event e_3 in the actual world.

The final step is to introduce the event dref ε' , encoding the meeting events. This is done by postulating the existence of another info state, K , which differs from H at most with respect to the values for ε' :

(176)

Info state K	...	p^*	u	ε	u'	p	ε'	...
k_1	...	w^*	b_1	e_1	p_1	w_1	e_{m1}	...
k_2	...	w^*	b_1	e_1	p_1	w_2	e_{m2}	...
...
k'_1	...	w^*	b_2	e_2	p_2	w'_1	e'_{m1}	...
k'_2	...	w^*	b_2	e_2	p_2	w'_2	e'_{m2}	...
...
k''_1	...	w^*	b_3	e_3	p_3	w''_1	e''_{m1}	...
k''_2	...	w^*	b_3	e_3	p_3	w''_2	e''_{m2}	...
...

Here, for each $k \in K$, $\varepsilon'k$ is a meeting event in pk , whose agent is uk and whose theme is $u'k$. An info state K satisfying these conditions will exist if there are three boys in the actual world, and for each boy b there is one policeman p in the actual world, such that b wants to meet p , and at least two of the boys want to meet different policemen. This amounts to a wide-scope dependent reading of the bare plural in sentence (161b).

As already noted above, the reason that we don't end up with a contradiction when we try to derive a wide scope reading for sentence (161b), as opposed to sentence (161a), is that the weak distributivity operator increases the cardinality of the info state to which the non-uniqueness condition associated with the bare plural indefinite is applied. The specific type of syntactic element that induces weak distributivity, be it a syntactic distributivity operator, as in (161b), or a plural quantificational determiner, as in examples (116)-(119), is not significant. What is crucial is that the bare plural occurs in the scope of this element.

To conclude this section, I have demonstrated how by postulating a null cardinality head *Card* which allows a bare plural to function as a genuine indefinite, we can derive the effects of Partee's Generalisation. This account crucially relies on

the idea of weak distributivity as an operation that increases the cardinality of an info state, as well as on the assumption that the semantic content of bare plurals is enriched via a mechanism of implicature calculation, in competition with singular indefinites.

5.5 Conclusion

In this chapter I addressed three distinct phenomena related to the semantics of dependent plurals: intervention effects, long-distance dependent plurals, and Partee's Generalisation. I demonstrated that the analysis developed in the previous chapters is able to account for 'mixed readings' of constructions involving plural indefinites intervening between dependent plurals and their licensors. We were also able to derive the contrast between singular and plural interveners in such constructions, and provide a simple account of inter-speaker variation in this domain. Next, I addressed the issue of long-distance dependent plurals (LDDPs), demonstrating that a dependent plural and its licensor can be separated by a complement or adjunct clause boundary. I argued that the analysis of dependent plural readings in such constructions is problematic for existing approaches to dependent plurals. On the other hand, the approach developed in this thesis is able to derive the observed interpretations both for LDDPs occurring in the complement clauses of attitude predicates and in temporal adjunct clauses. Finally, I proposed an account of Partee's Generalisation, i.e. the contrast between dependent and non-dependent plurals with respect to their ability to take wide scope with respect to intensional operators. I demonstrated how this contrast can be derived from the assumption that bare plurals optionally combine with a null cardinality head imposing a domain-level atomicity condition.

All the accounts presented in this chapter crucially rely on the notion of weak distributivity as distributivity across the assignments in a plural info state. Insofar as these accounts are successful, they provide further support for the theory of distributivity proposed in this thesis.

Chapter 6

Final Remarks and Conclusion

6.1 Introduction

The issue that I want to discuss in this chapter has to do with what can be referred to as ‘backward compatibility’, borrowing a term from computer science. Specifically, we may ask to what extent the semantic system argued for in this thesis, PCDRT*, is applicable to the phenomena that have previously been analysed in related semantic frameworks, namely frameworks where natural language expressions are interpreted relative to plural info states/sets of assignments. In the system proposed here the notion of plural info states is crucial for the formulation of a three-way distinction between domain-level plurality, weak distributivity and strong distributivity. Previously, however, essentially similar semantic systems have been used to account for a variety of distinct phenomena of which I will consider two: cross-sentential anaphora and dependent indefinites.

The final section of the chapter provides a conclusion to the thesis.

6.2 Cross-Sentential Anaphora

This thesis has focused almost exclusively on intra-sentential phenomena, related to the semantics of quantificational items and grammatical number. Originally, however, the notion of context as a set of assignments, i.e. the idea of dynamic semantics with plural info states, was introduced by van den Berg to account for certain aspects of cross-sentential anaphora which posed problems for existing compositional dynamic semantic systems, such as Groenendijk and Stokhof's (1991) Dynamic Predicate Logic (cf. van den Berg 1990, 1993, 1994, 1996*a,b*). In this section I will consider two relevant cases: abstraction and quantificational subordination.

6.2.1 Abstraction

Consider the following example:

- (1) Each student wrote an article. Then they went for a walk.

Here, the plural pronoun in the second sentence can be understood as referring to the whole plurality of students who wrote an article. How is this type of reference established? In Kamp and Reyle's (1993) DRT this cannot be done directly, since quantificational DPs such as *each student* do not themselves introduce referents accessible in the subsequent discourse. So Kamp & Reyle propose a special operation, called *abstraction*, which makes it possible to introduce new referents by re-using descriptions which occur in previously constructed duplex conditions (i.e. conditions associated with the semantics of quantificational items). Applying abstraction after the DRS for the first sentence in (1) is constructed, we obtain a plural discourse referent, call it Z , that sums up all the individuals that satisfy both the restrictor and the nuclear scope parts of the quantificational duplex condition, i.e. Z is the sum of all x such that x is a student and x wrote an article. This new discourse referent can then serve as antecedent for the plural pronoun in the second sentence.

As Nouwen (2003) demonstrates, the availability of abstraction can also account for anaphoric relations in examples like the following:

- (2) Each student wrote an article. They weren't very good.

Here, the plural pronoun in the second sentence is naturally interpreted as referring to the plurality of articles written by the students mentioned in the first sentence. Thus, in this case the antecedent of the pronoun must be constructed out of the referents introduced in the scope of a quantificational DP (i.e. by the indefinite DP *an article*), rather than referents associated with the quantificational DP itself, as in (1). The abstraction rule, as formulated in Kamp and Reyle 1993, makes this possible. Specifically, applying abstraction to the DRS constructed for the first sentence in (2), we can construct a plural referent which is the sum of all individuals that are articles and that were written by a student (cf. Nouwen 2003 for a more formal discussion). This referent can in turn function as antecedent for the plural pronoun in (2).

Although abstraction is powerful enough to account for anaphoric relations in examples like (1) and (2), it crucially relies on the representational nature of Kamp and Reyle's (1993) DRT system. Specifically, it requires the context to store previously introduced referent *descriptions* and make them available to be re-used and re-combined for the introduction of new referents. This means that abstraction would be difficult to implement in compositional dynamic systems, such as Groenendijk and Stokhof's (1991) Dynamic Predicate Logic and Muskens's (1996) Compositional DRT, which view context as only storing the *values* of previously introduced referents, in the form of a single assignment (cf. the discussion in Nouwen 2003).

Van den Berg's (1990, 1993, 1994, 1996*a*, 1996*b*) proposal aimed to account for complex anaphoric relations, such as those in (1) and (2), within a compositional dynamic framework by making use of a richer notion of context. Since context in this system is formalised as a set of assignments, and correspondingly sentences are translated as relations between such sets, it becomes possible to store the multiple

values that a referent is assigned within a quantificational structure. Consider, again, examples (1) and (2). In van den Berg’s Dynamic Plural Logic, the translation of the first sentence updates the context with two variables, call them x and y , corresponding to the students and the articles involved. These variables will store all the atomic students and the corresponding articles as their values across the assignments in the output context, e.g.:

(3)

	x	y
g_1	s_1	a_1
g_2	s_2	a_2
...
g_n	s_n	a_n

This set of assignments then serves as input for the translation of the second sentence. Thus both types of variables, those associated with quantificational DPs and those associated with indefinites in their scope, become accessible for future pronominal reference, accounting for examples like (1) and (2).

Let us now consider how the system developed in this thesis applies to such examples. Take example (1) first. Recall, that in our system quantificational structures are translated as DRSs of the following general form, where P is the QD’s restrictor, P' is the nuclear scope predicate, and **DET** is the corresponding static quantifier:

$$(4) \quad \mathbf{max}^u([\mathbf{dist}_{w/s}(P(u); P'(u))(u)]); \mathbf{max}^{u'}([\mathbf{dist}_{w/s}(P(u'))(u')]); [\mathbf{DET}\{u', u\}]$$

Recall, further, that the function of the **max** operator is to introduce a new dref into the discourse which returns the maximal sum of individuals that satisfy its argument DRS. Thus, every QD in our system introduces two drefs: one that returns the maximal sum individual satisfying the restrictor predicate (taken under the appropriate distributivity operator), and one that returns the maximal sum

individual satisfying both the QD's restrictor and its nuclear scope predicate (again, placed under a weak or strong distributivity operator). Both of these drefs become accessible for pronominal reference in the subsequent discourse.

