Cumulativity from Homogeneity

by

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Abstract

Since Schein (1996), cumulative readings of quantifiers have often motivated a departure from standard assumptions about composition. This dissertation proposes a new theory of these cumulative readings that connects them to the phenomenon of homogeneity. Specifically, taking inspiration from Bar-Lev (2018), I argue that predicates sometimes have weak existential meanings, which are revealed when placed under negation. The stronger meaning observed in positive sentences are the result of a procedure of exhaustification. By recognizing predicates' underlying weak meanings and their liability to strengthening, cumulative reading of quantifiers can be accounted for by maintaining relatively standard assumptions about composition. This analysis predicts a range of intricate cases, including Schein's famous video-game examples. It also predicts the truth-conditions of negative cumulative sentences and asymmetries in the availability of cumulative readings of quantifiers.

Thesis Supervisor: Martin Hackl
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Ces jours qui te semblent vides
Et perdus pour l'univers
Ont des racines avides
Qui travaillent les déserts.

- P. Valéry

Writing a thesis is a singular form of collective effort. One person takes the credit but in truth, a thousand hands shape the work. Even more hands shape the mind behind the work. Here, I want to unmask some of the anonymous forces who, in the shadow, have brought together the pieces that constitute this thesis.

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To break out of the never-ending cycle of gratitude, let me conclude by acknowledging how lucky I am to have lived my confinement surrounded by family. I admire my parents for enduring incomprehensible endless babble about squirrels. This dissertation is dedicated to my brother and my sister. Only by imitating them do I ever make progress in life.

Contents

Chapter 1

Weak meanings for cumulativity

1.1 Short primer on plural semantics

This section locates the problem tackled in this work - cumulativity - within the galaxy of phenomena pertaining to plural semantics.

Link's assumption The point of departure of this dissertation is the assumption that the subjects of the sentences in (1) denote entities (Link, 1998). Just as "*Joana*" denotes something in the world out there, i.e. Joana, "*Joana and Marius*" denotes something, namely Joana + Marius. Type-wise, one would say that both expressions are type *e*.

(1) a. Joana and Marius smile.

b. The golfers are celebrating.

c. They look great.

Entities like Joana + Marius are like any regular entity. They can hold properties, be true of predicates, etc. For instance, (1a) asserts that Joana + Marius has the property *smile*. What's special about entities like Joana + Marius is that they are composed of other entities: as is implicit in the notation, Joana + Marius is composed of a Joana part and a Marius part. We'll call entities which are composed of other entities, like Joana + Marius, *pluralities*. The things they are composed of will be called their *parts* or *plural parts*, if we need to be specific. By convention and commodity, we'll say that every plurality is a part of itself. Entities which only have themselves as parts (i.e. Joana) are called *singularities*.

Having accepted Link's assumption, we may broadly outline two research agendas for a semantics of plurality: research pertaining to lexical semantics and research pertaining to compositional semantics. Let me detail both types of research question in turn.

Questions of lexical semantics. With pluralities as new entities and a new structure on the set of entities, one wonders what properties these pluralities have, whether and how their properties are connected to the properties of the singularities they are composed of.

Let me briefly illustrate a simple partial answer to this question. What does it take for Joana + Marius to have the property sleep? We observe: if (2a) and (2b) are true, (2c) must be true as well. Reciprocally, if (2c) is true, it has to be that (2a) and (2b) are true.

(2) a. Joana slept.

b. Marius slept.

c. Joana and Marius slept.

Generalizing, it seems that for every entity X, sleep is true of X if and only if all singularities which are part of X are true of sleep. More formally, we can write (3). (Throughout this dissertation, when the variable of a quantifier is represented as lower-case, the quantifier is implicitly restricted to singularities.)

(3) $\mathsf{sleep}(X) \Leftrightarrow \forall x \prec X,\ \mathsf{sleep}(x)$

Many predicates are characterized by the same property as *sleep*: *smile, dance, be 5 years-old, be in Tanzania*. We call these predicates *lexically distributive predicates*. For these predicates, it is entirely clear what it takes for a plurality X to be in the extension, as a function of its parts.

Not all predicates are lexically distributive like *sleep*. The properties of a plurality cannot always be connected so straightforwardly to the properties of their parts. *expensive* is a case in point. Unlike *sleep*, the truth of (4a) seems independent from the truth of (4b): because of heavy discounts on bottles bought together, (4b) may be false while (4a) are true ; because three inexpensive products can cost a lot taken together, (4a) can be false while (4b) is true. Predicates like *expensive* are therefore not *lexically distributive* ; we call such predicates *collective predicates*.

(4) a. Bottle 1 is expensive. Bottle 2 is expensive. Bottle 2 is expensive.

b. Bottle 1, bottle 2 and bottle 3 are expensive.

Questions of compositional semantics. A second type of questions raised by admitting pluralities as entities is the question of composition. Is the machinery we use to derive the meaning of a sentence from the meaning of its different pieces sufficient when these new entities are introduced? If not, what additional components need to be added to explain the behavior of expressions denoting pluralities?

There is one place where plurality-specific mechanisms have indeed been argued for. For instance, Roberts (1987) observes that (5a) can be read as saying that each woman brought one salad. It appears as if, in this sentence, *the women from Boxborough* had the same effect as *each woman from Boxborough*, a *bona fide* quantifier.

(5) The women from Boxborough brought a salad. Roberts (1987)

How can we maintain Link's assumption that plural noun phrases denote entities given this observation? Roberts (1987) and much of the literature following her propose that in such sentences, an invisible operator, represented as DIST, converts the plurality *the women* (type e) to a universal quantifier *each of the women* (type $(et)t$). This operator is called a distributivity operator and sentences where it occurs are said to display *phrasal distributivity*.

(6) The women from Boxborough DIST brought a salad. Roberts (1987)

With DIST, we have a first example of a mechanism of composition which is specific to pluralities. With singularities, the operator has no effect. Its effect can only be appreciated with sentences that contains pluralities.

Lexical or compositional? We have seen two types of research questions in plural semantics: first, questions of lexical semantics (what properties do pluralities have?) ; second, questions of composition (what compositional mechanisms are there for pluralities?). I have illustrated questions of lexical semantics by reference to *lexical distributivity*. I have illustrated questions of compositional semantics, by reference to *phrasal distributivity*.

Problems of lexical semantics and compositional semantics overlap in the data they consider. It often happens that the presence of certain truth-conditions can be explained either by positing a new operator or semantic rule (compositional semantics) or by making postulates about the meaning of certain verbs or predicates (lexical semantics) or a combination of both. Untangling the contribution of the lexical and the compositional is not always an easy task.

In this thesis, I am concerned with cumulativity. Cumulativity is one phenomenon for which this untangling seems necessary. With cumulativity, we find ambiguous evidence: under one perspective, this phenomenon seems to instruct us about the conditions under which a relation holds between two pluralities ; under another perspective, this phenomenon seems to instruct us about yet other mechanism of composition needed for pluralities. The key to the conundrum, developed in this thesis, comes from adopting more sophisticated view on how the truth-conditions of sentences containing pluralities come about.

1.2 The problem of cumulativity

What is cumulativity? Cumulativity concerns sentences containing two arguments denoting pluralities, like (7a). *Typically*, such sentences give rise to truth-conditions that assert that parts of the subject acted on parts of the object and that all parts of the object acted and all part of the object were acted on. This is expressed by the cumulative truth-conditions in (7b), the cumulative truth-conditions.

(7) a. The squirrels cracked the nuts.

b. **Truth-conditions:**[1]

Every squirrel cracked a nut.

Every nut was cracked by some squirrel

The cumulative truth-conditions in (7b) seem to teach us what it means for X to crack Y, i.e. the lexical semantics of *crack* as it applies to pluralities. Just as earlier, we concluded that X slept if and only if every singularity in X slept, we now learn the equivalence in (8), which decomposes the meaning of *crack* as it applies to X and Y in terms of its parts. Call the equivalence in (8) the *cumulative lexical stipulation*.

(8) $$\mathsf{crack}(X)(Y) \Leftrightarrow \begin{array}{l} \forall x \prec X, \exists y' \prec Y, \mathsf{crack}(X')(Y') \\ \wedge\ \forall y \prec Y, \exists x' \prec X, \mathsf{crack}(X')(Y') \end{array}$$

We saw that predicates like *expensive* were not characterized by lexical distributivity. Similarly here for cumulativity, we find that the *cumulative lexical stipulation* is not adequate for all verbs. In other words, not all transitive verbs give rise to cumulative truth-conditions.

outweigh is one such case. (9a) does not mean the same as (9b). For (9a) to be true, it must be the case the weight of the squirrels is greater than the weight of the nuts. The cumulative truth-conditions stated in (9b) do not guarantee that this holds: if a very heavy squirrel is heavier than all nuts and a very light nut is lighter than all squirrels, (9b) is met and yet, (9a) is not true.

(9) a. The squirrels outweigh the nuts

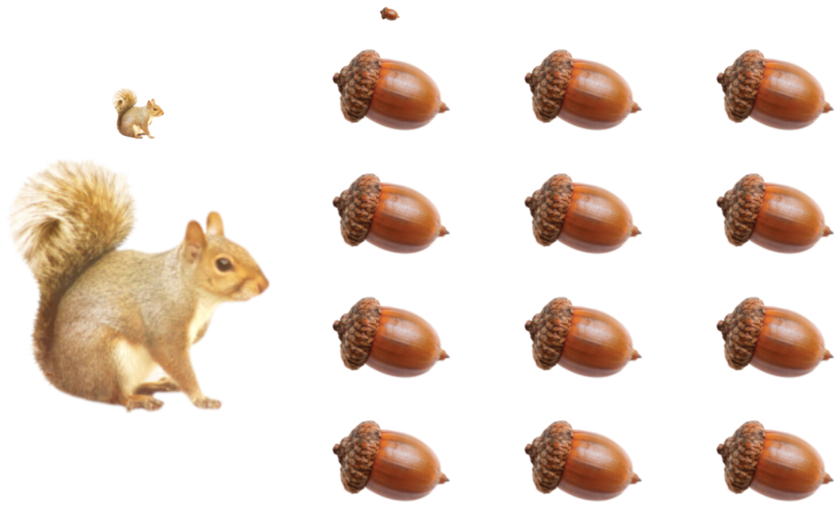
b. **Incorrect truth-conditions:**

Every squirrel outweighs a nut

[1] As we'll discuss later, these paraphrases fail to take into account the fact that multiple squirrels could crack one nut at the same time. This paraphrase is accurate enough to present the problem of cumulativity.

Every nut is outweighed by some squirrel

c. (9a) false, (9b) true



Cumulative readings of *every*. The cumulative lexical stipulation is good as far as simple examples go but yields results that are too strong with more complex examples. The central case that this thesis tries to solve is the case of *cumulative readings of quantifiers*. The problem is illustrated by the sentence in (10a). This sentence seems to be true in more or less the same situations that (10b) is true in, namely the situations described by the cumulative truth-conditions in (10c).

(10) a. The squirrels cracked every nut.

b. The squirrels cracked the nuts.

c. **Truth-conditions:**
Every squirrel cracked a nut.
Every nut was cracked by a squirrel.

Taking *every nut* to be a universal quantifier, one might reasonably expect that the truth of (10a) would reduce to a conjunction of propositions of the form "*the squirrels cracked x*", as the informal paraphrase in (11b) shows. By the cumulative lexical stipulation stated in (8), "*the squirrels cracked x*" is true if and only if every squirrel cracked *x* (and, redundantly, x was cracked by some squirrels). This means that, if the meaning equivalence in (8) is correct, the sentence in (10a) should be true if and only if every squirrel cracked every nut, which is not what we observe.

(11) a. The squirrels cracked every nut.

b. The squirrels cracked nut 1.
and the squirrels cracked nut 2.
and the squirrels cracked nut 3.
...
$\forall x \in [\![\text{nut}]\!],\ [\![\text{crack}]\!](x)(\iota\text{squirrels})$

c. Every squirrel cracked nut 1.
Every squirrel cracked nut 2.
Every squirrel cracked nut 3.
...
$\forall x \in [\![\text{nut}]\!], \forall y \prec \iota\text{squirrels}, [\![\text{crack}]\!](x)(y)$

So there is a problem: cumulative lexical stipulations cannot account for all cumulative truth-conditions. The problem is quite general. It may be replicated with other quantifiers, as we will discuss in chapter 2. Since lexical semantics is not enough, we believe that some form of compositional semantics will be required, either a new semantic rule or a new operator for cumulativity. Whatever the mechanism, the lexical semantics of individual verbs still has some role to play: as we saw, some verbs, like *outweigh*, don't give rise to cumulative truth-conditions.