Going back to example (1), both drefs introduced by the universal QD *each* return the same sum individual, namely the maximal sum of students, and either of these drefs can be chosen as the antecedent for the plural pronoun in the second sentence, yielding the required interpretation. As discussed in section 4.2.1, with non-universal QDs, we are able to distinguish reference to the maximal individual satisfying the QDs restrictor and reference to the maximal individual satisfying both the restrictor and the nuclear scope predicates, and in fact both types of reference are possible.

Thus, we may conclude that examples like (1) are not problematic in the semantic framework adopted here. Examples like (2), on the other hand, are more tricky. Note, that the DRSs that the **max** operators combine with in (4) (i.e. $[\mathbf{dist}_{w/s}(P(u); P'(u))(u)]$ and $[\mathbf{dist}_{w/s}(P(u'))(u')]$) are tests, i.e. they do not introduce any new drefs into the output info state of the whole quantificational DRS. This is due to the way distributivity operators are defined, and specifically to the fact that combined with their arguments distributivity operators return predicates of info states rather than DRSs. I repeat the definitions here for convenience:

(5) *Distributivity Operators (externally static version)*

a. $\mathbf{dist}_w(D)(u) := \lambda I_{st}. \exists J_{st}. (\langle u \rangle; D)IJ$

b. $\mathbf{dist}_s(D)(u) := \lambda I_{st}. \exists J_{st}. (\langle u \rangle; \mathbf{dist}(D))IJ$

This means that all the drefs that are introduced within the nuclear scope predicate or the restrictor predicate of a QD, e.g. the dref introduced by the indefinite *a paper* in (2), are not added to the output info state of the quantificational DRS, and are thus not directly accessible for pronouns in the subsequent discourse.¹ Thus, anaphoric relations such as the one exemplified in example (2)

¹In this respect the proposed system follows the classical approach to quantification in dynamic systems, cf. e.g. Kamp and Reyle (1993), Groenendijk and Stokhof (1991), Muskens (1996), as

are unaccounted for in the current system. I can see two possible solutions to this problem. One is to invoke a more complex theory of pronominal reference, analysing (at least some) pronouns as covert definite descriptions, along the lines of Heim (1990), Neale (1990), Heim and Kratzer (1998), Elbourne (2001, 2005), etc. Then, plural pronouns in cases like (2) can be argued to receive reference by means of (phonologically) covert descriptive content (which may or may not be syntactically represented, cf. the discussion in Elbourne 2005), rather than via a direct relation to established discourse referents. Admittedly, this kind of solution would be a retreat from the spirit and aims of the original DRT program and subsequent dynamic theories, which were built to account for complex cases of pronoun-antecedent relations while retaining a maximally simple analysis of pronominal items themselves.

The second option would be to modify the semantics of the distributivity operators in such a way that (at least part of) the information introduced in their restrictor and scope is made accessible in the subsequent discourse. Here is one possible way to do this:

(6) *Distributivity Operators (singleton output version)*

a. $\mathbf{dist}_w(D)(u) := \lambda I_{st}.\lambda J_{st}.\exists K_{st}.\langle u \rangle; D)IK \wedge J = \oplus K$

b. $\mathbf{dist}_s(D)(u) := \lambda I_{st}.\lambda J_{st}.\exists K_{st}.\langle u \rangle; \mathbf{dist}(D))IK \wedge J = \oplus K$,

where $J = \oplus K := \exists j_s.(J = \{j\} \wedge \forall v_{se}.(vj = \oplus vK))$

Under this definition, distributivity operators apply to their arguments and return a DRS, whose output info state J is singleton and represents the ‘compressed’ version of the plural info state K generated by the distributivity operation, i.e. the values of each discourse referent in the plural distributive info state K are summed up and assigned as the value for that dref in the output info state J . For instance, consider the first sentence in (2) with the indexing in (7). Given that there are three students in the model, applying the strong distributivity operator to the

well the versions of Brasoveanu’s PCDRT presented in Brasoveanu 2008 and Brasoveanu 2007:Ch. 5.

nuclear scope predicate would generate the set of three singleton info states in (8), where s_1 , s_2 and s_3 are three atomic student-individuals, a_1 , a_2 and a_3 are atomic article-individuals, and s_1 wrote a_1 , s_2 wrote a_2 , and s_3 wrote a_3 .² These singleton info-states are then gathered into the distributive plural info state in (9), which is in turn compressed into the singleton output info state in (10):

(7) Each ^{u, u'} student wrote an ^{u''} article. They _{u''} weren't very good.

(8)

H_1	u'	u''
h_1	s_1	a_1

H_2	u'	u''
h_2	s_2	a_2

H_3	u'	u''
h_3	s_3	a_3

(9)

K	u'	u''
k_1	s_1	a_1
k_2	s_2	a_2
k_3	s_3	a_3

(10)

J	u'	u''
j	$s_1 \oplus s_2 \oplus s_3$	$a_1 \oplus a_2 \oplus a_3$

The info state in (10) (together with the value for u which in this case is identical to that of u') is then passed on as the input state for the second sentence in (7), and thus the reference of the plural pronoun indexed with u'' can be correctly resolved.

²Here and in the following I am disregarding event drefs.

The modification to the semantics of the distributivity operators given in (6) is benign from the point of view of the whole system developed here since it preserves the restriction that non-singleton info states arise only in the scope of distributivity operators. In our analysis, this restriction has played an important role in accounting for a number of empirical observations, a point to which I return in the next section. However, as we will now see, not all aspects of cross-sentential anaphora can be accommodated in this way.

6.2.2 Quantificational Subordination

Consider the following example from Krifka 1996 (cf. also Karttunen 1976):

(11) Three students each wrote an article. They each sent it to L&P.

In this example, the second sentence can be understood as stating that each of the three students mentioned in the first sentence sent the article that she wrote to L&P. Thus, the singular pronoun *it* is able to pick up for each student the value of the referent introduced by the indefinite *an article*, corresponding to that student. Following Brasoveanu (2007), I will refer to this type of anaphoric relation as *quantificational subordination*. It is clear, that quantificational subordination cannot be captured if we adopt the definition of the distributivity operators in (5), assuming that pronouns only receive reference via indexation with previously introduced drefs. This is due to the same feature of these definitions as already discussed in connection with example (2): under these definitions all the information introduced in the scope of a distributivity operator is not passed on to the subsequent discourse, and thus the dref associated with the indefinite *an article* which occurs in the scope of *each* in the first sentence cannot serve as the antecedent for the pronoun in the second sentence. Now, it turns out the modified definitions proposed in (6) to account for example like (2) also fail to generate the required reading in (11). Under these modified definitions, the translation of the first sentence in (12), an indexed version of (11), will define an output info state of the form given in (10), which is, again, derived by ‘compressing’ a plural distributive info state in (9).

(12) Three^{*u'*} students each wrote an^{*u''*} article. They_{*u'*} each sent it_{*u''*} to L&P.

Consider now the translation of the second sentence in (12). It takes the info state in (10) as input, and generates the set of singleton info states in (12) by splitting the referent of *u'* into three atomic sub-individuals:

(13)

H_1	u'	u''
h_1	s_1	$a_1 \oplus a_2 \oplus a_3$
H_2	u'	u''
h_2	s_2	$a_1 \oplus a_2 \oplus a_3$
H_3	u'	u''
h_3	s_3	$a_1 \oplus a_2 \oplus a_3$

Note, that when this kind of ‘splitting’ occurs, the new assignments differ from the the original assignment only with respect to the values of the dref that the distributivity operator applies to, i.e. the assignments in (13) can differ from the assignment in (10) only with respect to the value for *u'*, the values for all other drefs remain the same. This means, that the value of *u''* for each assignment in (13) is the sum of three articles written by the students. Since these values are non-atomic sums, they will not satisfy the atomicity condition associated with the singular feature on the pronoun in (12), ruling out the relevant anaphoric relation.

There is a deeper issue with examples like (12), which is independent of the specific approach to the semantics of number features and distributivity that we adopt. Once the plural info state in (9) is compressed into the singleton output info state in (10), we lose information about the correspondence between the values of *u'* and *u''*, i.e. between the individual students and the articles that they wrote. Thus, even if we manage, somehow, to set up the system in such a way that the values for *u''* are co-distributed with the values for *u'* in the translation of the second sentence, there is no way to ensure that each student ends up in a relation to her own article.

In other words, there is no way to rule out unattested interpretations of the second sentence where, e.g., s_1 sent the article a_2 to L&P, student s_2 sent the article a_3 , and student s_3 sent the article a_1 . We may thus conclude that quantificational subordination, as exemplified in (11), is indeed problematic for the current system, even if we adopt the modified definitions in (6).

On the other hand, it is easy to see how van den Berg's system (cf. van den Berg 1996*b*) can handle examples like (11) (see also Nouwen 2003, Brasoveanu 2007:Ch. 6). In this system, the translation of the first sentence will define an output info state as in (14), analogous to (9).

(14)

	x	y
g_1	s_1	a_1
g_2	s_2	a_2
g_3	s_3	a_3

This set of assignments then functions as input to the second sentence. Due to the presence of *each*, the predicate applies separately to the values of the variables x and y , and the singular pronoun is able to correctly pick up the article corresponding to each of the students.

The reason that this account succeeds where the PCDRT* approach fails is that in van den Berg's system plural info states generated by distributivity operators are passed on, non-compressed, as input for subsequent discourse. Technically, it is not difficult to mirror this approach in PCDRT* by redefining the distributivity operators in the following way:

(15) *Distributivity Operators (non-singleton output version)*

a. $\mathbf{dist}_w(D)(u) := \lambda I_{st} \cdot \lambda J_{st} \cdot \exists K_{st} \cdot (\langle u \rangle; D)IJ$

b. $\mathbf{dist}_s(D)(u) := \lambda I_{st} \cdot \lambda J_{st} \cdot \exists K_{st} \cdot (\langle u \rangle; \mathbf{dist}(D))IJ$

This would mean rejecting the overarching restriction currently implemented in our system that allows non-singleton info-states to appear only in the scope of

distributivity operators. The reason that I did not adopt the definitions in (15) is that, in the context of the proposed analysis, they lead to incorrect predictions with respect to at least two phenomena that I have addressed. First, recall that at least for some speakers plural indefinite DPs with numerals do not induce intervention effects in the scope of weak distributivity operators. For instance, for some speakers sentence (16) is compatible with a situation where each boy tells a different pair of girls one secret:

(16) Three^{*u*₁} boys (all) told two^{*u*₂} girls secrets^{*u*₃}.

In section 5.2, we accounted for this by assuming that in the relevant dialect numerals do not impose a uniqueness requirement on the values of a dref, which means that these values can vary across the assignments in a plural info state. Given the definitions in (15), the translation of this sentence will be compatible with a plural output info state of the following form, where b_1 , b_2 and b_3 are distinct atomic boy-individuals, g_1 , g_2 , g_3 , g_4 , g_5 and g_6 are distinct atomic girl-individual, and s_1 , s_2 and s_3 are secret-individuals:

(17)

J	u_1	u_2	u_3
j_1	b_1	$g_1 \oplus g_2$	s_1
j_2	b_2	$g_3 \oplus g_4$	s_2
j_3	b_3	$g_5 \oplus g_6$	s_3

Consider now example (18):

(18) John^{*u*₄} talked to three girls^{*u*₅}. They^{*u*₅} were all very friendly.

Suppose that the sentences in (18) immediately follow (16) in the discourse. Then, the info state in (17) functions as the input info state for the translation of the first sentence in (18), which adds two new drefs, u_4 and u_5 . The first of these returns John for all assignments in the output info state, while the second returns a sum of three girls for each of these assignments. Given that in the relevant dialect

the numeral does not impose a uniqueness condition on the value of the dref, u_5 can return different sums for different assignments. For instance, the following info state would qualify as an output info state for the translation of the first sentence in (18):

(19)

J	u_1	u_2	u_3	u_4	u_5
j_1	b_1	$g_1 \oplus g_2$	s_1	<i>john</i>	$g_1 \oplus g_2 \oplus g_3$
j_2	b_2	$g_3 \oplus g_4$	s_2	<i>john</i>	$g_4 \oplus g_5 \oplus g_6$
j_3	b_3	$g_5 \oplus g_6$	s_3	<i>john</i>	$g_7 \oplus g_5 \oplus g_6$

Now consider the second sentence in (18). In this example the plural pronoun is indexed with the dref introduced by the plural indefinite DP in the first sentence. Assuming that the input info state for this sentence is as in (19), we expect the second sentence to have a reading on which the predicate is applied to nine distinct girls. In reality, the plural pronoun in the second sentence can only be understood as referring to three girls. On the other hand, if we preserve the restriction that confines non-singleton info states to the scope of distributivity operators by adopting e.g. the definitions in (5) or (6), the undesired interpretation in examples like (16)-(18) does not arise.

Another empirical domain where the above restriction on non-singleton info states plays an important role in our analysis is Partee's Generalisation, discussed in sections 1.4.2 and 5.4. Recall that in English the availability of wide-scope readings of bare plurals in the complements of intensional predicates depends on the presence of weak distributivity operators in the main clause. Thus, in (20a) the main clause does not contain weakly distributive items and the bare plural *policemen* can only be interpreted as scoping below the intensional verb *want*, i.e. sentence (20a) does not have a reading on which there is a specific group of policemen that Miles wants to meet. In (20b) on the other hand, the main clause subject is a weakly distributive DP *all the boys*, and in this case the bare plural can be interpreted as taking both narrow and wide scope with respect to the

intensional verb. Thus, sentence (20b) has a reading where for each of the boys there is a specific policeman that he wants to meet.

- (20) a. Miles wants to meet policemen. $want > \exists, * \exists > want$
 b. All the boys want to meet policemen. $want > \exists, \exists > want$

I analysed this contrast by suggesting that bare plurals may function as proper indefinites when they combine with a cardinality head that introduces a domain-level atomicity condition. Furthermore, in this case the bare plural is enriched with a non-uniqueness condition via the standard mechanism of implicature calculation, which leads to the negation of the singular alternative. This in turn ensures that bare plurals combined with the cardinality head may only occur in the scope of weak distributivity operators since the non-uniqueness condition can only be satisfied with respect to non-singleton info states.

Now, if we allow non-singleton info states to be passed on between sentences in the discourse, we lose the account of the above contrast. Suppose that sentence (20a) follows sentence (21) in the discourse:

- (21) All the older boys met with firemen.

Under the definition of the weak distributivity operator in (15a), the DRS corresponding to this sentence will be compatible with an output info state of the following form, assuming that there are three older boys in the model:

(22)

J	u_1	u_2
j_1	b_1	f_1
j_2	b_2	f_2
j_3	b_3	f_3

Here, b_1 , b_2 and b_3 are the three older boys and f_1 , f_2 and f_3 are (possibly atomic) sums of firemen, such that b_1 met f_1 , b_2 met f_2 , and b_3 met f_3 . If this info state is then passed on as the input info state for the translation of (20a),

we expect the bare plural to be able to function as a proper indefinite capable of taking wide scope, as long as the non-uniqueness condition associated with it is satisfied. Thus, the following output info state will satisfy the DRS corresponding to (20a), where p_1 , p_2 and p_3 are distinct policemen whom Miles wants to meet:

(23)

J	u_1	u_2	u_3	u_4
j_1	b_1	f_1	<i>miles</i>	p_1
j_2	b_2	f_2	<i>miles</i>	p_2
j_3	b_3	f_3	<i>miles</i>	p_3

In fact, the bare plural in (20a) cannot be interpreted as taking wide scope with respect to the intensional verb even if this sentence is uttered after (21). Thus, allowing non-singleton info states to be generated as output info states of sentence DRSs leads us to expect that the availability of wide scope readings in sentences like (20a) should be sensitive to the type of output generated in the preceding discourse. In fact, it is only sensitive to the presence of c-commanding weak distributivity operators in the same sentence.

Thus, we can see that an account of quantificational subordination that relies on non-singleton info states being passed on between DRSs in the discourse is in conflict with our proposed analysis of intervention effects and Partee's Generalisation. This means that either the former or the latter have to be modified, or abandoned. One possibility is to adopt an alternative analysis of examples involving quantificational subordination, such as (11), which does not rely on plural information states, e.g. an analysis based on the treatment of pronouns as covert definite descriptions, mentioned above. This may allow us to account for examples involving quantificational subordination without abandoning the restriction on non-singleton info states that has been crucial for the aspects of our analysis discussed above. I will leave a deeper investigation of this issue for future research.³

³There is independent evidence that the analysis of quantificational subordination in terms

To conclude, an attempt to apply the system proposed in this thesis to complex cases of cross-sentential anaphora produces mixed results. On the one hand, a class of examples captured with the help of the abstraction operation in classical DRT can be directly accounted for in the current framework. Another class of such examples requires only a minor modification, which does not come into conflict with any aspects of the proposed analysis. On the other hand, adopting an analysis of quantificational subordination in lines with the the previously proposed accounts in related semantic frameworks would require us to abandon a core feature of the system, namely the condition that non-singleton info states should arise only in the scope of distributivity operators. As we have seen, this condition plays an important role in our analysis of intervention effects and Partee’s Generalisation. It remains to be seen whether the proposed account of these phenomena can be reconciled with an analysis of quantificational subordination in terms of plural info states, or an alternative approach to quantificational subordination is needed.