Towards a solution. In this thesis, I propose a particular solution to this problem. The solution builds on homogeneity, another phenomenon of plural semantics. More specifically, I am inspired by Bar-Lev (2018a)'s perspective on homogeneity. If his analysis of homogeneity is correct, complex compositional operations underlie even the truth-conditions of the most simple sentences like *Jill and Jack slept* or *the squirrels cracked the nuts*. This guiding insight of this dissertation is that by recognizing the additional complexity indepedently needed for homogeneity, we can provide an elegant solution to the puzzle raised by cumulative readings of quantifiers.

1.3 Clues from homogeneity

What is homogeneity? There are situations that neither a sentence nor the corresponding negative sentence can describe. In a world where only male saber-tooth tigers had stripes, neither (12a) nor (12b) would be adequate to utter.

(12) a. The saber-tooth tiger had stripes.

b. The saber-tooth tiger didn't have stripes.

We say that there is a truth-value gap between (12a) and (12b). Truth-value gaps are genuinely mysterious ; we expect the set of circumstances that make a sentence true to be exactly the complement of the set of situations that makes its negation true. This is not the case when there are truth-value gaps.

Sentences with expressions denoting pluralities often give rise to truth-value gaps. For instance, one can neither utter (13a) nor (13b) to truthfully describe a situation where only one out of the two students slept. Indeed, (13a) seems to convey that both students slept and (13b) seems to convey that neither student did. There is a truth-value gap.

(13) a. The two students slept.
$\rightsquigarrow$ *both students are alseep.*

b. The two students didn't sleep.
$\rightsquigarrow$ *neither student is asleep.*

One could say that both (13a) and (13b) require the two students to be "*homogeneous in their sleeping*" (either all slept or all remained awake). For this reason, we call the phenomenon of truth-value gaps that occur with expressions denoting pluralities, *plural homogeneity* or *homogeneity* for short.

Analogy with implicatures Why is there homogeneity? As indicated earlier, this is not what we expect if negation simply means taking the complement. Bar-Lev (2018b) (following Magri (2014)) draws an analogy with implicatures, more specifically Free Choice implicatures. The phenomenon of Free Choice implicatures is illustrated in (14). From the elements in the sentence, one would expect (14a) to mean that either ice-cream or cake is allowed. But the sentence receives a stronger interpretation: both items are allowed. By contrast, the negative sentence in (14b) means exactly what one expects: that it is not the case that one or the other is allowed. The interesting point is that Free Choice implicatures, just like homogeneity, are an instance of a truth-value gap: there are situations that neither (14a) nor (14b) describe (namely when only one of the two items is allowed).

(14) a. You may eat ice-cream or cake.
$\rightsquigarrow$ *both ice-cream and cake is allowed*

b. You may not eat ice-cream or cake.
$\rightsquigarrow$ *neither ice-cream nor cake is allowed*

Free Choice implicatures are deemed an instance of implicatures: we take the meaning "*ice-cream or cake*"to be the "*underlying*" meaning of *you may eat ice-cream or cake*. Following the grammatical tradition of implicatures (Chierchia, 2013; Chierchia et al., 2012; Fox, 2007), this underlying meaning is then strengthened to the meaning observed in positive contexts by application of an EXH operator. The effect of the strengthening is represented by the gray line in the truth-conditions of (15a):

(15) a. EXH You may eat ice-cream or cake

b. **Truth-conditions:**
You may eat ice-cream or you may eat cake.
You may eat ice-cream and you may eat cake.

The EXH is assumed to be inactive or simply absent in negative sentences. That way, we may say that negation "*reveals*" the underlying weak meaning of (15a). This is to say that by taking the complement of the truth-conditions of (16a), we find exactly the meaning of (16a) before EXH applies (i.e. the first line of (15a)).

From Free Choice to homogeneity. Bar-Lev (2018b) proposes to apply the description of Free Choice implicatures to the phenomenon of homogeneity. By analogy to Free Choice implicatures, we take negation to reveal an underlying meaning of the predication "*the two students slept*". This underlying meaning is weak: it simply asserts that either one of the students slept. Added to this underlying meaning, EXH give rise to implicatures that both students slept arise.

(16) a. The two students slept.

b. The two students didn't sleep.

c. **Truth-conditions of (16a):**
Either student slept.
Both students slept.

Because it asserts that both students took part in the activity of sleep, I will label the gray line in (16c) as an exhaustive participation inference. The effect of EXH in homogeneity is then to enforce, it seems, exhaustive participation.

Broader impact of homogeneity. If Bar-Lev (2018b)'s description of homogeneity is correct, we cannot trust positive sentences to tell us the underlying meaning of a particular predication. Earlier, in section 1.1, we characterized the meaning of *sleep* as in (17). But we now see that this conclusion, based on positive sentences, was incorrect. We failed to take into account the obscuring factor EXH.

(17) $\mathsf{sleep}(X) \Leftrightarrow \forall x \prec X,\ \mathsf{sleep}(x)$

Rather, we should have written (18) (and likewise for all lexically distributive predicate): the universal meaning is treated as a exhaustive participation inference created by EXH.

(18) $\mathsf{sleep}(X) \Leftrightarrow \exists x \prec X,\ \mathsf{sleep}(x)$

Bearing in mind, the realization that some of the inferences drawn from a positive sentence may not be "*underlying*" but the effect of strengthening, we can now turn back to cumulative sentences.

1.4 A derivation of cumulativity from homogeneity

The perspective of negative sentences Cumulative truth-conditions were illustrated by (19a). Which part of the cumulative truth-conditions are underlying or the effect of strengthening? To know this, we consider the negative counterpart (19b) of (19a). (19b) is judged true if and only if no squirrels cracked any nuts. As seen earlier, we can retrieve the underlying truth-conditions by taking the complement truth-conditions of (19b). This means that underlyingly, (19a) is true as soon as some squirrels cracked some nuts.

(19) a. The squirrels cracked the nuts.

b. The squirrels didn't crack the nuts.

c. **Truth-conditions:**

Some squirrels cracked some nut.

Every squirrel cracked a nut.

Every nut was cracked by a squirrel.

Both of the gray lines in (20c) must be the result of strengthening. Just as before, I label these inferences exhaustive participation inferences. This is an appropriate label here as well: the first line asserts that all squirrels did some cracking (they all participated!) ; the second line asserts that all nuts were involved in a crack (they were all involved!). In short, we find that there is one exhaustive participation inference associated to each expression denoting a plurality in the sentence.

When first presented with (19a), we concluded that to explain cumulative truth-conditions, crack must obey the equivalence in (20a). At the time, we failed to distinguish between what is underlying and what is an effect of Exh. With our new understanding, we now write the equivalence in (20b) which gives the underlying meaning of *crack* as it applies to pluralities.

(20) a. **Strong meaning:**

$$\mathsf{crack}(X)(Y) \Leftrightarrow \begin{array}{c} \forall x \prec X, \exists X' \prec X, \exists Y' \prec Y,\ x \prec X' \wedge \mathsf{crack}(X')(Y') \\ \wedge\ \forall y \prec Y, \exists Y' \prec Y, \exists X' \prec X,\ y \prec Y' \wedge \mathsf{crack}(X')(Y') \end{array}$$

b. **Weak meaning:**

$$\mathsf{crack}(X)(Y) \Leftrightarrow \exists x \prec X, \exists y \prec Y,\ \mathsf{crack}(x)(y)$$

crack is thus better characterized by the weaker meaning in (20b), hereafter *the weak meaning*, than by the stronger meaning in (20a). The central idea of this thesis is that by adopting the weak meaning of *crack*, cases of cumulative readings of quantifiers cease to be so problematic. I will now illustrate this idea for the case of cumulative readings of *every*.

Cumulative readings of quantifiers. The cumulative reading of the quantifier *every* in (21a) was problematic. Because of standard rules of composition, we expected (21a) to mean (21b). With the initial strong meaning for *crack*, we then expected (21a) to mean "*every squirrel cracked every nut*".

(21) a. The squirrels cracked every nut.

b. The squirrels cracked nut 1.
and the squirrels cracked nut 2.
and the squirrels cracked nut 3.
...
$\forall x \in [\![\text{nut}]\!],\ [\![\text{crack}]\!](x)(\iota\mathsf{squirrels})$

The weak meaning makes a different prediction. Applying the equivalence in (20b) to (21b), we derive a meaning as in (22). This meaning is paraphrasable as *every nut was cracked by some squirrels.*

(22) a. Some squirrel cracked nut 1.

and some squirrel cracked nut 2.

and some squirrel cracked nut 3.

...

$\forall x \in [\![\text{nut}]\!], \exists y \prec \iota\text{squirrels}, [\![\text{crack}]\!](x)(y)$

This is not quite the cumulative truth-conditions ; an inference that every squirrel cracked a nut is lacking. Yet, we are closer to the expected truth-conditions than we were with the strong meaning.

The gap is closed by EXH. We haven't taken into account its contribution in (22a). By now, we have some generalizations about how EXH behaves. We know that it triggers for each expression denoting a plurality, a exhaustive participation inference. In the cumulative sentence, repeated in (23a), we expect it to trigger an exhaustive participation inference for "*the squirrels*". As seen earlier, this would be an inference that every squirrel cracked a nut, which is precisely the inference lacking for the cumulative truth-conditions. To summarize, we predict the dichotomy between underlying meaning and exhaustive participation inferences in (23c).

(23) a. The squirrels cracked every nut.

b. **Truth-conditions:**

Every nut cracked by some squirrel.

Every squirrel was cracked by a nut

These are the cumulative truth-conditions. We arrived at them by applying the same recipe and meaning for *crack* as we did for (24).

(24) a. The squirrels cracked the nuts.

b. **Truth-conditions:**

Some squirrels cracked some nut.

Every squirrel cracked a nut.

Every nut was cracked by a squirrel.

While the truth-conditions of (23a) and (24a) are the same, they are not split in the same way. In other words, the underlying meaning of the two sentences is different. Since negation reveals underlying meanings, the difference should be visible in negative contexts ; negative contexts, as we saw, reveal underlying meanings. That is what we indeed find: (25a) and (25b) have different meanings, even when their positive counterparts have the same meaning.

(25) a. The squirrels didn't crack the nuts.
$\rightsquigarrow$ *no squirrel didn't crack any nut*

b. The squirrels didn't crack every nut.
$\rightsquigarrow$ *not every nut was by some squirrel (or at all)*

This illustrates the case of cumulative readings of *every*. The strategy outlined here has broader implications. In this work, I defend the idea that all cumulative readings of quantifiers may be reduced to the following recipe: weak existential meanings for verbs and exhaustive participation inferences.

The recipe for cumulative readings

- **weak existential meanings:** underlyingly, the meaning of a verb as it applies to a plurality is existential.

$$\mathsf{crack}(X)(Y) \Leftrightarrow \exists x \prec X, \exists y \prec Y,\ \mathsf{crack}(x)(y)$$

- **exhaustive participation inferences:** to each expression denoting a plurality is associated an inference that all members of the plurality were involved in the action.

$$\forall x \in \iota\mathsf{squirrel}, \exists y \in \mathsf{nut},\ \ldots$$

The general recipe demands to be spelled out. Can we really design an operator EXH which delivers precisely the exhaustive participation inferences? How is the weak meaning implemented ? The rest of the thesis is devoted to giving precise answers to these questions. The next section illustrates the roadmap

1.5 Roadmap

This thesis offers two theories of cumulativity based on the ideas presented above. The first theory - the event-less analysis - is presented in chapter 2. It is designed to make as few departures from the compositional assumptions of e.g. Heim and Kratzer (1998) as possible. This chapter is complete and self-sufficient: a reader may limit themselves to this chapter and get a solid understanding of the strategy adopted in this work. By its existence, this account reinforces an argument that the logic of cumulative readings does not require event semantics, as has been argued (Schein, 1993).

The second analysis of cumulativity is based on events. It is aimed to remedy the following limitations of the theory of chapter 2: first, it does not immediately account for collective readings ; second, it will not explain why certain verbs seem to lack homogeneity and cumulativity. To gain insights about the latter point, we must understand what gives rise to weak meanings. The goal of chapter 3 is to give a broader perspective on homogeneity and cumulativity, which will shed light on the question of what gives rise to weak meanings. This chapter shows that non-plural DPs - group nouns and DPs referring to substances - may in some circumstances give rise to homogeneity and cumulativity. The chapter also presents empirical generalizations about when cumulativity and homogeneity occurs with those non-plurals DPs.

Capitalizing on the data of chapter 3, chapter 4 forms a broad theoretical generalization about what it takes for a predicate to be homogeneous and cumulative, based on event semantics. The main idea is that an event predicate will give rise to homogeneity, when the events in its extensions are made of parts. The second part of the Chapter is devoted to develop an analysis of homogeneity and cumulativity, based on weak meanings and strengthening.