6.3 Dependent Indefinites

The idea that natural language expressions are evaluated relative to plural info states, or sets of assignments, has also played an important role in the analysis of so-called *dependent indefinites* (cf. Farkas 1997, see also Choe 1987 and an earlier discussion from a typological perspective in Gil 1982a). Dependent indefinites are morphologically marked indefinite forms that only occur in the scope of nominal or adverbial quantifiers or distributively interpreted plurals (the *licensors*), and whose

of plural information states as presented in van den Berg 1996*b,a* and Brasoveanu 2007 needs to be modified. For instance, neither of these accounts is able capture the asymmetry that exists between referents associated with quantificational DPs and those introduced by indefinite DPs in the scope of quantifiers. Only the latter easily allow for quantified subordination, as the following contrast demonstrates:

- (i) Each boy_{*i*} read a book_{*j*}. Most of them_{*i*} were impressed by it_{*j*}.
- (ii) #Each boy_{*i*} read a book_{*j*}. Most of them_{*j*} impressed him_{*i*}.

In these accounts the status of the two types of drefs in the output of the antecedent quantificational DRS is identical, cf. e.g. the info state in (3). Thus, the contrast we observe between (i) and (ii) is unexpected.

reference must co-vary with the individual or event quantified over by the licenser. For instance, in Hungarian dependent indefinites are marked by the reduplication of certain determiners. Compare the following examples from Farkas 1997:

- (24) a. Minden gyerek olvasott egy / hét könyvet.
 every child read a / seven book-ACC
 ‘Every child read a/seven book(s).’
- b. Minden gyerek olvasott egy-egy / hét-hét könyvet.
 every child read a-a / seven-seven book-ACC
 ‘Every child read a/seven book(s).’

Sentence (24a) contains a standard, non-dependent indefinite in the object position. In this case the indefinite can be interpreted as having both wide or narrow scope with respect to the quantificational subject. In (24b), on the other hand, the DP in the direct object position is a dependent indefinite marked by the reduplication of the determiner/numeral. Here the indefinite can only be interpreted as having narrow scope with respect to the subject, i.e. the (sums of) books must co-vary with the children. As the following example shows, dependent indefinites are also licensed in the scope of plural DPs, which in this case must be interpreted distributively:

- (25) A gyerekek hoztak egy-egy könyvet.
 the children brought a-a book.ACC
 ‘The children brought a book each.’

In the absence of appropriate licensors, dependent indefinites are infelicitous:

- (26) *Hét-hét gyerek szalad.
 seven-seven child runs
 ‘Seven children are running.’

Dependent indefinites have been reported to exist in a diverse range of languages, including Georgian (Gil 1988), Hungarian (Farkas 1997, 2001), Romanian (Farkas 2002), Telugu (Balusu 2006), Tlingit (Cable 2014), Kaqchikel (Henderson 2014), etc. (for a broad typological overview see Gil 2013).

The challenge for semantic theory is to compositionally derive the restrictions that are imposed on the distribution of dependent indefinites and their interpretation. Brasoveanu and Farkas (2011) propose an account of dependent indefinites couched within a semantic framework similar in important respects to the one developed in this thesis. Thus, even though Brasoveanu and Farkas' (2011) Choice-First Order Logic (C-FOL) is static while the system we adopt is dynamic, formulas in C-FOL are interpreted relative a set of assignments, rather than a single assignment. In Brasoveanu & Frakas' system, indefinites are syntactically indexed with sets of variables they are dependent on, i.e. each indefinite is indexed with a subset U of previously introduced variables V , relative to which the values of its witness are allowed to vary. Relative to all the other variables in V , i.e. $V \setminus U$, the value of the witness must be fixed. As an illustration, consider sentence (27a) and its possible C-FOL translations in (27b) and (27c):

- (27) a. Every ^{x} student read a ^{y} paper.
- b. $\forall x[\text{STUD}(x)] (\exists^{\emptyset} y[\text{PAPER}(y)] (\text{READ}(x, y)))$
- c. $\forall x[\text{STUD}(x)] (\exists^{\{x\}} y[\text{PAPER}(y)] (\text{READ}(x, y)))$

The formulas in (27b) and (27c) are evaluated relative to a non-empty set of assignments G and an initially empty set of variables. Somewhat informally, the universal quantifier adds x to the set of accessible variables, and substitutes G for a set of assignments H , such that H differs from G at most with respect to the values for x , for each assignment h in H , $h(x)$ is a student, and H is the maximal set of assignments satisfying these conditions. Assuming that there are three distinct students in the model, the set of assignments H can be represented in the following, familiar, way:

(28)

H	...	x	...
h_1	...	s_1	...
h_2	...	s_2	...
h_3	...	s_3	...

The nuclear scope formula is then evaluated relative to the set of variables $\{x\}$ and the set of assignments H . The existential quantifier adds a new variable y to the set of accessible variables, and substitutes H for a new set of assignments, K , such that K differs from H at most with respect to the values for y , for each $k \in K$, $k(y)$ is a paper, and the values for y are fixed with respect to all the variables which are not in the set of variables that the existential is indexed with. In (27b) the existential quantifier is indexed with the empty set, which means that y will return the same individual for all the assignments in K :

(29)

K	...	x	y	...
k_1	...	s_1	p_1	...
k_2	...	s_2	p_1	...
k_3	...	s_3	p_1	...

Thus, the interpretation of (27b) corresponds to the wide-scope reading of the indefinite in (27a), where all the students read the same paper.

In (27c) the existential quantifier is indexed with the set $\{x\}$, which means that the values for y may, but need not to, co-vary with the values for x . This means that the conditions on K will again be satisfied by the set of assignments in (29) above, or by the that in (30), among other options:

(30)

K	...	x	y	...
k_1	...	s_1	p_1	...
k_2	...	s_2	p_2	...
k_3	...	s_3	p_3	...

The interpretation of (27c) thus captures the narrow-scope reading of the indefinite in (27a).

Let us now go back to dependent indefinites. According to Brasoveanu & Farkas' proposal, dependent indefinites are similar to standard indefinites in that they introduce an existential quantifier co-indexed with a set of variables, which is a subset of the accessible variables. As with standard indefinites, the existential quantifier introduces a new variable by substituting the current set of assignments, say G , with a new one, that differs from G at most with respect to the values for that variable. However, dependent indefinites impose an additional condition on the values of the variable they introduce. Specifically, they require that variable to return different values for at least two assignments that differ with respect to the value of at least one variable in the set that the indefinite is indexed with. In other words, whereas standard indefinites allow the variable they introduce to co-vary with the variables in the set they are indexed with, dependent indefinites make such co-variation obligatory. For example, consider again the Hungarian sentence in (31a), and its C-FOL translation in (31b):

- (31) a. Minden ^{x} gyerek olvasott egy-egy ^{y} könyvet.
 every child read a-a book-ACC
 'Every child read a book.'

b. $\forall x[\text{CHILD}(x)] (\mathbf{dep}\text{-}\exists^{\{x\}}y[\text{BOOK}(y)] (\text{READ}(x, y)))$

The interpretation of (31b) proceeds in the same way as that of (27c), with the universal quantifier introducing the variable x , whose values across the set of assignments constitute the maximal set of children, and the existential operator introducing the variable y , which returns a book for each assignment. However, in

this case the **dep**- \exists enforces co-variation between x and y , i.e. it is required that at least two children read different books.

Note, that the co-variation condition imposed by a dependent indefinite entails that the set of variables it is indexed with cannot be empty. Moreover, this condition captures the fact that dependent indefinites can only occur in the scope of distributive quantifiers, since these are the only items that can introduce variables which have distinct values across the assignments. Other types of DPs, such as indefinites, can only introduce variables with multiple values if they are indexed for co-variation with variables previously introduced by quantificational items.

Summing up, Brasoveanu and Farkas' (2011) account of dependent indefinites relies on two core ingredients. The first is the assumption that formulas are interpreted relative to sets of assignments. This makes it possible to access the whole set of values associated with the variables introduced by quantificational items. The second is a system of formally representing co-variation relations between variables in a formula. In this framework it then becomes possible to formulate the semantics of dependent indefinites in such a way that it enforces co-variation between the variable introduced by the dependent indefinite and a variable introduced by a distributive quantifier.