Chapter 2, 3 and 4 forms one coherent narrative arc. They are better read in succession. They present two very different implementations of the same recipe. This dissertation leaves is open which of the two analyses should be privileged. An in-depth

The event-less analysis of chapter 2	The eventful analysis of chapter 4
Event-less semantics	Event semantics
Existential verb denotations (type $e^n t$)	Event part verb denotations (type $e^n v t$)
Strengthening via recursive exhaustification	Strengthening via single exhaustification in the event domain
Regular quantifier denotations	Event denotations for quantifiers

Table 1.1: Comparison of the two analyses in this dissertation.

comparison is proposed in chapter 8, summarizing the major features and empirical merits of each analysis.

From there on, subsequent chapters explore independent themes connected to homogeneity and cumulativity. They mainly build on the second theory presented in chapter 4. Although they make occasional references to each other, they may be read independently.

In chapter 5, I compare the event-based system of Chapter 4 to previous event-based analysis. Previous event analysis of cumulativity are founded on the use of argument separation (a.k.a. the Neo-Davidsonian analysis), whereas the analysis of chapter 4 builds on mereological properties of events. I then outline a challenge to both theories based on downward-entailing quantification.

In chapter 6, I classify predicates based on their homogeneity types and show how this classification lines up with traditional typologies of plural predication. I then show how some properties of this typology can be explained by the analysis of chapter 4.

Chapter 7 steps aside from cumulativity to consider phrasal distributivity. It reviews and considers Bar-Lev (2018b)'s proposal that the same mechanism is responsible for homogeneity in distributive sentences and sentences without phrasal distributivity. I give an argument against this approach and in favor of an approach that derive the two types of homogeneity through different mechanisms.

In chapter 8, I offer an in-depth comparison of the event-less theory of chapter 2 and the event-based theory of chapter 4. We will review several empirical case studies mentioned throughout the dissertation.

Chapter 9 reviews the literature on non-local cumulativity. These are cases where cumulative relations seem to be established across a constituent, motivating either an operator-based approach to cumulativity or a compositional approach. I propose alternative pathways which could derive these readings without the need for operators for cumulativity or cumulative composition.

Chapter 2

Exhaustive participation as a distributive implicature

2.1 What is cumulativity?

When two or more plural-referring expressions[1] are arguments of the same verb, they give rise to the so-called cumulative reading. In (1), the cumulative reading asserts that the squirrels and the nuts were involved in some cracking but does not specifically say which of the squirrels cracked which of the nuts. A good enough paraphrase could be (1b)[2]:

(1) a. The 10 squirrels cracked the 15 nuts

b. **Truth-conditions:**

Every squirrel cracked a nut.

Every nut was cracked by a squirrel.

The presence of these readings is not, by itself, a semantic puzzle. It could be analyzed as a simple predication, as in (2). Any inference drawn from (1a), under that view, could be

[1] In this thesis, the technical words or mathematical operators are underlined on first mention and link to a glossary at the end.

[2] This paraphrase, found in Scha (1984) but made prominent in Sternefeld (1998) isn't adequate when collective actions are possible, for instance if more than one squirrel collaborate to crack one nut. This chapter ignores collectivity for the time being, which we turn back to in chapter 6.

attributed to the meaning of the word *crack* and what it means for a plurality of squirrels to crack a plurality of nuts. This analysis of cumulativity is *prima facie* plausible and has been pursued in Roberts (1987); Scha (1984).

(2) a. $[\![\text{cracked}]\!]\,(\iota\textsf{10-squirrels})(\iota\textsf{15-nuts})$

b. **Lexical stipulation:**
$[\![\text{cracked}]\!]\,(X)(Y)$ iff
every one of X cracked one of Y
and every one of Y cracked one of X

However, more complicated examples by Schein (1993) show that at least sometimes, lexical stipulations alone cannot deliver attested cumulative readings. Take the sentence in (3a) for instance ; it simply replaces one of the plural-referring expressions with a quantifier *every*. It seems that this sentence can be paraphrased similarly to the original sentence in (1) (cf (3b)[3]): it is true if every squirrel cracked a nut and every nut was cracked by a squirrel. Given the universal quantificational semantics commonly attributed to *every*, we may expect that the meaning of (3a) would be rendered as in (3d). Along with the lexical stipulation of (2b), that would mean that the sentence could be paraphrased as in the second line of (3d):

(3) a. The ten squirrels cracked every nut.

b. **Truth-conditions:**
Every squirrel cracked a nut.
Every nut was cracked by a squirrel.

c. $\forall x \in [\![\text{nut}]\!],\, [\![\text{cracked}]\!]\,(\iota\textsf{10-squirrels})(x)$

d. **Predicted:**
for every nut x, the squirrels cracked x
↔*for every nut x, every squirrel cracked x and x was cracked by every squirrel*

[3]There are some truth-conditional differences between this type of sentence and the ordinary cumulative sentences like (1): one involves collective action and is covered in chapter 6, the other negative sentences and is discussed in section 2.6.3.

Problematically, this is not the cumulative reading that the sentence seems to have. At least one of our assumptions is to blame: either the cumulative reading of that sentence does not arise through lexical stipulations or our assumptions about *every* need to be revised or both.

One way to revise our stipulation for *every* would be to claim that in some circumstances at least, *every nut* denotes the same object that *the fifteen nuts* denotes, a plurality of fifteen nuts. Since, as we saw in (1), there is no particular problem in accounting for ordinary cumulative sentence with meaning postulates if both the subject and the object denote pluralities, (3) would not pose any particular issues under this assumption. However, with example (4), Schein (1993) has established that even in its cumulative reading, *every* retains a distributive semantics for elements in its scope, i.e. there are four new plays *per* player. If *every nut* denoted a plurality of quarterbacks, this obligatory distributive semantics would be unexpected ; (5), by contrast, does not require *the quarterbacks* to be read distributively.

(4) a. The ten video-games taught every quarterback four new plays.

b. **Truth-conditions:**
Every quarterback was taught two new plays by some of the video-games
Every video-game taught a quarterback some plays.

(5) The ten video-games taught the quarterbacks four new plays.
(ok) four new plays in total

All of this suggests that putative group readings of *every* are not the reason behind cumulative readings of *every*. Since *every* cannot be blamed for generating cumulative readings, we can conclude that cumulative readings sometimes arise compositionally, rather than through lexical stipulations. This conclusion, drawn in various works, has been most prominently defended by Beck and Sauerland (2000)[4]. The goal of this chapter is to build a theory of the composition which can account for cumulative readings and, in particular, cumulative readings of *every*.

[4] On the basis of different data ; we review their approach in chapter 9.

Other quantifiers than *every* Cumulativity is a very general phenomenon and *every* is not an exception among quantifiers in giving rise to cumulative readings. The examples in (6-8) are all examples of cumulative readings with varied quantifiers.

(6) a. The ten squirrels cracked between 28 and 35 nuts.

b. **Truth-conditions:**
Between 28 and 35 nuts were cracked by some of the ten squirrels.
Every one of the ten squirrels cracked a nut.

(7) a. The ten squirrels cracked a prime number of nuts.

b. **Truth-conditions:**
A prime number of nuts were cracked by some of the ten squirrels.
Every one of the ten squirrels cracked a nut.

(8) a. The ten squirrels cracked most nuts.

b. **Truth-conditions:**
Most nuts were cracked by some of the ten squirrels.
Every one of the ten squirrels cracked a nut.

However, the examples above are less interesting to the study of cumulative readings ; unlike *every*, accounting for their truth-conditions doesn't seem to require resources beyond the meaning postulate already mentioned in (2b).

While their intrinsic interest to the theorist may differ, this is not ground to consider cumulative readings of *every* and cumulative readings of other quantifiers separate cases. As we will see, both types of readings satisfy identical generalizations: both obey the generalizations discussed in section 2.2.2. This is why I will also include the study of other quantifiers in the scope of my analysis.

This chapter's dataset. There is a general phenomenon of cumulative readings, as this section hopes to have shown. Some of the varied cases of cumulativity can be reduced to a simple lexical stipulation on the meanings of verbs. If it were for them alone, our semantic work would be done. However, cumulative readings of *every* and in particular, the video-game examples show that at least some of these cases must arise through compositional means.

In addition to setting the problem, this section serves the purpose of showcasing the core dataset of this chapter.

(9) a. The 10 squirrels cracked the 15 nuts

b. The ten squirrels cracked every nut.

c. The ten video-games taught every quarterback four new plays.

d. The ten squirrels cracked between 28 and 35 nuts.

e. The ten squirrels cracked a prime number of nuts.

The dataset in place, this chapter pursues two goals. The first goal is descriptive: I want to state complete generalizations about the truth-conditions of the sentences in the dataset. The second is analytical: I want to provide a first pass at an analysis which delivers these truth-conditions.

Some caveats are in order. First, I will simplify the problem somewhat by disregarding the possibility of collective action. For that purpose, I will assume that cracking is a one-squirrel task ; a nut is always cracked by one squirrel alone. Similarly, video-games always teach full plays ; it doesn't take a quarterback more than one video-game to learn a play. Later chapters will remedy this gap.

Second, for most of this chapter, ordinary cumulative sentences, like (9a), will be left aside. The generalizations and analyisis are more easily presented in the examples b to d, hence my focus on the latter. In section 2.6.3, we will see that the ordinary cumulative sentences raise no particular issues for either the generalization or the analysis.

Roadmap. This chapter has three parts. The first part, which consists of section 2.2, studies cumulativity and another phenomenon related to plurality, homogeneity. From this dual perspective, section 2.2 arrives at two descriptive generalizations, the *low-scope existential* generalization and the *exhaustive participation* generalization. Together, these generalizations completely characterize the phenomenon of homogeneity and cumulativity in our dataset.

In the second part, which consists of section 2.3, I give a formal account of the first generalization, the low-scope existential generalization. I propose that verbs come to the syntax with built-in existential meanings. This proposed mechanism of "*built-in existentials*" will be shown to be independently attested in disparate semantic phenomena, such as *impersonal pronouns* or *metonymy*.

The third part finalizes the theory by providing an account of the *exhaustive participation* inferences. In section 2.4, I show that *exhaustive participation inferences* of non-cumulative sentences are similar to Free Choice inferences (following Bar-Lev (2018b)) and *exhaustive participation inferences* of cumulative sentences are similar to distributive implicatures. Sections 2.5 opens a parenthesis on Free Choice and distributive implicatures ; section 2.5 describes an account of Free Choice and distributive implicatures in terms of recursive exhaustification ; section 2.5.1 shows that only one of these accounts - the recursive exhaustification of Fox (2007) - can truly capture distributive implicatures. Closing the parenthesis on scalar implicatures, section 2.6 applies the theory to our dataset: not only is our dataset fully captured by the theory, including the more complex video-game example, it also provides a principled account of asymmetries in cumulative reading of *every* (Champollion, 2010; Haslinger and Schmitt, 2018; Kratzer, 2000).

2.2 Generalizations about plural interpretations: the dual perspective of homogeneity and cumulativity

The previous section has established cumulativity as a semantic puzzle. However, my description of the facts is still partial. In this section, we will see that there is much to be learned about cumulative readings from the perspective of homogeneity, another aspect of plural interpretation. Specifically, we will systematically compare sentences with cumulative readings with their negation. By paying close attention to patterns that arise from this comparison, this section will establish two descriptive generalizations about the interpretation of plural-referring expressions, which together completely characterize the truth-conditions of cumulative sentences. It will be the goal of the rest of the chapter to provide an account of these inferences.

2.2.1 Homogeneity and why it relates to cumulativity

There are situations which neither a sentence containing a plural nor its negation can appropriately describe. For instance, in the context of (10), neither (10a) nor (10b) can be truthfully asserted.

(10) **Context:** *Half of the dancers are smiling and the other half is crying*

a. # The ten dancers are smiling.

b. # The ten dancers aren't smiling.

This "*truth-value gap*" that plural-referring expressions give rise to is what we call *homogeneity*[5] (Bar-Lev, 2018a,b; Kriz, 2015; Križ, 2016; Križ and Spector, 2020; Löbner, 2000; Magri, 2014; Malamud, 2012; Schwarzschild, 1993). To be more precise, *the ten dancers* in the positive sentence (11a) seems to have a universal or quasi-universal meaning, being roughly equivalent to *every dancer*, whereas it only has an existential meaning in the negative sentence *one of the dancers*.