Let us now consider dependent indefinites from the point of view of the semantic framework developed in this thesis. As already discussed in this chapter, a core feature of this system is that non-singleton info states only arise in the scope of distributivity operators. This means that we could capture the condition on co-variation associated with dependent indefinites without resorting to the additional mechanism of formally representing dependencies between variables in the logic. Instead, dependent indefinites can be taken to impose a non-uniqueness condition, which would require their drefs to return multiple values with respect to the assignments in a plural info state. It would then automatically follow that dependent indefinites can only occur in the scope of distributivity operators. However, there is a problem. Recall that in our system only formulas in the scope of weak distribu-

tivity operators are interpreted relative to non-singleton input info states. Strong distributivity operators, on the other hand, split the plural info state into a set of singleton info states, and the formulas they scope over are interpreted relative to each of these singleton info states separately. This assumption was crucial in our account of the difference between strong and weak distributivity operators in terms of licensing dependent plurals, as well as in terms of their ability to combine with collective predicates. Thus, if we analyse dependent indefinites as simply imposing a non-uniqueness condition on the values of their drefs in the output info state, we would predict that they should only be licensed in the scope of items inducing weak, but not strong, distributivity. This prediction, however, is incorrect.

Consider the case of Russian. In Russian, dependent indefinites are marked by the preposition *po*, and display the core characteristics associated with this class of items cross-linguistically (cf. e.g. Crockett 1976, Pesetsky 1982, Franks 1995, Harves 2003, Kuznetsova 2005, a.o.). Specifically, they are licensed in the scope of quantificational items, and are infelicitous in the absence of such items:

- (32) a. Vse malčiki posmotreli po filmu.
 all boys watched PO movie
 ‘All the boys watched a movie.’
- b. *Ivan posmotrel po filmu.
 Ivan watched PO movie
 Intended: ‘Ivan watched a movie.’

In (32a) the dependent indefinite occurs in the scope of a plural quantificational DP *vse malčiki* ‘all the boys’, enforcing a co-variational interpretation, i.e. this sentence cannot mean that there is a specific film that all the boys watched. In (32a), quantificational licensors are absent and the use of a dependent indefinite is blocked. Consider now sentence (33):

- (33) Každýj malčik posmotrel po filmu.
 each boy watched PO movie
 ‘Each boy watched a movie.’

In this example, a dependent indefinite is licensed in the scope a singular quantificational DP, *každyj malčik* ‘each boy’, and again only a co-variational reading is

possible. Recall, that our theory predicts that quantificational determiners which combine with singular restrictor NPs should induce strong distributivity. This is indeed confirmed for Russian, as the following contrasts demonstrate:

- (34) a. Vse malčiki nadeli šl'apy.
 all boys put.on hats
 'All the boys out on hats.'
- b. #Každyj malčik nadel šl'apy.
 each boy put.on hats
 'Each boy put on hats.'
- (35) a. Vse studenty sobralis' v auditorii.
 all students gathered in lecture.hall
 'All the students gathered in the lecture hall.'
- b. *Každyj student sobral's'a v auditorii.
 each boy gathered in lecture.hall
 Intended: 'All the students gathered in the lecture hall.'

As evident from example (34a), plural DPs with the quantificational determiner *vse* 'all' license dependent plurals, i.e. this sentence is compatible with a reading on which each boy put on one hat. On the other hand, singular DPs with *každyj* 'each' do not license dependent plurals. Thus, sentence (34b) has only the pragmatically odd reading on which each boy put on more than one hat. Moreover, as examples (35a) and (35b) illustrate, quantificational DPs with *vse*, but not those with *každyj*, are compatible with *gather*-type collective predicates. These facts indicate that *každyj* indeed induces strong distributivity, while *vse* induces weak distributivity. Hence, the fact that (33) is perfectly acceptable forces us to conclude that dependent indefinites can indeed be licensed in the scope of strong distributivity operators. As pointed out above, this is problematic if we assume that dependent indefinites impose a non-uniqueness condition on the values of their drefs.

Luckily, this complication can be overcome if we adopt an alternative approach to the semantics of dependent indefinites, proposed by Henderson (2014). Henderson analyses dependent indefinites in the Mayan language Kaqchikel within a dynamic framework based on van den Berg's (1996) Dynamic Plural Logic, discussed

above. This system is similar to the one adopted here in that formulas in the scope of distributive quantificational determiners like *every* are interpreted distributively relative to a set of individual singleton info states. This means that it will not be sufficient to simply assume that dependent indefinites impose a non-uniqueness condition on the values of their drefs in the output info state, as discussed above. Instead, Henderson (2014) proposes to analyse the non-uniqueness condition associated with dependent indefinites as a *post-supposition*, in the sense of Brasoveanu (2012) (cf. also Constant 2012, Farkas 2002, Lauer 2009). The basic idea is that post-suppositional conditions are not evaluated with respect to the immediate output context of an expression, but at some later stage in the semantic derivation. Brasoveanu (2012) proposed to use post-suppositions to account for cumulative readings of sentences involving multiple DPs with modified numerals, as in (36):

(36) Exactly three boys saw exactly five movies.

Henderson (2014) adapts Brasoveanu’s (2012) system to capture the licensing conditions on dependent indefinites. I will not provide a detailed exposition of Henderson’s account here, since some of the specific assumptions behind his analysis differ from those that I have adopted in the present study.⁴ Instead, I will briefly outline how the same core idea can be implemented in the system developed here.

In Brasoveanu’s (2012) and Henderson’s (2014) systems, the notion of context is extended to include a set of tests, that are passed on in the course of the interpretation procedure. The simplest way to implement this in the current system is to modify the notion of a DRS. Instead of takings DRSs to be two-place predicates of info states, i.e. expressions of type $(st)((st)t)$, we can now take them to apply to four arguments: an input info state of type st , an input set of predicates over info states representing previously introduced post-suppositions (type $((st)t)t$), an output info state of type st , and an output set of predicates over info states of type

⁴For instance, Henderson (2014) assumes that new event drefs are always associated with a uniqueness condition, which coupled with the Thematic Uniqueness Requirement rules out the analysis of dependent plurals that has been argued for in this thesis. Furthermore, Henderson follows Brasoveanu (2008) in adopting a state-level definition of maximality which does not deliver the required results in our system, cf. section 3.10.1 for discussion.

$((st)t)t$. DRSs will then have the complex type $(st)((((st)t)t)((st)((((st)t)t)t)))$.

We can then re-define our basic notation in the following way:

$$(37) \quad [\psi_{(st)t}] := \lambda I_{st}. \lambda \pi_{((st)t)t}. \lambda J_{st}. \lambda \pi'_{((st)t)t}. I = J \wedge \pi = \pi' \wedge \psi(J)$$

$$(38) \quad [u_{se}] := \lambda I_{st}. \lambda \pi_{((st)t)t}. \lambda J_{st}. \lambda \pi'_{((st)t)t}. \pi = \pi' \wedge \exists f_{ss}. (\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = J \wedge \forall i \in I. i[u]f(i)),$$

where f is a function of type (ss) , $\mathbf{Dom}(f) := \{i_s : \exists j_s. (f(i) = j)\}$ and

$$\mathbf{Ran}(f) := \{j_s : \exists i_s. (f(i) = j)\}J$$

$$(39) \quad D; D' := \lambda I_{st}. \lambda \pi_{((st)t)t}. \lambda J_{st}. \lambda \pi'_{((st)t)t}. \exists H. \exists \pi'' (D(I)(\pi)(H)(\pi'') \wedge D'(H)(\pi'')(J)(\pi'))$$

Furthermore, we add the following definition to deal with post-suppositions. I will follow Brasoveanu (2012) and Henderson (2014) in using $\overline{\quad}$ to mark post-suppositions:

$$(40) \quad [\overline{\psi}_{(st)t}] := \lambda I_{st}. \lambda \pi_{((st)t)t}. \lambda J_{st}. \lambda \pi'_{((st)t)t}. I = J \wedge \pi' = \pi \cup \psi,$$

$$\text{where } \pi' = \pi \cup \psi := \forall \psi'. (\psi' \neq \psi \rightarrow (\pi(\psi') \wedge \pi'(\psi')) \vee (\neg \pi(\psi') \wedge \neg \pi'(\psi'))) \wedge \pi'(\psi)$$

Finally, we redefine the truth of a DRS with reference to post-suppositions:

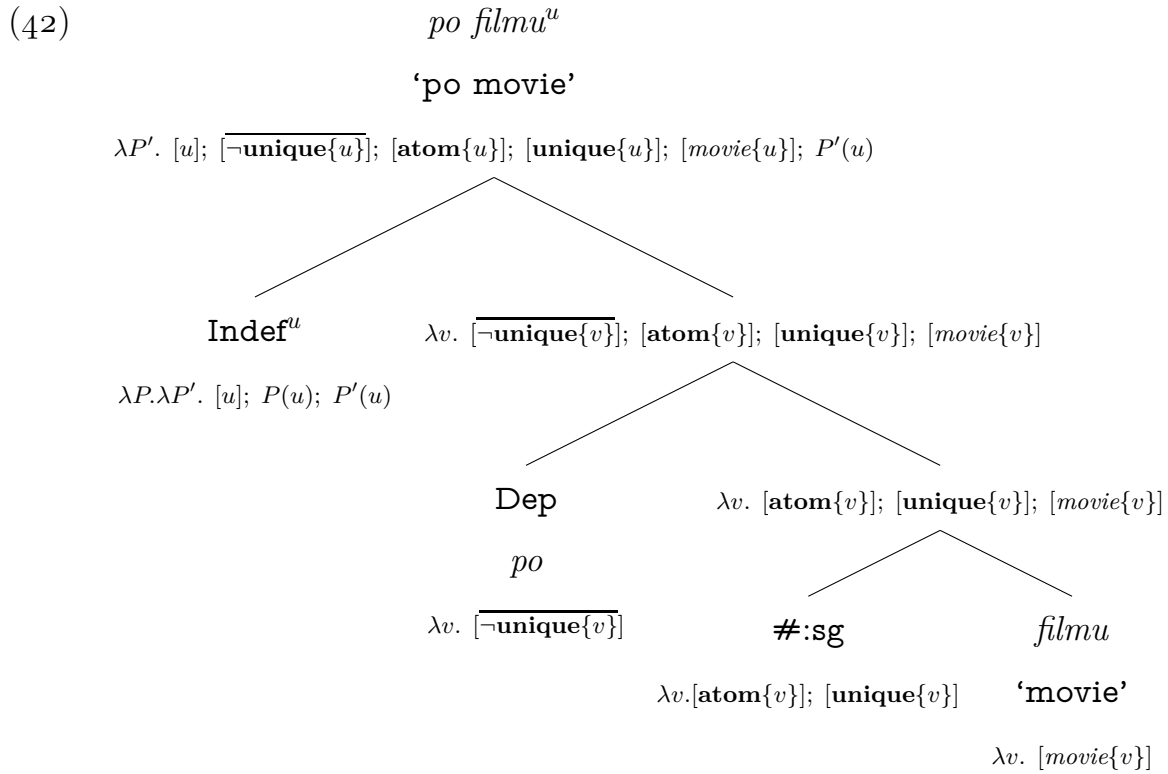
$$(41) \quad \textit{Truth}$$

For a DRS D of type $(st)((st)t)$, an input info state I_{st} and a set $\pi_{((st)t)t}$ such that I is a singleton set of assignments and π is an empty set of post-suppositions, D is *true* with respect to I and π iff there exists a info state J_{st} and a (possibly empty) set $\pi'_{((st)t)t}$ such that:

a) $D(I)(\pi)(J)(\pi') = 1$ and

b) for any ψ such that $\pi(\psi) = 1$, $\psi(J) = 1$.

Dependent indefinites can then be decomposed into a standard indefinite and a *Dep* head which in Russian is lexicalised by *po* and in Hungarian by the reduplication of the numeral, and which encodes the non-uniqueness condition as a post-supposition, e.g.:



The final step is to ensure that the post-supposition introduced by a dependent indefinites in the scope of a distributivity operator is applied to the correct info state. Recall our definition of the distributivity operators in (5), repeated in (43):

(43) *Distributivity Operators*

a. $\mathbf{dist}_w(D)(u) := \lambda I_{st}. \exists J_{st}. (\langle u \rangle; D)IJ$

b. $\mathbf{dist}_s(D)(u) := \lambda I_{st}. \exists J_{st}. (\langle u \rangle; \mathbf{dist}(D))IJ$

What we want is for the post-suppositions associated with dependent indefinites within the DRS D in (43) to be discharged with respect to the plural info state J . This can be accomplished if we redefine the distributivity operators in the following way:

(44) *Distributivity Operators (post-suppositional version)*

- a. $\mathbf{dist}_w(D)(u) := \lambda I_{st}. \exists J_{st}. \exists \pi_{((st)t)t}. \exists \pi'_{((st)t)t}. (\pi = \emptyset \wedge (\langle u \rangle; D)(I)(\pi)(J)(\pi') \wedge \forall \psi. (\pi'(\psi) \rightarrow \psi(J)))$
- b. $\mathbf{dist}_s(D)(u) := \lambda I_{st}. \exists J_{st}. \exists \pi_{((st)t)t}. \exists \pi'_{((st)t)t}. (\pi = \emptyset \wedge (\langle u \rangle; \mathbf{dist}(D))(I)(\pi)(J)(\pi') \wedge \forall \psi. (\pi'(\psi) \rightarrow \psi(J))),$
- where $\pi = \emptyset := \neg \exists \psi_{(st)t}. \pi(\psi)$.

The definitions of the auxiliary operators $\langle \rangle$ and \mathbf{dist} must also be modified, albeit in a rather trivial way, to deal with post-suppositions:

$$(45) \quad \langle u \rangle := \lambda I_{st}. \lambda \pi_{((st)t)t}. \lambda J_{st}. \lambda \pi'_{((st)t)t}. \pi = \pi' \wedge \exists f. (I = \mathbf{Dom}(f) \wedge J = \cup \mathbf{Ran}(f) \wedge \forall i_s. \forall H_{st}. (f(i) = H \rightarrow \forall h_s \in H. (i[u]h \wedge \mathbf{atom}(uh)) \wedge \oplus uH = ui)),$$

where f is a partial function from \mathcal{D}_s to \mathcal{D}_s , $\mathbf{Dom}(f) := \{i_s : \exists j_s. (f(i) = j)\}$ and $\mathbf{Ran}(f) := \{j_s : \exists i_s. (f(i) = j)\}$.

$$(46) \quad \mathbf{dist}(D) := \lambda I_{st}. \lambda \pi_{((st)t)t}. \lambda J_{st}. \lambda \pi'_{((st)t)t}. \exists R_{s((st)t)} \neq \emptyset (I = \mathbf{Dom}(R) \wedge J = \cup \mathbf{Ran}(R) \wedge \forall k_s \forall L_{st} (RkL \rightarrow D(\{k\})(\pi)(L)(\pi'))),$$

where D is a DRS, $\mathbf{Dom}(R) := \{k_s : \exists L_{st}(RkL)\}$, $\mathbf{Ran}(R) := \{L_{st} : \exists k_s(RkL)\}$, and $\{k\}$ is the singleton set of assignments containing k .

The $\langle \rangle$ -operator, whose function is to generate a plural info state by splitting the value of a dref into its atomic parts, simply passes on the set of post-suppositions unchanged. On the other hand, the \mathbf{dist} operator, which splits a plural info state into a set of singleton info states, applies a DRS to each of these info states separately, and then ‘glues’ the singleton info states back together into a plural info state, allows for the set of post-suppositions to be expanded by the DRS it applies to.

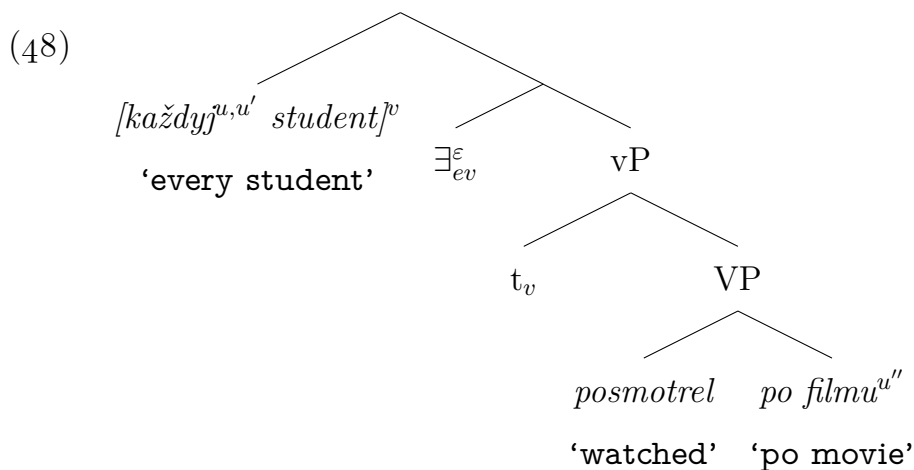
Finally, we need to re-define the maximality operator in order to derive the translation for quantificational determiners:

$$(47) \quad \mathbf{max}^u(D) := \lambda I_{st} \lambda \pi_{((st)t)t} \lambda J_{st} \lambda \pi'_{((st)t)t} \exists f_{ss} \exists K_{st}. (\mathbf{Dom}(f) = I \wedge \mathbf{Ran}(f) = K \wedge \forall i \in I. (i[u]f(i)) \wedge D(K)(\pi)(J)(\pi'))$$

$$\wedge \forall f'_{ss} \forall K'_{ss}. (\mathbf{Dom}(f') \subseteq I \wedge \mathbf{Ran}(f') = K' \wedge \forall i \in \mathbf{Dom}(f'). (i[u]f'(i)) \wedge \exists J'_{st}. (D(K')(\pi)(J')(\pi')) \rightarrow \forall i \in \mathbf{Dom}(f'). (uf'(i) \leq uf(i))),$$

where f is a partial function from \mathcal{D}_s to \mathcal{D}_s , $\mathbf{Dom}(f) := \{i_s : \exists j_s. (f(i) = j)\}$ and $\mathbf{Ran}(f) := \{j_s : \exists i_s. (f(i) = j)\}$.

We now have all the ingredients we need to account for the semantics and distribution of dependent indefinites. As an illustration, consider the compositional translation of sentence (33), with the structure in (48):



First, the dependent indefinite, with the translation in (42), combines with the verb in the familiar way:

$$\begin{array}{c}
(51) \quad \mathbf{max}^u([\mathbf{dist}_s([\mathit{student}\{u\}]; [\varepsilon]; [u'']; \overline{[\neg\mathbf{unique}\{u''\}]}]; [\mathbf{atom}\{u''\}]; [\mathbf{unique}\{u''\}]; \\
\quad [\mathit{movie}\{u''\}]; [\mathit{watch}\{\varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}, \mathbf{Ag}\{u, \varepsilon\}](u)); \\
\quad \mathbf{max}^{u'}([\mathbf{dist}_s([\mathit{student}\{u'\}](u'))]; [\mathbf{EVERY}\{u', u\}]) \\
\quad \swarrow \quad \searrow \\
\begin{array}{cc}
[\mathit{kazdyj}^{u, u'} \mathit{student}]^v & [\varepsilon]; [u'']; \overline{[\neg\mathbf{unique}\{u''\}]}]; [\mathbf{atom}\{u''\}]; [\mathbf{unique}\{u''\}]; \\
\text{'every student'} & [\mathit{movie}\{u''\}]; [\mathit{watch}\{\varepsilon\}, \mathbf{Th}\{u'', \varepsilon\}, \mathbf{Ag}\{v, \varepsilon\}] \\
\lambda P. \mathbf{max}^u([\mathbf{dist}_s([\mathit{student}\{u\}]; P(u))(u)); & \\
\mathbf{max}^{u'}([\mathbf{dist}_s([\mathit{student}\{u'\}](u'))]; [\mathbf{EVERY}\{u', u\}]) & \\
& \swarrow \quad \searrow \\
& \exists_{ev}^\varepsilon \quad vP \\
& \lambda V. [\varepsilon]; V(\varepsilon) \quad \lambda \zeta. [u'']; \overline{[\neg\mathbf{unique}\{u''\}]}]; [\mathbf{atom}\{u''\}]; \\
& \quad [\mathbf{unique}\{u''\}]; [\mathit{movie}\{u''\}]; \\
& \quad [\mathit{watch}\{\zeta\}, \mathbf{Th}\{u'', \zeta\}, \mathbf{Ag}\{v, \zeta\}]
\end{array}
\end{array}$$

The final DRS in (51) is the translation we obtain for sentence (33). Given the definition of truth in (41), let us consider how this DRS is interpreted relative to a singleton input info state I and an empty set of conditions π . This DRS will be true iff there exists an output info state J and set of conditions π' such that it applies to I , π , J and π' . Since the maximality operators in (51) are both applied to tests, and $[\mathbf{EVERY}\{u', u\}]$ is a test, the DRS will introduce two new drefs into the output context: u and u' . Given our definition of new dref introduction, the output info state J will be singleton, i.e. $J = \{j\}$. Consider now the conditions on uj and $u'j$. The latter must be the maximal sum of students in the model. Thus, if there are three students, s_1 , s_2 and s_3 , $u'j$ must return the sum $s_1 \oplus s_2 \oplus s_3$. The conditions on uj are more complex. Specifically, following the definition of the strong distributivity operator in (44b), uj must be the maximal sum of individuals, $x_1 \oplus x_2 \dots \oplus x_n$, such that there exists an info state K and a set of conditions π'' , where K is generated by a series of steps as defined in (44b) and (46). First, the $\langle u \rangle$ operator generates a plural info state of the following form:

(52)

H	...	u	...
h_1	...	x_1	...
h_2	...	x_2	...
...
h_n	...	x_n	...

Next, the **dist** operator splits this info state into a set of singleton info states:

(53)

H_1	...	u	...
h_1	...	x_1	...
H_2	...	u	...
h_2	...	x_2	...
...			
H_n	...	u	...
h_n	...	x_n	...

Then, the DRS that the distributivity operator applies to in (51), defines an output info state relative to each of the singleton info states in (53) and an empty input set of post-suppositions:

(54)

H'_1	...	u	u''	ε	...
h'_1	...	x_1	m_1	e_1	...
H'_2	...	u	u''	ε	...
h'_2	...	x_2	m_2	e_2	...
...					
H'_n	...	u	u''	ε	...
h'_n	...	x_n	m_n	e_n	...

Here, $x_1 \dots x_n$ must be atomic student individuals, $m_1 \dots m_n$ must be atomic

movie individuals, $e_1 \dots e_n$ must be watching events, and for each k , it must be the case that x_k watched m_k in e_k . Moreover, following the definition in (40), the DRS $[\neg\mathbf{unique}\{u''\}]$ adds the condition $\neg\mathbf{unique}\{u''\}$ to the set of post-suppositions π'' .

Finally, the info states in (54) are ‘glued’ together into the info state K :

(55)

K	...	u	u''	ε	...
k_1	...	x_1	m_1	e_1	...
k_2	...	x_2	m_2	e_2	...
...
k_n	...	x_n	m_n	e_n	...

Crucially, the info state in (55) is the one that the post-suppositions in π'' are applied to, which means that it must be the case that u'' returns distinct values for at least two assignments in K . Thus, u_j must return the maximal set of students who each watched one movie, and at least two of whom watched different movies. The final condition in (51) requires for the number of atomic individuals in u_j to be equal to the number of atomic individuals in u'_j , i.e. the set of all students. We have thus derived the required interpretation for sentence (33), which incorporates the co-variation condition associated with the dependent indefinite. Note that since non-singleton info states are never generated outside the scope of distributivity operators and since the non-uniqueness post-supposition associated with dependent indefinites cannot be satisfied relative to a singleton info state, we correctly rule out examples like (26) and (32b) which lack quantificational licensors.

One final comment is in order. Brasoveanu and Farkas (2011) note that the restriction associated with dependent indefinites may in fact be weaker than we have assumed. They cite example (56) from Romanian, where *cîte* is the marker of dependent indefinites:

- (56) Fiecare băiat a recitat câte un poem.
 every boy has recited câte a poem.
 ‘Every boy recited a poem.’

Brasoveanu and Farkas (2011) note that this example can be followed by a sentence stating that later on it turned out that the poems were identical. The same observation applies to the Russian example in (33), i.e. this sentence can be coherently followed by one stating that all the students in fact watched the same movie. This is unexpected if dependent indefinites, as part of their semantics, require their dref to return multiple values. However, in our framework there is a way to weaken the condition associated with dependent indefinites while still accounting for their distribution, i.e. the fact that dependent indefinites must be licensed by quantificational items. Specifically, we can replace the non-uniqueness post-supposition in (57a) with a post-suppositional restriction on the cardinality of an info state, as in (57b):

- (57) a. $\text{Dep} \rightsquigarrow \lambda v_{se}. [\overline{\lambda J. \neg \text{unique}\{v\}(J)}]$
 b. $\text{Dep} \rightsquigarrow \lambda v_{se}. [\overline{\lambda J. |J| > 1}]$

This will ensure that dependent indefinites will only be felicitous in the scope of distributivity operators generating non-singleton info states, but still allow for their drefs to (accidentally) return the same individual for all the assignments. It remains to be seen whether the weakened condition in (57b) is in fact a more accurate characterisation of the semantics of dependent indefinites.

Summing up, I have discussed how the system developed in this thesis can be modified to account for the properties of dependent indefinites. We have seen that analysing dependent indefinites as imposing a standard non-uniqueness condition on the values of their drefs will not work, since dependent indefinites are licensed in the scope of both weak and strong distributivity operators. However, I have argued that the problem can be solved if we analyse the non-uniqueness condition imposed by dependent indefinites as a post-supposition, as proposed by Henderson (2014), and have outlined how the post-suppositional approach can be implemented in our

system.

6.4 Conclusion

This thesis has focused on the semantics of distributivity, grammatical number, and cardinality predicates (i.e. numerals and quantity modifiers such as *several*), and more generally on the way the concept of multiplicity is represented in the semantics of natural language. We have seen that constructions involving so-called *dependent plurals*, i.e. plurals lacking numerals or quantity modifiers occurring in the scope of certain quantificational items, pose a challenge to the classical semantic framework which distinguishes between two sources of multiplicity: domain-level plurality and distributive quantification. Dependent plurals, therefore, constituted the main focus of this study. The investigation proceeded as follows. First, I introduced the core grammatical properties of dependent plurals: co-distributivity, overarching multiplicity, and intervention effects. I then considered the class of items that are able to function as licensors for dependent plurals and formulated the Licensing Generalisations, which links the ability of a quantificational DP to function as a licensor to the number feature on its restrictor NP. Next, I provided an overview of the classes of DPs that can and cannot function as dependent plurals, and proposed the Neutrality Generalisation, which states that only DPs that are underlyingly number-neutral can function as dependents. I also discussed the phenomenon discovered by Partee (1985) and summarised in what I have referred to as Partee's Generalisation, whereby dependent plurals are able to have wide-scope interpretations in contexts where non-dependent bare plurals are confined to narrow scope.