(11) a. The ten dancers smiled.
$\leftrightsquigarrow$ ***every** one of the ten dancers smiled*

b. The ten dancers didn't smile.
$\leftrightsquigarrow$ *it's not the case that **one** of the ten dancers smiled*

The relevance of this phenomenon to the puzzle of cumulativity may not seem obvious. However, we are now going to see that there are parallels between the way homogeneity and cumulativity have been described in the literature. These parallels will be our initial motivation to study both phenomena in parallel.

[5] By extension, the name is also applied to truth-value gaps exhibited by other constructions such as conditionals (Bassi and Bar-Lev, 2018), embedded questions(Kriz, 2015).

Existentials for homogeneity and cumulativity. According to one type of analysis (Bar-Lev, 2018b; Magri, 2014) of the truth-value gap exhibited in (11a) and (11b), the meaning of plural-referring expression, as revealed in negative environments, is underlyingly existential. This means that by default, plural-referring expression receive the same existential readings seen in (11b). In positive environments, they propose that the underlying existential reading is masked by additional inferences, which come about through exhaustification (additional inferences color-coded in gray below).

(12) a. The ten dancers smiled.
$\rightsquigarrow \exists x \prec \iota\text{10-dancers}, \text{smiled}(x) \wedge \forall x \prec \iota\text{10-dancers}, \text{smiled}(x)$

b. The ten dancers smiled.
$\rightsquigarrow$
$\neg\exists x \prec \iota\text{10-dancers}, \text{smiled}(x)$

An interesting connection enters the stage at this point: independently from any debates around homogeneity, Bayer (2013) has also suggested that plural-referring expressions may sometimes receive existential interpretations, precisely in order to account for cumulative readings of *every*. Specifically, he observes that treating *the squirrels* as an existential (cf red quantifier in (13b)), we derive one of the two inferences that form the truth-conditions of cumulative reading, namely that *every nut was cracked by a squirrel*. He notes that the other inference *every squirrel cracked a nut*, color-coded in gray below, is missing. He refers to this problem as *the leakage problem*.

(13) a. The ten squirrels cracked every nut.

b. **Bayer's translation:** $\forall x \in \text{nut}, \exists y \prec \iota\text{10-squirrels}, \text{crack}(x)(y)$

c. **Attested truth-conditions:**
Every nut was cracked by a squirrel.
Every one of the ten squirrels cracked a nut.

This "*leakage*" problem is parallel to the situation discussed in (11) for homogeneity: with homogeneity, additional inferences were missing in order to account for the attested universal meaning of plural-referring expression in positive environment. As we saw, these additional inferences were only required for positive sentences.

The new observation I make here is that the same holds of the cumulative sentence in (13): the negation of Bayer's paraphrase is perfectly adequate for negative sentences ; no additional inferences is needed to derive the meaning of the sentence in negative environment. Indeed, consider the negative version of (13). Speakers judge that this sentence is true if and only not every nut was cracked by a squirrel, i.e. the negation of Bayer's paraphrase in (13b). Whether or not all squirrels cracked a nut is deemed irrelevant to the truth of the sentence. No "*leakage*" problem arises in negative environments.

(14) a. The ten squirrels didn't crack every nut.

b. **Bayer's translation:** $\neg\forall x \in \mathsf{nut}, \exists y \prec \iota 10\text{-squirrels}, \text{crack}(x)(y)$

c. **Attested truth-conditions:**
Not every nut was cracked by a squirrel.

Summary. Conjoining two independent lines of thought in the literature, we see two parallels between cumulativity and homogeneity: first, in both the typical case of homogeneity and cumulativity, the plural-referring expressions is paraphrasable as an existential ; second, these paraphrases must be supplemented with additional inferences for to fully capture the truth-conditions of positive sentences. The next section is devoted to spelling out more precisely what the parallels consist in. I present two descriptive generalizations which together completely characterize the phenomena of homogeneity and cumulativity in our dataset.

2.2.2 The two generalizations

Let us reflect on the two examples seen so far. They are repeated below in their positive and negative form.

(15) a. The dancers smiled

b. $\underline{\exists x \prec \iota\text{10-dancers},}\ \text{smiled}(x)$

$\forall x \prec \iota\text{10-dancers},\ \text{smiled}(x)$

(16) a. The dancers didn't smile

b. $\neg\underline{\exists x \prec \iota\text{10-dancers},}\ \text{smiled}(x)$

(17) a. The squirrels cracked every nut.

b. $\forall x \in \text{nut}, \underline{\exists y \prec \iota\text{10-squirrels}}, \text{crack}(x)(y)$

$\forall y \prec \iota\text{10-squirrels}, \exists y \in [\![\text{nut}]\!], \text{crack}(x)(y)$

(18) a. The squirrels didn't crack every nut.

b. $\neg\forall x \in \text{nut}, \underline{\exists y \prec \iota\text{10-squirrels},}\ \text{crack}(x)(y)$

As seen in the previous section, in all of the paraphrases of the negative sentences and at least one half of the paraphrase of the paraphrase of positive sentences, the plural-referring expression is translated as a existential over atomic parts of the plurality denoted by plural-referring expression (underlined in the examples above). The restriction to atoms is a consequence of this chapter's narrow focus on the non-collective case

We may moreover observe that when there are operators in the clause, this existential always takes the lowest scope within the paraphrase. Any other scope-ordering in our logical paraphrases misses the attested reading:

(19) a. The dancers didn't smile

b. **Inadequate paraphrase**

$\underline{\exists x \prec \iota\text{10-dancers},}\ \neg\text{smiled}(x)$

(20) a. The squirrels didn't crack every nut.

b. **Inadequate paraphrase**

$\neg\underline{\exists y \prec \iota\text{10-squirrels}}, \forall x \in \text{nut}, \text{crack}(x)(y)$

= *no squirrel cracked every nut*

This makes the basis for the first generalization[6]:

Low-scope existential meaning

In the logical paraphrase of a sentence, a plural-referring expression are interpreted as an existential over parts which takes a lower scope than any other quantifier or operator in the clause:

$$\text{the squirrels} \rightsquigarrow \ldots Q y, \ldots \exists x \prec \iota\textsf{squirrels}, \ldots$$

The second generalization we can make from our sample so far concerns the shape of the inferences which are only attested in positive sentences (in gray above). Informally, these inferences all convey that all members denoted by the plural-referring expression participated in the action described by the verb. What it means for an x to "*participate in the action described by the verb*" in our paraphrases is simply to be true of the predicate with all of the other arguments existentially bound by appropriately restricted quantifiers. These inferences will therefore be referred to as *exhaustive participation inferences.*

More formally, we can state the generalization as follows:

[6] The generalization specifies that the existential corresponding to the plural-referring expression must scope lower than any element *in the clause*. The addition of "*in the clause*" does not rule out the existential scoping higher than an operator in an embedded clause, as in (21):

(21) The headlines didn't say the president wasn't in trouble.
$\neg\exists x \prec \iota\textsf{headlines},\ \textsf{say}(x)(\neg\textsf{in-trouble}(\iota\textsf{president}))$

On closer inspection however, note that the addition of *in the clause* is in fact unnecessary since a quantifier may not scope lower than the variable it binds. Since its variable is in the matrix clause, the existential cannot scope below that point.

Exhaustive participation inferences

In positive environments only, each plural-referring expression gives rise to an *exhaustive participation inference*.

This *exhaustive participation inference* of a plural-referring expressions DP is of the form "$\forall x \prec [\![DP]\!], \exists y \in C, \ldots$" where the plural-referring expression is interpreted universally with high-scope and the other arguments are interpreted as existentials ranging over the NP restriction of the arguments, as below:

$$\text{the NP} \ldots \mathcal{Q}\ \text{NP}' \ldots \mathcal{Q}\ \text{NP}'' \ldots \rightsquigarrow \forall x \prec [\![\text{NP}]\!], \exists y \in [\![\text{NP}']\!], \exists z \in [\![\text{NP}'']\!], \ldots$$

There are several comments to make about this generalization. First, the fact that this condition is specified to apply *only* in positive environments means that plural-referring expressions will yield truth-value gaps, just as we observed. Indeed, there will be inferences of positive sentences which are not found under negation in negative sentences.

The second remark is a forewarning: because of cases discussed in section 2.6.1, we will see that this generalization is not true in all generality, in ways that the analysis predicts. However, it is enough as far as our main dataset is concerned.

In the remainder of this section, we will put these generalizations to the test by seeing how they apply beyond the two classes of examples that motivated them. We will turn to the other sentences in the dataset: Schein's video-game example, cumulative readings with other quantifiers than *every* and finally a non-cumulative sentence.

The video-game examples In Schein (1993)'s video-game example, a plural-referring expression shares the predicate with *every* and a numeral quantifier. Our first generalization, the low-scope existential generalization states that one half of the truth-conditions of the video-game example can be obtained by translating the plural-referring expression as a low-scoping existential, as in the black part of (22b).

The second generalization dictates the shape of the exhaustive participation inferencesof *the ten video-games*. It states that this inferences will be as the gray part of (22b), the definite plural replaced by a universal and all other quantifiers mutated into existential ones.

Comparing the paraphrase we obtained by following the mandates of our two generalizations to the attested reading of the sentence from section 2.1 and repeated below, we find that the match is perfect.

(22) a. The ten video-games taught every quarterback two new plays.

b. $\forall y \in \mathsf{quarterback}, \exists 2z \in \mathsf{plays}, \exists x \prec \iota\mathsf{video\text{-}games},\ \mathsf{teach}(x)(y)(z)$

$\forall x \prec \iota\mathsf{video\text{-}games}, \exists y \in \mathsf{quarterback}, \exists z \in \mathsf{plays},\ \mathsf{teach}(x)(y)(z)$

c. **Attested reading:**

Every quarterback was taught two new plays by some of the video-games

Every video-game taught a quarterback some plays.

Our generalizations also leads us to the expectation that sentence (22a) has a truth-value gap. Namely, its negation should only be the negation of the black part of (22b) rather than the negation of the whole of (22b), since the *exhaustive participation inference* is only derived for positive contexts. In other words, (23) should mean (24a) rather than (24b).

(23) The ten video-games didn't teach every quarterback two new plays.

(24) a. **Expected truth-conditions:**

$\neg\forall y \in \mathsf{quarterback}, \exists 2z \in \mathsf{plays}, \exists x \prec \iota\mathsf{video\text{-}games},\ \mathsf{teach}(x)(y)(z)$

b. **Unexpected truth-conditions:**

$\neg\forall y \in \mathsf{quarterback}, \exists 2z \in \mathsf{plays}, \exists x \prec \iota\mathsf{video\text{-}games},\ \mathsf{teach}(x)(y)(z)$

$\vee\neg\forall x \prec \iota\mathsf{video\text{-}games}, \exists y \in \mathsf{quarterback}, \exists z \in \mathsf{plays},\ \mathsf{teach}(x)(y)(z)$

One way to probe this difference on native speakers is to compare the acceptability of continuations provided as justifications for the statement:

(25) The ten video-games didn't teach every quarterback two new plays.

a. #... indeed, although all quarterback learned two plays, one of the video-games wasn't working.

b. ... indeed, although all video-games taught some plays, one quarterback didn't learn anything.

All in all, the generalizations extend to the relatively complex case of video-game examples, which is a testament to their robustness.

Cumulative reading with other quantifiers than *every*. As we noted, cumulative sentences can be constructed with other quantifiers than *every*.

(26) a. The ten squirrels cracked at least 5 nuts.

b. The ten squirrels cracked most of the nuts.

As before, our paraphrases have two parts: a core meaning and an *exhaustive participation inference*. By the low-scope existential paraphrase, *the ten squirrels* must be translated in the paraphrase as a low-scope existential meaning ; this is what I have done in the black part on (27). To obtain the exhaustive participation inference, as per the second generalization, one simply needs to replace every argument other than *the ten squirrels* by an existential and treat the latter as a high-scope universal. This is done in the gray part of (27). The truth-conditions predicted by the two generalizations match the observed truth-conditions.

(27) a. **Predicted truth-conditions of (26a):**

$$\#\left\{x \in \mathsf{nut} \;\middle|\; \exists y \prec \iota\mathsf{squirrels}, \mathsf{cracked}(x)(y)\right\} > 5$$

$$\wedge \forall x \prec \iota\mathsf{squirrels}, \exists y \in \mathsf{nut}, \mathsf{crack}(x)(y)$$

b. **Predicted truth-conditions of (26b):**

$$\frac{\#\{x \in \mathsf{nut} \mid \exists y \prec \iota\mathsf{squirrels}, \mathsf{cracked}(x)(y)\}}{\#\mathsf{nut}} > .5$$

$$\wedge \forall x \prec \iota\mathsf{squirrels}, \exists y \in \mathsf{nut}, \mathsf{crack}(x)(y)$$

What we see here is that from the perspective of the generalizations, nothing really distinguishes these cases from the video-game example and the cumulative sentence with *every*. My approach thus departs from some of the previous literature (reviewed in chapter 9) which frequently give cumulative reading of *every* a distinguished status.