Next, I discussed existing theories of dependent plurals, dividing them into three groups. The first group, which I have referred to as the distributive approach, analyses dependent plural constructions in terms of distributive quantification, arguing that the plural feature is semantically 'neutralised' when plural DPs function as dependents. The second group, referred to as the mereological approach, assimilates

dependent plural readings to cumulative ones. Finally, in Ivlieva's (2013) mixed approach, quantificational licensors of dependent plurals are taken to combine the semantics of cumulativity and distributivity. I considered the strengths and weaknesses of these approaches, arguing that none of them is completely successful in accounting for the full range of properties associated with dependent plurals.

I then moved on to formulate the core of my own proposal. The basic idea of this proposal is that the special status of dependent plural readings as distinct both from cumulative and distributive interpretations, in the classical sense, should be taken at face value. I argued that this can be accomplished in a semantic framework where expressions are evaluated relative to sets of assignments, or plural info states, as originally proposed by van den Berg (1990, 1993, 1994, 1996*a,b*). The specific formal implementation that I proposed, PCDRT*, is based on Brasoveanu's (2007, 2008) Plural Compositional DRT, with a number of significant modifications. I demonstrated how in this framework we are able to distinguish between two types of distributivity: weak distributivity across the assignments in a single plural info state, and strong distributivity across multiple info states. I argued that both of these types of distributivity play a role in the semantics of natural language, e.g. accounting for the contrasting properties of the floating quantifiers *all* and *each*. On the other hand, I argued that the distinction between state-level and assignment- (or domain-) level plurality is crucial for an account of the semantic properties of grammatical number features and cardinality modifiers. I proposed that the singular feature imposes two conditions on the values of a discourse referent in a plural info state: a domain-level atomicity condition, which requires for all the values that the *dref* returns to be atomic sums, and a state-level uniqueness condition, which requires for all these values to be identical. The plural feature, on the other hand, was treated as semantically vacuous. However I demonstrated, building on the proposals in Zweig 2008, 2009 and Ivlieva 2013, how the semantics of plurals in non-downward entailing contexts is enriched with a disjoint non-atomicity/non-uniqueness requirement via a formalised mechanism

of implicature calculation. I further argued that dependent plural readings arise when plurals lacking cardinal modifiers occur in the scope of weak distributivity operators. The fact that the semantics of plurals is enriched to include a disjunction of the form $\neg\mathbf{atom}(u) \vee \neg\mathbf{unique}(u)$ means that drefs introduced by plural DPs can return atomic individuals for the assignments in a plural info states, as long as they do not return the same individual for all the assignments. This accounts for the two core properties of dependent plural readings: co-distributivity and overarching multiplicity. Cardinality expressions, such as numerals and modifiers like *several*, were analysed as imposing assignment-level cardinality conditions on the values of a dref, which accounts for the fact that numerical DPs only allow for a strictly distributive interpretation in the scope of both weak and strong distributivity operators. I also demonstrated how the proposed analysis is able to account for the distinct semantic behaviour of plural pronouns.

Next, I addressed the semantics of quantificational items, focusing on the distinction between ‘plural quantificational determiners’, such as *all* and *most*, and ‘singular quantificational determiners’, such as *each* and *every*. I proposed that plural QDs give rise to weak distributivity, while singular QDs induce strong distributivity, which accounts for the fact that the former, but not the latter, are able to function as licensors of dependent plurals. I also addressed the broader Licensing Generalisation, according to which QDs that combine with restrictor NPs carrying a singular number feature are necessarily strongly distributive. I demonstrated how this generalisation can be derived on the proposed analysis from an independently established Conservativity Universal, which restricts the possible semantics of natural language determiners. Next, I addressed the Neutrality Universal, demonstrating how co-distributive readings between weakly quantificational DPs and DPs containing cardinality predicates are generally blocked on the proposed account, including cases involving modified numerals which, as I have argued, are problematic for a number of existing theories of dependent plurals.

I then addressed the issue of collective predication. I proposed an analysis

of *gather*-type and *numerous*-type collective predicates, and showed how their (in)compatibility with the two types of quantificational DPs can be derived from the semantics of weak and strong distributivity. I argued that this analysis is preferable in comparison to the existing alternatives because it does not require any additional distinctions between singular and plural quantificational DPs to be stipulated.

I also considered the role of pluractional adverbials as licensors for dependent plurals, and showed how the relevant data can be incorporated into the proposed semantic framework. In contrast to pluractional adverbials, modals are not able to license dependent plural readings, however they do induce a certain weakening of the multiplicity condition associated with plurals in their scope. I showed how both of these facts can be made to follow in an intensional variant of PCDRT*.

I then moved on to consider some further applications of the proposed analysis. I demonstrated how the intervention effects discovered by Zweig (2008, 2009) are naturally explained under the PCDRT" analysis, and moreover that the proposed theory can handle so-called ‘mixed readings’, available for some speakers, which are particularly problematic for the mereological and mixed approaches to dependent plurals.

In the next part of the thesis I considered the phenomenon of long-distance dependent plurals, i.e. constructions where the licensor and the dependent are separated by a clausal boundary. Based on both elicited and freely occurring data, I concluded that such dependency relations are possible both across the boundaries of finite complement clauses of attitude and speech predicates, as well as across the boundaries of temporal adjunct clauses. I further demonstrated that all previous approaches to dependent plurals face difficulties in accounting for the semantics of this kind of examples. The analysis developed here, on the other hand, makes it possible to derive the required interpretations.

The next section of the thesis was devoted to an account of Partee’s Generalisation. The analysis I proposed builds on Carlson’s (1977, 1980) original theory of

English bare plurals as kind-referring expressions. The crucial assumption I adopt is that bare plurals can optionally combine with a cardinality head which turns them into standard predicates over individual drefs and encodes a domain level atomicity condition. The presence of the cardinality head allows a bare plural to combine with the indefinite determiner, and thus to function as a standard indefinite in terms of scope. I demonstrated, that this assumption, combined with our previously adopted theory of implicature calculation, is sufficient to derive the fact that bare plurals only have wide-scope readings when they function as dependent plurals in the scope of weak distributivity operators.

Finally, in this chapter, I discussed the issue of ‘backward compatibility’ between PCDRT* and a number of previous analyses developed in related semantic frameworks. I showed that while some of these accounts can be reproduced in PCDRT*, e.g. the analysis of dependent indefinites in terms of a non-uniqueness post-supposition, others rely on assumptions which come into conflict with important aspects of the theory proposed here, and thus the relevant phenomena would require an alternative treatment.

Going back to the general question addressed at the beginning of the thesis, the following picture emerges from our investigation of the properties of dependent plurals. Natural language semantics involves three distinct levels at which the notion of multiplicity can be represented:

I. Domain-level, or assignment-level, multiplicity. This is the level of application for the cardinality conditions associated with numerals and the atomicity condition which is part of the semantics of the singular number feature, as well as for *numerous*-type collective predicates.

II. State-level multiplicity. This type of multiplicity arises in the scope of weak distributivity operators. This is the level at which the uniqueness condition associated with the singular number feature operates, as well as the non-uniqueness condition derived as an implicature for the corresponding plurals. This level of multiplicity is also accessible to *gather*-type collective predicates.

III. Cross-state multiplicity. This is the type of multiplicity that arises in the scope of strong distributivity operators. Since formulas are interpreted relative to a single pair of input and output info states, no condition applied in the scope of a strong distributivity operator can directly access this level of multiplicity. However, it may be accessible to conditions functioning as post-suppositions, e.g. those associated with dependent indefinites.

A number of important questions remain unresolved. These include the status of the Neutrality Generalisation as a language-specific fact or a cross-linguistic universal, the exact nature of the restriction that blocks the combination of certain weakly distributive items, e.g. *both* in some dialects, with *gather*-type collective predicates, the status of the ‘Converse Licensing Generalisation’ (i.e. the observation that quantificational DPs involving plural restrictor NPs are never strongly distributive), and its explanation if it is true, and probably many more. I have also not discussed the semantics of such modifiers as *same* and *different*, a problem which is clearly related to the issues at hand and has been the focus of much recent research (cf. e.g. Carlson 1987, Moltmann 1992, Beck 2000*b*, Barker 2007, Dotlačil 2010, Brasoveanu and Farkas 2011, Bumford and Barker 2013, Hardt and Mikkelsen 2015, a.o.), and completely disregarded the properties of mass nouns and the well-known parallelism between them and plurals. All these topics and many others are left for future research.

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