The low-scope existential generalization in non-cumulative sentences So far, all of the examples used to showcase the generalizations have involved cumulative sentences. However, the generalizations have been stated to hold for plural interpretation in general. In principle then, their empirical use could also be appreciated on non-cumulative sentences as well.

Consider (28). It only contains one plural-referring expression and *only*. As such, it does not fall within what I narrowly defined as a cumulative reading. Let us focus on the assertive meaning of (28).

(28) Last week, the neighbor's dogs only barked on Sunday

The low-scope generalization predicts that one part of (28) is paraphrasable as the black part of (29). This part asserts that on days that were not Sunday, no dog barked. Whether the *exhaustive participation* generalization applies is more tricky to say, since *only* does not form a typical positive or negative environment. However, whether it applies or not, the derived inference in gray below does not strengthen the assertive meaning of the sentence. The predicted reading match the intuition that the sentence can only be true if no barking happen on any other day than Sunday.

(29) $\neg\exists d \neq \textsf{Sunday}, \exists y \prec \iota\textsf{10-dogs}, \textsf{bark-on}(y)(d)$

$\wedge \forall y \prec \iota\textsf{10-dogs}, \neg\exists d \neq \textsf{Sunday}, \textsf{bark-on}(y)(d)$

Note what would happen for (28), if the *low-scope existential* generalization did not specify that the existential had to be low-scope. If the *exhaustive participation inference* generalization does apply, nothing would change since the exhaustive participation inference already delivers the right meaning:

(30) $\exists y \prec \iota 10\text{-dogs}, \neg\exists d \neq \text{Sunday}, \text{bark-on}(y)(d)$

$\wedge \forall y \prec \iota 10\text{-dogs}, \neg\exists d \neq \text{Sunday}, \text{bark-on}(y)(d)$

= *no dog barked on any other day than Sunday*

However, there is reason to doubt that the meaning of (28) is due to an exhaustive participation inference. This is because we find no truth-value gap as far as the assertive meaning is concerned. If (30) truly represents the truth-conditions of (28), then we would expect (31a), its negation, to receive the meaning in (31b). In fact, it receives the meaning of (31c), which is simply the negation of the truth-conditions specified in (29).

(31) a. I doubt that the neighbor's dogs only barked on Sunday.

b. *high-scope existential:*

$\neg\exists y \prec \iota 10\text{-dogs}, \neg\exists d \neq \text{Sunday}, \text{bark-on}(y)(d)$

$\leftrightarrow \forall y \prec \iota 10\text{-dogs}, \exists d \neq \text{Sunday}, \text{bark-on}(y)(d)$

=*all dogs barked on some other day*

c. *low-scope existential:*

$\neg\neg\exists d \neq \text{Sunday}, \exists y \prec \iota 10\text{-dogs}, \text{bark-on}(y)(d)$

$\leftrightarrow \exists y \prec \iota 10\text{-dogs}, \exists d \neq \text{Sunday}, \text{bark-on}(y)(d)$

=*some dogs barked on some other day*

This example both confirms the validity of the generalizations on non-cumulative sentences, in addition to illustrating once more the importance of the *low-scope* property. We will come back to this example in section 2.3.

2.2.3 Summary and outlook

Both the analysis of cumulativity and homogeneity suggest that plural receive an existential interpretation, as independently suggested by Bar-Lev (2018b); Magri (2014) for homogeneity and Bayer (2013) for cumulativity. Here, I furthermore suggested that this existential interpretation is bound to take the lowest-scope in the clause. These facts formed the basis of our first generalization, the low-scope existential generalization.

In positive environments, this existential reading may be obscured by additional inferences, the *exhaustive participation inferences*, which asserts that all individuals denoted by plural-referring expression are in some sense involved in the action. It is the object of the second generalization to characterize the shape of the *exhaustive participation inferences*.

In the next sections, we move beyond the descriptive level and I will propose a derivation of these generalizations.

2.3 Analysis of the low-scope existential meaning

I will analyze the two generalizations of the previous section in two separate parts.

In this section 2.3, I will propose that verbal predicates build in existential meanings for their plural arguments ; this will provide an account of the *low-scope existential generalization*. While strange, this proposal will have unexpected parallels in other areas of the semantics.

Section 2.4 will start our investigation of exhaustive participation inferences. Expanding on Bar-Lev (2018b), who proposed that exhaustive participation inferences (in my terminology) are free-choice-like inferences, I will propose that *exhaustive participation inferences* are a case of *generalized distributive implicatures*, of which free-choice inferences are a sub-case. I will then show the mechanism of recursive exhaustification by which both can be derived.

2.3.1 First try: a problematic account

An operator existential. To ensure that plural-referring expressions are interpreted as existential quantifiers, we could simply assume that every plural-referring expression must be accompanied at LF with an operator $\exists$ which effectively converts it into an existential quantifier (over singularities, since we are still disregarding collective action, which will be addressed in chapter 6).

(32) a. $[\![\exists]\!] = \lambda X_e . \lambda p_{et} . \exists x \prec X, p(x)$

b. [The dancers ∃] smiled
$\rightsquigarrow \exists x \prec \iota\mathsf{dancers}, \mathsf{smiled}(x)$

Problematically, this analysis predicts that the scope of the existential quantification is married to the position of the plural-referring expression[7]. If, as per our generalization, this existential quantification always takes the lowest scope within the clause, then by this analysis, it must be that the plural-referring expression is always syntactically dominated by any other operator in the clause.

Setting aside the fact that it is unclear how we might impose this syntactic restriction, the data that we have seen shows that in fact, the scope of the existential quantification seem to completely disregard scopal restrictions that usually affect the plural-referring expression's syntactic position. Consider (28), repeated below in (33).

(33) Last week, the neighbor's ten dogs only barked on Sunday.

In this sentence, the existential paraphrase of *the neighbor's ten dogs* under-scoped VP *only*. By contrast, quantifiers in that syntactic position have an exceedingly hard time under-scoping VP *only*.

(34) a. Every dog only barked on Sunday.
≠ *only on Sunday did every dog bark* (*only ≫ ∀)

b. Some dog only barked on Sunday.
≠ *only on Sunday did some dog bark* (*only ≫ ∃)

c. Half of the ten dogs only barked on Sunday.
≠ *only on Sunday did half of the dogs bark* (*only ≫ ∃)

This may not be a hard and fast rule. Some speakers (R. Schwarzschild, p.c.) do accept a low-scope for unstressed *some*, glossed below as *sm*. In this example, it is unclear to me

[7]This is essentially the operator that Bar-Lev (2018b) assumes. By making this assumption, he wants to identify the ∃ operator to the well-motivated distributivity operator (Roberts, 1987), which also exhibits homogeneity effects. However, we will have reasons not to do so, cf section 2.6.3 and chapter 7.

whether the low-scope is truly rendered possible by *sm* or by the inaccusative verb *fall*. (35b) tries to tease apart these factors.

(35) a. Sm snow only fell on Sunday.

b. Sm snow only covers Joshua.
$\stackrel{?}{=}$ Only Joshua is covered by snow.

If this is not convincing, we may turn to scope-rigid languages, e.g. Hungarian[8]. In Hungarian, scope is explicitly marked by constituent order. In particular, the position of *czak* "*only*" clearly marks its scope. Unlike English, Roger Schwarzschild's examples are not replicable in Hungarian. Like English however, the existential paraphrase of a plural-referring expression like *the ten dogs* takes the lowest scope possible. This is illustrated in (36):

(36) Plurals existential meaning takes lowest scope

a. *A tiz kutyam csak Gabitot harapta meg.*
the ten dog-my only Gabito-acc bit vm

My ten dogs only bit Gabito.

b. **Judgments:**
True if none of them bit Gabito.
False if 5 or more of them bit Gabito.
False if all 10 of them bit Gabito.
$\rightsquigarrow$ only $\gg \exists$

c. *Nem hiszem, hogy a tiz kutyam csak Gabitot harapta meg.*
not think that the ten dog-my only Gabito-acc bit vm

I don't think that the ten dogs only bit Gabito

d. False if none of them bit Gabito.
True if 5 or more of them bit Gabito.
True if all 10 of them bit Gabito.
$\rightsquigarrow \neg \gg$ only $\gg \exists$

[8] I thank Dorá Kata Takács for sharing both her language and her linguistic expertise with me.

This shows that the scope of the existential quantifier over pluralities does not track the syntactic position of the plural-referring expression that it translates, as the operator analysis I sketched would have it.

2.3.2 Second try: built-in existentials

As an alternative to this view, I submit that the existential meaning is part of the meaning of the verbal predicate, as in (37):

(37) a. $[\![\exists\text{-danced}]\!] = \lambda X.\, \exists x \prec X,\ \mathsf{danced}(x)$

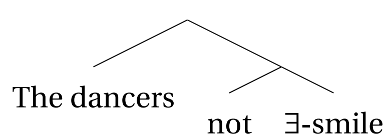
b. $[\![\exists\text{-cracked}]\!] = \lambda X.\lambda Y.\, \exists x \prec X, \exists y \prec Y,\ \mathsf{cracked}(x)(y)$

By packaging the verbal predicate with the existential semantics for plural, we semantically forbid any operator to under-scope these existentials. The scope of the existential meaning is decoupled from the syntactic position of the argument and no syntactic stipulations constraining scope are required. We can fully appreciate these denotations on a representative sample of our dataset (introduced in section 2.1). Since we do not yet have an account of exhaustive participation inferences, I focus on negative environment where these inferences do not arise.

A simple non-cumulative sentence Let us start with simple non-cumulative sentences like (38). The assumed LF is given in (38b) and its composition is given in (38c).

(38) a. The dancers didn't smile

b.



c. $[\![\text{not } \exists\text{-smile}]\!] = \lambda X.\, \neg\exists x \prec X, \mathsf{smile}(x)$

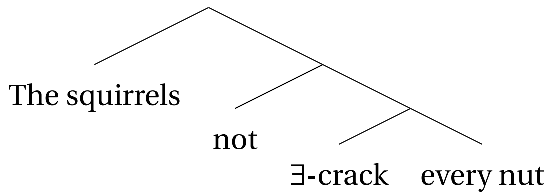
$[\![(38a)]\!] = \neg\exists x \prec \iota\mathsf{dancers}, \mathsf{smile}(x)$

$\rightsquigarrow$ *it's not the case that any dancers smiled.*

The truth-conditions are as expected for negative sentences. Note that despite the subject out-scoping negation in the LF of (38b), the existential meaning associated with the plural-referring expression takes scope below it, because we made sure to build it in the meaning of the verb.

Cumulative readings of *every*. Let us now turn to a negative cumulative sentence with *every*. The LF and composition are detailed in (39).

(39) a. The squirrels didn't crack every nut.

b. 

c. $[\![\text{every nut}]\!] = \lambda p_{eet}.\lambda X.\ \forall y \in \mathsf{nut},\ p(y)(X)$[9]

$[\![\text{cracked every nut}]\!] = \lambda X.\ \forall y \in \mathsf{nut}, \exists x \prec X, \exists y' \prec y,\ \mathsf{cracked}(x)(y')$

$\lambda X.\ \forall y \in \mathsf{nut}, \exists x \prec X,\ \mathsf{cracked}(x)(y)$

(simplification since y is atomic)

$[\![\text{not cracked every nut}]\!] = \lambda X.\ \neg\forall y \in \mathsf{nut}, \exists x \prec X,\ \mathsf{cracked}(x)(y)$

$[\![\text{the squirrels not cracked every nut}]\!] = \neg\forall y \in \mathsf{nut}, \exists x \prec \iota\mathsf{squirrels},\ \mathsf{cracked}(x)(y)$

$\rightsquigarrow$ *not every nut was cracked by a squirrel.*

As the reader can see, the composition is classical, the meaning of quantifiers is standard and the truth-conditions are the correct ones. Furthermore, it straightforwardly extends to the other data points of our dataset:

(40) a. The squirrels didn't crack a prime number of nuts.

b. $[\![\text{a prime number of nuts}]\!] = \lambda p_{eet}.\lambda X.\ \#\{y \in \mathsf{nut} \mid p(y)(X)\}$ is prime

$[\![\text{cracked a prime number of nuts}]\!]$

$= \lambda X.\ \#\{y \in \mathsf{nut} \mid \exists y' \prec y, \exists x \prec X,\ \mathsf{crack}(y')(x)\}$ is prime

$= \lambda X.\ \#\{y \in \mathsf{nut} \mid \exists x \prec X,\ \mathsf{crack}(y)(x)\}$ is prime

(simplification since y is atomic)

$[\![\text{not cracked a prime number of nuts}]\!]$

$= \lambda X.\ \#\{y \in \mathsf{nut} \mid \exists x \prec X,\ \mathsf{crack}(y)(x)\}$ is not prime

[9] I am assuming a type-shifting approach here but of course, this is an orthogonal point: a QR-based approach would yield exactly the same result.

$$[\![\text{the squirrels not cracked a prime number of nuts}]\!]$$
$$= \lambda X.\, \#\{y \in \mathsf{nut} \mid \exists x \prec \iota\mathsf{squirrels},\ \mathsf{crack}(y)(x)\} \text{ is not prime}$$

2.3.3 Motivating built-in existentials: beyond plurality

The proposal of building existential meanings into the meaning of the verb may seem strange. Interestingly, there are in fact a number of unrelated phenomena which call for a similar analysis. In many instances, natural language imposes existential meanings onto a verb's argument and this existential force takes the narrowest scope. These existential shifts include (at least): existential reading of impersonal pronouns[10], derived kind predication, and some cases of metonymy. All the phenomena are illustrated in (41).

(41) a. **Derived Kind predication**

That kind of bee only stung Fatma.

≈ *an instance of that kind only stung Fatma*

b. **Existential readings of impersonal pronouns** (German *man*)

Gestern	*hat*	*man*	*die*	*Uni*	*angezündet.*
yesterday	has	MAN	the	university	set-on-fire

≈ "*yesterday, someone put the university on fire*" (Zobel, 2016)

c. **Physical location metonymy**[11]

[10] I thank S. Zobel for pointing this out to me.

[11] One may wonder whether this example truly calls for an existential shift. Couldn't it just be that the predicate "*in Abu Dhabi*" is true of NYU? If this were so, Parsons (1990) notes, we would predict that (41a) and (41b) together entail (41c), by the logic of *Predicate Modification*, but they don't. Some quantificational force must prevent us from conjoining the meaning of predicates together.

(41) a. NYU is in Abu Dhabi.

b. NYU is on a hilly area.

c. ⇏ NYU is in Abu Dhabi on a hilly area.

NYU is in Abu Dhabi.

≈ *a physical branch of NYU is in Abu Dhabi*

Interestingly, just as I argued for plurals, the low-scope readings of these existentials always trumps independently attested scopal restrictions on their syntactic position. For instance, the existentials introduced by these shift under-scopes VP-only (or in (43), the equivalently scope-rigid *nur*)

(43) a.

b. **Derived Kind predication**

That kind of mosquito only stung Fatma.

≈ *no one beyond Fatma was stung by an instance of that kind* (only ≫ ∃)

c. **Existential readings of impersonal pronouns** (German *man*)

Gestern hat man mich nur per E-Mail kontaktiert.

yesterday has MAN me.acc only by e-mail contacted

≈ "*yesterday, I was only contacted by e-mail*[12]"

d. **Branch metonymy**

NYU is only in Abu Dhabi.

≈ *in no other places is there an NYU branch*

The conclusion to draw from this fact is that a general mechanism of low-scope existential generation is needed not just for cumulativity, and my proposal to incorporate existentials in the meaning of the verb is the simplest way to implement this mechanism.

2.4 Exhaustive participation inferences: analogies with scalar implicature

Having derived the low-scope existential meanings through existential meanings packaged in the verb's denotation, we can turn to the second generalization, which is repeated below.

Exhaustive participation inferences

In positive environments only, each plural-referring expression gives rise to an *exhaustive participation inference.*

This *exhaustive participation inference* of a plural-referring expressions DP is of the form "$\forall x \prec [\![DP]\!], \exists y \in C, \ldots$" where the plural-referring expression is interpreted universally with high-scope and the other arguments are interpreted as existentials ranging over the NP restriction of the arguments, as below:

$$\text{the NP} \ldots \mathcal{Q}\ \text{NP}' \ldots \mathcal{Q}\ \text{NP}'' \ldots \rightsquigarrow \forall x \prec [\![\text{NP}]\!], \exists y \in [\![\text{NP}']\!], \exists z \in [\![\text{NP}'']\!], \ldots$$

This generalization will require considerably more machinery to do justice to. To help us, this section develops some guiding intuitions. Specifically, we will construct an analogy between exhaustive participation inferences and certain classes of implicatures, which will guide the theory. We will see that on the one hand, the exhaustive participation inferences of *non*-cumulative sentences have similarities to Free Choice inferences (*following* Bar-Lev (2018b)) and that on the other hand, the exhaustive participation inferences of cumulative sentences mirror distributive implicatures.

2.4.1 Why implicatures?

In non-cumulative sentences, the underlying existential meaning of *the dancers* (cf (44)) is obscured by the exhaustive participation inference that all dancers smiled.

(44) a. The dancers ∃-smiled.

b. $\exists x \prec \iota\mathsf{dancers}, \mathsf{smiled}(x)$

$\forall x \prec \iota\mathsf{dancers}, \mathsf{smiled}(x)$

In cumulative sentences like (45), the exhaustive participation inference simply asserts that all squirrels cracked a nut:

(45) a. The squirrels ∃-cracked every nut.

b. $\forall y \in \mathsf{nut}, \exists x \prec \iota\mathsf{squirrels},\ \mathsf{cracked}(y)(x)$

$\forall x \prec \iota\mathsf{squirrels}, \exists y \in \mathsf{nut},\ \mathsf{cracked}(y)(x)$

Where could these universal inference come from? Several clues constrain our theoretical options. First, these inferences only arise in positive environments. Second, these inferences are conditioned by contextual information. This is something that I haven't commented on so far. In particular contexts, the universal force of the exhaustive participation inference becomes a quasi-universal inference (cf (46a)) ; in some contexts, it may even be absent altogether, leaving the underlying existential meaning apparent (cf (46b)). As argued by Križ (2016); Malamud (2012), the presence of weaker meanings depends on what is relevant to the speaker *vis-á-vis* their current purposes.

(46) a. The townspeople are asleep. (Lasersohn, 1999)

$\rightsquigarrow$ *ok, if one or two professors aren't smiling*

b. The windows are open. (Malamud, 2012)

$\rightsquigarrow$ *ok, if at least one window is open*

These less-than-universal readings extend to cumulative sentences:

(47) The chickens laid every egg. (Buccola and Spector, 2016, crediting S. Cable)

$\rightsquigarrow$ *ok, if one or two chickens didn't lay any egg*

So exhaustive participation inferences are in general both polarity-sensitive and context-sensitive. As implicatures are also both polarity-sensitive and contingent on context, taking exhaustive participation inferences to be implicatures is a natural identification. This is the path that Bar-Lev (2018b); Magri (2014) take and that I will follow them on.

Exhaustive participation and Free Choice. Bar-Lev (2018b) specifically makes the parallel between exhaustive participation inferences and free choice inferences. Free Choice inferences (illustrated in (48) with our color-coding conventions for truth-value gaps) refers to cases where a disjunction embedded under an existential modal is interpreted as a wide-scope conjunction.

(48) a. You are allowed to eat apple or cake.

b. **Truth-conditions:**

$\Diamond(\mathsf{cake} \vee \mathsf{apple})$

$\wedge \Diamond\mathsf{cake} \wedge \Diamond\mathsf{apple}$

Bar-Lev (2018b) notes that in non-cumulative sentences too, an existential/disjunctive meaning is turned into a universal/conjunctive meaning:

(49) a. The dancers ∃-smiled.

b. $\exists x \prec \iota\mathsf{dancers},\ \mathsf{smiled}(x)$

$\forall x \prec \iota\mathsf{dancers},\ \mathsf{smiled}(x)$

Both classes of inferences - Free Choice and exhaustive participation - apply to an existential or disjunctive meaning and convert it to a universal or conjunctive meaning. This analogy is somewhat loose, since the typical free choice inference only occurs in the scope of a possibility modal (cf (48)), and the exhaustive participation in non-cumulative sentences typically occurs in the absence of a modal.

However, Bar-Lev (2018b) argues, following a substantive previous literature, that the free choice exhibited under possibility modals is only the tip of the Free Choice iceberg. The assumption that Free Choice can also, in some cases, strengthen unembedded disjunctions to conjunctions has proven useful to account for properties of Warlpiri connectives *manu* (Bowler, 2014)[13] and children's conjunctive interpretation of *or* (Singh et al., 2016)[14].

Exhaustive participation and distributive implicature. With cumulative sentences, the analogy to Free Choice does not seem to hold. Consider (50). The basic meaning asserts that all nuts were cracked by a squirrel and the exhaustive participation inference we need to derive is one that asserts that all squirrels cracked a nut. This exhaustive

[13]The data of Szabolcsi and Haddican (2004) from Hungarian could also be interpreted as a *manu*-like connective, although the authors' interpretation is different.

[14]The conjunctive interpretation of children's "*or*" is not settled: some follow-up either replicate the pattern Tieu et al. (2015), but others attribute it to confounds in design Skordos et al. (2020)

participation inference certainly does not look like a Free Choice inference: an existential of the underlying meaning is indeed converted to a universal, but in addition, the universal meaning of *every* in the underlying meaning is "*weakened*" to an existential.

(50) a. The squirrels ∃-cracked every nut.

b. **Attested meaning:**

$\forall x \in \mathsf{nut}, \exists y \prec \iota\text{squirrels}, \mathsf{crack}(x)(y)$

$\forall y \prec \iota\text{squirrels}, \exists y \in [\![\text{nut}]\!], \mathsf{crack}(x)(y)$

I argue that this inference is in fact familiar. To see more clearly, consider a case where there are only three squirrels - Scrat, Acorn and Waggs. Then, the underlying existential meaning derived by the proposal of section 2.3 can be rewritten as in (51a) and the needed exhaustification inference as in (51b):

(51) a. $\forall x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{scrat}) \vee \mathsf{crack}(x)(\mathsf{acorn}) \vee \mathsf{crack}(x)(\mathsf{waggs})$

⇝ *every nut was cracked by Scrat, Acorn or Waggs*

b. $\exists x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{scrat})$

$\exists x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{acorn})$

$\exists x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{waggs})$

Observe how the meta-language paraphrase of (51a) (i.e. *every nut was cracked by Scrat, Acorn or Waggs*) does have the exhaustive participation inference in (51b). This is because the metalanguage paraphrase has a *distributive implicature*. Distributive implicatures occur when disjunctions are embedded under a quantifier $\mathcal{Q}$ (cf (52)) ; when they occur, each disjunct is implicated to relate to at least one member of the domain of $\mathcal{Q}$.

(52) Every ambassador speaks Arabic, English or Mandarin.

⇝ at least one ambassador speaks Arabic.

⇝ at least one ambassador speaks English.

⇝ at least one ambassador speaks Mandarin.

The parallel does not stop at cumulative readings of *every*. Other quantifiers as well give rise to exhaustive participation inferences. For instance, *most*:

(53) a. The squirrels ∃-cracked most nuts.

b. Most $x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{scrat}) \vee \mathsf{crack}(x)(\mathsf{acorn}) \vee \mathsf{crack}(x)(\mathsf{waggs})$

⇝ *most nuts were cracked by Scrat, Acorn or Waggs*

c. $\exists x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{scrat})$

$\exists x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{acorn})$

$\exists x \in \mathsf{nut}, \mathsf{crack}(x)(\mathsf{waggs})$

Correspondingly, these quantifiers give rise to distributive implicatures when they embed disjunctions[15]:

(54) Most ambassadors speak Arabic, English or Mandarin.

⇝ at least one ambassador speaks Arabic.

⇝ at least one ambassador speaks English.

⇝ at least one ambassador speaks Mandarin.

The parallel between exhaustive participation in cumulative sentences and distributive implicatures even extends to more than one quantifier, as happens in the video-game example example. Compare the inferences of the video-game example (55a) to that of a close paraphrase (56):

(55) **Cumulative sentences**

a. The video-games taught every quarterback ten new plays.

b. Every quarterback learned ten newplays from one of the video-games.

Video-game 1 taught one of the quarterbacks some play.

Video-game 2 taught one of the quarterbacks some play.

...

[15]Credits for this observation goes to F. Hisao Kobayashi (p.c.).

(56) **Distributive implicatures**[16]

a. Every quarterback learned ten new plays from video-game 1, 2 or 3

b. Every quarterback learned ten newplays from one of the video-games.
$\rightsquigarrow$ video-game 1 taught one of the quarterbacks some play.
$\rightsquigarrow$ video-game 2 taught one of the quarterbacks some play.
$\rightsquigarrow$ ...

2.4.2 Summary: Generalized distributive implicatures.

The exhaustive participation inferences we are trying to derive not only match the signature of implicatures (polarity-sensitivity and context-sensitivity), they are formally identical to free choice in the case of non-cumulative sentences and distributive implicatures in the case of cumulative sentences.

Since free choice inferences and distributive implicature do not form an obvious natural class, the reader may justifiably be worried that two accounts of exhaustive participation will be needed: one for free-choice/non-cumulative sentences and one for distributive implicatures/cumulative sentences. However, it will not be so ; there will be a unified account of Free Choice and distributive implicatures. Before we can see this formally, I want to point out tentative evidence that natural languages do see a parallel between the two types of inference.

As is well know, some items cross-linguistically lexicalize the behavior of Free Choice implicatures. Consider the German item *irgendein* (Kratzer and Shimoyama, 2017). Un-

[16]The video-game example is not the best example to demonstrate distributive implicatures of multiple quantifiers on, since the paraphrase in (57a) has all sorts of scope ambiguities. In addition, Denic (2020) notes that distributive implicatures compete with ignorance inferences when quantifiers have small domains. The following example is isomorphic to the one I used in the main text but is, I think, clearer:

(57) Every president gave at least ten ambassadors cash or judicial information.
$\rightsquigarrow$ at least one president gave at least one ambassador cash
$\rightsquigarrow$ at least one president gave at least one ambassador judicial information

der a possibility modal, it gives rise to a free choice inference that any doctor is a permissible option:

(58) *Maria kann irgendeinen Arzt heiraten*
Mary can IRGENDEIN doctor marry
"*Mary can marry some doctor ; any doctor is allowed*"

However, the same item also triggers a "*Free Choice*" inference under a universal modal. In (59) too, it is implicated that any doctor is a permissible option.

(59) *Maria muss irgendeinen Arzt heiraten*
Mary must IRGENDEIN doctor marry
"*Mary must marry some doctor ; any doctor is allowed*"

However, note that this inference is nothing more than a distributive implicature in the modal realm. Indeed, imagining that there are only three doctors *a*, *b* and *c*, then the truth-conditions of (59) can be rendered logically as in (60). And these truth-conditions precisely match *mutatis mutandis* the distributive implicatures I reported on the ambassador example (52).

(60) $\forall w, \mathsf{marry}(a)(w) \vee \mathsf{marry}(b)(w) \vee \mathsf{marry}(c)(w)$
$\wedge \exists w, \mathsf{marry}(a)(w)$
$\wedge \exists w, \mathsf{marry}(b)(w)$
$\wedge \exists w, \mathsf{marry}(c)(w)$

The parallel does not go further than that, since *irgendein* does not trigger distributive implicatures with ordinary universal quantifiers like the German counterpart of *every*. Whatever the contribution of *irgendein* is seems to be bound to the presence of a modal quantifier. However, it does highlight a point of convergence between Free Choice and distributive implicatures which makes the unification that the account I will develop likely.

2.5 Free Choice and exhaustive participation in non-cumulative sentences

(A word of caution: the discussion will presuppose familiarity with Innocent Exclusion exhaustification and I refer the reader to Fox (2007) for a refresher)

In this section, I present a unified account of free choice/distributive implicatures based on Bar-Lev and Fox (2016); Fox (2007), using recursive exhaustification. I will then translate this account to cumulative readings.

To motivate the use of recursive exhaustification, I will present in section 2.5.1 reasons to think that both Free Choice and distributive implicatures cannot be accounted for by a simple exclusion mechanism. Interestingly, the data presented will be shown to mirror an equivalent problem discussed by Kratzer (2003), in the analysis of cumulative sentences. Section 2.5.2 presents the account of Fox (2007) in terms of recursive exhaustification. Section 2.5.4 applies the account to cumulative sentences.

2.5.1 Inclusivity: free choice and distributive implicatures

Free Choice Free Choice inferences are typically positive: they assert that something is allowed. While Kratzer and Shimoyama (2017) gave reasons for treating Free Choice as an implicature (from downward-entailing environments), the positivity of the inference contrasts with typical implicatures. With typical implicatures, like the implicatures of *some*, a stronger alternative to the sentence is negated (e.g. *all*). Here however, the gray inferences of (61b) could only be obtained as the negation of "*You're not allowed to eat apples*" or the negation of "*You're not allowed to eat cake*". Because these two sentences contain a negation, it is difficult to see how they could be alternatives to the sentence, under most theories of alternatives.

(61) a. You are allowed to eat apples or cake.

b. **Paraphrase:**

You're allowed to eat apples or cake

You're allowed to eat apples

You're allowed to eat cake

The reasoning above is meant as suggestion that something extra, which goes beyond classical implicatures, is required for Free Choice. Recursive exhaustification will, in this chapter, provide the extra bit. Below, I show that the same need for something extra is required for distributive implicatures.

Distributive implicatures. The same conclusion can be drawn for distributive implicatures. Let us look at accounts of distributive implicatures. In our identification, these would correspond to exhaustive participation inferences in cumulative sentences like (62):

(62) a. The squirrels ∃-cracked every nut.

b. **Attested meaning:**

$\forall x \in \mathsf{nut}, \exists y \prec \iota\text{squirrels}, \text{crack}(x)(y)$

$\forall y \prec \iota\text{squirrels}, \exists y \in [\![\text{nut}]\!], \text{crack}(x)(y)$

In either the Gricean tradition (Sauerland, 2004) or the grammatical grammatical tradition, distributive implicatures are obtained by negating alternatives which leave one disjunct out, as in (63a). The inferences in (63a), together with the prejacent, entail that at least one ambassador speaks Arabic, at least one English, etc. Indeed, any ambassador who does not speak two out of the three languages must speak the third one, if the prejacent is true.

(63) EXH Every ambassador speaks Arabic, English or Mandarin. [nb]

a. **Negated alternatives:**
- not every ambassador speaks Arabic or English

  ⇝ *some ambassador doesn't speak Arabic or English*
- not every ambassador speaks Arabic or Mandarin

  ⇝ *some ambassador doesn't speak Arabic or Mandarin*
- not every ambassador speaks Mandarin or English

  ⇝ *some ambassador doesn't speak Mandarin or English*

However, Crnič et al. (2015) argue that the inferences derived by a traditional account are too strong. Indeed, the implicatures of (63) not only imply the existence of an ambassador who speaks Arabic but of an ambassador who *only* speaks Arabic. They offer experimental evidence that the sentence (or one similar to it) can be uttered if all ambassadors are bilingual in two of the languages, so long as all languages are spoken by at least one ambassador[17]. This means that the initial description of the distributive implicature, repeated below, was exactly correct, *pace* the predictions of (63).

(64) Every ambassador speaks Arabic, English or Mandarin.
$\rightsquigarrow$ *some ambassador speaks Arabic*
$\rightsquigarrow$ *some ambassador speaks English*
$\rightsquigarrow$ *some ambassador speaks Mandarin*

As it turns out, an isomorphic discussion independently occurs in Kratzer (2003)'s discussion of cumulative readings. Consider the cumulative sentence with *every* in (65a). With the existential meanings posited in section 2.3, (65a) would be equivalent to "*every mistake was caught by copy-editor 1, copy-editor 2 or copy-editor 3*". Kratzer, working in an event semantics, also derives these readings. (These parallels between event semantics and the account here are explored in more depth in chapter 5). To obtain the exhaustive participation inference that all copy-editors contributed, we could exhaustify the sentence against alternatives where "*the 3 copy-editors*" is replaced by smaller pluralities (e.g. *copy-editor 1 and copy-editor 2 caught every mistake*). Doing so would generate the strong implicatures in (65b). In Kratzer (2003), the counterpart of exhaustification is a minimality operator in the semantics of *every*.

(65) a. The three copy-editors caught every mistake

b. **Strong Dist implicatures:**
for every copy-editor, there is a mistake that only they caught.

c. Two mistakes: Add and Omit
Copy-editor 1 caught Add

[17] And not every ambassador speaks all three languages. The latter inference comes from the *and* implicature which I haven't shown.

Copy-editor 2 caught Omit

Copy-editor 3 caught Omit

Kratzer notes that this way of deriving exhaustive participation inferences incorrectly predicts that (66) is false in the scenario in (66b), since there isn't a mistake that either of the last two copy-editors caught alone.

The problem uncovered by Crnič et al. (2015) to the traditional account of distributive implicature runs deep. It also extends to other quantifiers than *every*, perhaps more blatantly so. As already discussed, distributive implicatures are also attested with other quantifiers than *every*. The inference derived by applying the exhaustification recipe in (63), replacing *every* with *many*, yields strong unattested inferences about the number of speakers of each language, i.e. (66b).

(66) a. Many ambassadors speak Arabic, English or Mandarin.
$\rightsquigarrow$ at least one ambassador speaks Arabic.
$\rightsquigarrow$ at least one ambassador speaks English.
$\rightsquigarrow$ at least one ambassador speaks Mandarin.

b. **Problematic inferences:**
not [many ambassadors speak Arabic or English]
not [many ambassadors speak Arabic or Mandarin]
not [many ambassadors speak English or Arabic]

The case of other quantifiers than *every* is especially relevant to us, since as we saw, exhaustive participation inferences do not just arise with *every*. We must make sure that our account extends to these other quantifiers as well.

Crnič et al. (2015)'s problem is important to us because it reveals that distributive implicatures are not a run-of-the-mill implicature which a run-of-the-mill analysis could obtain. To reinforce the point, observe that the distributive implicatures, repeated below in (67a), do not include negation in their paraphrases. What type of alternative would have to be negated in order to derive any one of the distributive implicatures? In (67a) or (67b), these would be alternatives like "*there isn't any ambassador who speaks Arabic*" or "*every ambassador does not speak Arabic*". Because these two sentences contain a negation not present in the sentence, it is delicate, under most theories of alternatives, to explain how they could be alternatives to the sentence.

(67) a. Every ambassador speaks Arabic, English or Mandarin.
$\rightsquigarrow$ at least one ambassador speaks Arabic.
$\rightsquigarrow$ at least one ambassador speaks English.
$\rightsquigarrow$ at least one ambassador speaks Mandarin.

b. Many ambassadors speaks Arabic, English or Mandarin.
$\rightsquigarrow$ at least one ambassador speaks Arabic.
$\rightsquigarrow$ at least one ambassador speaks English.
$\rightsquigarrow$ at least one ambassador speaks Mandarin.

This reasoning, while certainly not unassailable, suggests that the distributive implicatures are not obtained by (simple) *ex*clusion, i.e. negating alternatives to the sentence, but by *in*clusion, i.e. asserting alternatives to the sentence. This is a further parallel to the case of Free Choice, motivating having the same account for both types of inference.

In the next section, I present Fox (2007)'s account of how including alternatives may be achieved by recursive exhaustification. This account will cover both the case of Free Choice and the case of distributive implicatures (Bar-Lev and Fox, 2016).

2.5.2 Recursive exhaustification

Both Free Choice and distributive implicatures require some way of *asserting alternatives*. Fox (2007) and Chierchia (2013) show how two rounds of exhaustification can achieve this effect. The simple idea, at times obscured by the necessary technicalities, is that by negating pre-negated alternatives, these alternatives end up asserted.

2.5.3 Free Choice and intransitive sentences with recursive exhaustification.

Fox (2007) treats free choice inferences as arising from the recursive application of the innocent exclusion EXH operator. Specifically, he assumes the sentence (67) to have the structure in (68).

(68) Exh_2 Exh_1 you are allowed to eat apple or cake.

To guide intuitions about what this is meant to accomplish, we can reason along the following Gricean lines (inspired by Kratzer and Shimoyama (2017)): by leaving one of the disjuncts out, as in (69), the speaker would have conveyed that this disjunct was the only possibility. Since the speaker didn't leave either of the disjuncts out, then one concludes that neither disjunct is the only possibility. This means that both disjuncts are in fact possible, i.e. the free choice inference.

(69) a. You are allowed to eat apples.
$\rightsquigarrow$ *you're allowed to eat apple and nothing else*

b. You are allowed to eat cake.
$\rightsquigarrow$ *you're allowed to eat cake and nothing else*

A more formal rendition of these intuitions within the grammatical tradition is possible with the structure in (68). To compute the meaning of that sentence, one needs to compute the result of applying Exh_2 to a structure like "Exh_1 *you are allowed to eat apples or cake*". This means comparing the sentence in (70a) to alternatives of the form (70b). Note that these alternatives are the formal renditions of the alternatives (69).

(70) a. **Prejacent:**
$\text{Exh}_1\left(\Diamond(\text{cake} \vee \text{apple}), \text{alts}_1\right)$

b. **Alternatives for Exh 2:**
$\text{alts}_2 = \left\{\text{Exh}_1(\Diamond\text{cake}, \text{alts}_1), \text{Exh}_1(\Diamond\text{apple}, \text{alts}_1)\right\}$

These alternatives in (71b) are themselves exhaustive statements. They are all exhaustified with respect to the same set of alternatives, the alternatives to "*You are allowed to eat apples or cake*". Their meaning is given in (71b):

(71) **Alternatives for Exh 1**:
$\text{alts}_1 = \left\{\Diamond\text{cake}, \Diamond\text{apple})\right\}$

a. $\textsc{Exh}(\Diamond\text{cake}, \text{alts}_1) = \Diamond\text{cake} \wedge \neg\Diamond\text{apples}$

$\rightsquigarrow$ *you're allowed to eat cake and not apples*

b. $\textsc{Exh}(\Diamond\text{apples}, \text{alts}_1) = \Diamond\text{apples} \wedge \neg\Diamond\text{cake}$

$\rightsquigarrow$ *you're allowed to eat apples and not cake*

Combining the results together yields the attested FC inference:

(72) $\textsc{Exh}_2(\textsc{Exh}_1(\Diamond(\text{cake} \vee \text{apple}, \text{alts}_1)))$

$= \textsc{Exh}_1(\Diamond(\text{cake} \vee \text{apple}, \text{alts}_1)) \wedge \neg\textsc{Exh}_1(\Diamond\text{cake}, \text{alts}_1) \wedge \neg\textsc{Exh}_1(\Diamond\text{apple}, \text{alts}_1)$

$= \Diamond\left(\text{cake} \vee \text{apple}\right) \wedge \neg\left(\Diamond\text{cake} \wedge \neg\Diamond\text{apples}\right) \wedge \neg\left(\Diamond\text{apples} \wedge \neg\Diamond\text{cake}\right)$

$= \Diamond\text{cake} \wedge \Diamond\text{apples}$

This recursive reasoning is very powerful. Applying it to a simple disjunction such as (73), it would seem that the same reasoning would derive that you ate both apple and cake, by simply negating (73a) and (73b) and their implicatures, just as in (69).

(73) $\textsc{Exh}_2$ $\textsc{Exh}_1$ You ate apple or cake.

a. You ate apple.

$\rightsquigarrow$ *You only ate apple.*

b. You ate cake.

$\rightsquigarrow$ *You only ate cake.*

However, these implicatures contradict the implicature that the hearer didn't eat both food items. The latter implication, a simple non-recursive implicature arising by competition with *and*, is derived by $\textsc{Exh}_1$, i.e. "*earlier*" in the computation. Since exhaustification in Fox (2007) is non-contradictory, this prevents the problematic recursive implicature that both disjuncts are true from being generated, since they are computed by $\textsc{Exh}_2$, i.e. "*later*". This correctly rules out any possibility of interpreting disjunction as conjunction.

Without the safeguard of the *not and* implicature, our disjunctions would, in positive environment, be strengthened to a conjunction. This unwelcome strengthening for ordinary disjunctions, is, as Bar-Lev (2018b) noted, exactly the result we wish to obtain for exhaustive participation inferences, replacing disjunctions with existentials and conjunctions with universals. The next section establishes this result

Applying Free Choice Reasoning to plural sentences Recall our non-cumulative sentence in (74a). As seen in section 2.3, the reading delivered by that sentence is existential:

(74) a. The dancers ∃-smiled.

b. **Unstrengthened meaning:**

$\exists x \prec \iota\mathsf{dancers},\ \mathsf{smiled}(x)$

c. **Attested meaning:**

$\exists x \prec \iota\mathsf{dancers},\ \mathsf{smiled}(x) \wedge \forall x \prec \iota\mathsf{dancers},\ \mathsf{smiled}(x)$

To make this case completely parallel to the case of Free Choice and deliver the attested universal truth-conditions, we need two assumptions about alternatives.

First, we need some counterpart to the individual disjuncts alternative of disjunction, seen in (73a) and (73b). Thinking of an existential as a grand disjunction, as in (75), these alternatives find a parallel in the *sub-domain alternatives* of the existential: alternatives where the existential is constrained to range over a smaller set of entities - in other words, these alternatives which have "*less disjuncts*". In our specific case, where the domain of the existential are the atomic parts of *the dancers*, the sub-domain alternatives are simply sentences where *the dancers* is replaced by a plurality of smaller size X, as in (75).

(75) a. $\exists x \prec \iota\mathsf{dancers},\ \mathsf{smiled}(x)$

$\leftrightsquigarrow \mathsf{smiled}(\mathsf{dancer\ 1}) \vee \mathsf{smiled}(\mathsf{dancer\ 2}) \vee \mathsf{smiled}(\mathsf{dancer\ 3}) \vee \ldots$

b. $\exists x \prec X, \mathsf{smiled}(x)$

where $X \prec \iota\mathsf{dancers}$

Second, we must prevent an implicature that *not all dancers smiled* from arising. Just as the *not and* implicature of disjunction blocks Free Choice strengthening of ordinary disjunction to conjunction, any *not all* implicature would block the Free Choice strengthening of existentials to universal. However, this *not all* implicature would only arise if there were an ∀-*smiled* counterpart to ∃-*smiled* (mirroring fact that *and* is an alternative to *or*). We can reasonably assume, following Bar-Lev (2018b), that something like ∀-*smiled* doesn't exist. These assumptions are summarized below:

Assumptions about alternatives

1. $[\![\text{the NP}]\!]$ has as alternatives all pluralities X, such that $X \prec [\![\text{the NP}]\!]$
2. There is no ∀-VP alternative to ∃-VP.

All the assumptions are in place to derive the exhaustive participation inferences of our non-cumulative sentence (74). The recursive exhaustification structure is given in (76).

(76) EXH_1 EXH_2 [The dancers ∃-smiled.]$_\alpha$

Alts. to α:

$\{[\![\exists\text{-smiled}]\!](X) \mid X \prec [\![\text{the dancers}]\!]\}$

As the reader can anticipate, the computation which delivers this result are somewhat involved. Existentials have more "*disjuncts*" than the simple disjunction seen for Free Choice. The complexity of the computations will only get worse, as we reach the cumulative sentences that this chapter builds towards. In an effort to properly separate the global narrative from the technical computations that it entails, I will perform the computation using the Python Exh package (Chatain, 2019a) and informally explain why the computation delivers the result it does. The EXH package, available on PyPI, performs innocent exclusion exhaustification on user-defined formulas ; it can manage the type of recursive exhaustification we need to consider. The curious reader will be able follow along the relevant computations on the Jupyter notebook, following the [nb] links scattered in this chapter. In addition to streamlining the presentation, this method has the added advantage of minimizing the risk of errors and ensuring reproducibility.

By recursive exhaustification, (76) will be strengthened to have a universal meaning in the same way that Free Choice disjunction was strengthened [nb]. Namely, alternatives to the constituent that EXH_2 heads, which can be paraphrased as *among the dancers, only X smiled*, where *X* is strictly contained in *the dancers*, will all be negated by EXH_1. The added contribution of all of these negated inferences is that all the dancers smiled or none of them did. Together with the assertion of the prejacent, this entails that all the dancers did.

(77) a. **Alternatives to** EXH_2 [The dancers ∃-smiled.]$_\alpha$:
- Only Marie-Lou ∃-smiled.
- Only the dancers who are not Marie-Lou ∃-smiled.
- ...

b. **Implicatures generated by** $\textbf{EXH}_2$**:**
1. Not only Marie-Lou ∃-smiled.

   ⇝ either Marie-Lou didn't smile or someone who wasn't Marie-Lou smiled.
2. Not only the dancers who aren't Marie-Lou ∃-smiled.

   ⇝ either Marie-Lou smiled or no one who wasn't Marie-Lou smiled.

   ⇝ either (Marie-Lou smiled and someone other than her did as well) or no one smiled *(together with 1)*
3. ...

Thus, we see that both the case of Free Choice and the isomorphic case of non-cumulative sentence can be dealt with using recursive exhaustification. Let us now turn to how the same process can account for distributive implicature and cumulative sentences.

2.5.4 Distributive implicature and cumulative readings of *every* with recursive exhaustification

As the reader recalls, Crnič et al. (2015)'s problem is to explain how to derive the inferences (78a), without generating the strong inferences that one ambassador speaks only one of the mentioned languages. The inferences mirror the exhaustive participation inferences that we need to derive for (78b).

(78) a. Every ambassador speaks Arabic, English or Mandarin.

$\rightsquigarrow$ at least one ambassador speaks Arabic.

$\rightsquigarrow$ at least one ambassador speaks English.

$\rightsquigarrow$ at least one ambassador speaks Mandarin.

b. The squirrels ∃-cracked every nut.

$\rightsquigarrow$ Scrat cracked at least one nut.

$\rightsquigarrow$ Acorn cracked at least one nut.

$\rightsquigarrow$ Waggs cracked at least one nut.

To my knowledge, Bar-Lev and Fox (2016) were the first to note that recursive exhaustification can solve the problem raised by (78a). They propose a structure as follows:

(79) EXH EXH every ambassador speaks Arabic, English or Mandarin.

To understand the effect of the second layer of exhaustification exhaustification informally, I will capitalize on the Gricean intuition used in section 2.5.3. Consider how hearers may interpret the alternative in (80) in a context where an informed speaker is answering the question of which language are represented among the ambassadors.

(80) *Of these three languages, which are spoken by the ambassadors?*

Every ambassador speaks Arabic or Mandarin.

$\rightsquigarrow$ no ambassador speaks English.

By uttering (81), the speaker seems to convey that the other language, English, is not spoken at all. A speaker who does not utter (81) would thus convey that the alternative and its implicatures are false, namely that either not every ambassador speaks Arabic or Mandarin or some ambassador speaks English. Either way, this entails that some ambassador speaks English, which is the desired implicature.

Note that in order to derive the critical implicature of (80), it must be assumed that "*some ambassador speaks English*" is an alternative to the original sentence. (Recall that it is the set of alternatives to the original sentence which is used in computing the implicatures of its alternatives). This alternative can be obtained by replacing *every* with *some* and simplifying the disjunction to just the "*English*" disjunct.

(81) Every ambassador speaks Arabic, English or Mandarin.

Some ambassador speaks Arabic, English or Mandarin. (*some*/*every* scale)

Some ambassador speaks English. (disjunction simplification)

This means in particular that the *some*/*every* scale is a necessary ingredient of this computation.

Assumptions about alternatives

1. ⟦the NP⟧ has as alternatives all pluralities X, such that $X \prec$ ⟦the NP⟧
2. There is no ∀-VP alternative to ∃-VP.
3. "*every*" has *some* as an alternative

The recursive exhaustification is a direct formal rendition of this Gricean intuition (cf [nb]). At a high level, the higher EXH will negate alternatives of the form in (80b), the counterpart of the alternatives that (81b) represents. Just as above, negating these inferences, together with the contribution of the prejacent will result in the attested distributive implicatures: some ambassador speaks Arabic, some ambassador speaks English, some ambassador speaks Mandarin.

(82) a. EXH EXH Every ambassador speaks Arabic, English or Mandarin.

b. **Excludable alternatives:**
   - EXH (Every ambassador speaks Arabic or Mandarin)
     ↔ *every ambassador speaks Arabic or Mandarin and it is not the case that some ambassador speaks English.*
   - EXH (Every ambassador speaks Arabic or English)
   - EXH (Every ambassador speaks English or Mandarin)
   - ...

Cumulative readings of *every*. The same set of assumptions explains the exhaustive participation inferences of cumulative sentences with *every*. Consider (83), whose counterpart in implicatures is the sentence (84). Just as the case above, assume *every* has *some* as an alternative and the plural-referring expression has sub-pluralities as its alternatives.

(83) a. EXH EXH The squirrels ∃-cracked every nut [nb]

b. **Alternatives:**

- EXH (S and W ∃-cracked every nut.)
  = *every nut was cracked by S or B*
  and no nut was cracked by A
- EXH (A and W cracked every nut.)
- EXH (S and A cracked every nut.)
- EXH (W cracked every nut.)
- EXH (S cracked every nut.)
- EXH (A cracked every nut.)
- EXH (S and W cracked some nut.)
- EXH (A and W cracked some nut.)
- EXH (S and A cracked some nut.)
- EXH (S cracked some nut.)
- EXH (A cracked some nut.)
- EXH (W cracked some nut.)

c. **Predicted implicatures:**

⇝ Scrat cracked a nut.

⇝ Acorn cracked a nut.

⇝ Waggs cracked a nut.

To understand this result at a high level, consider our three squirrels: Scrat, Acorn and Waggs. The top 6 alternatives in (83b) assert the squirrels that cracked a nut are among some sub-group of Scrat, Acorn and Waggs and no one outside this group cracked a nut. The higher EXH asserts that all these alternatives are false ; this means that all three squirrels are nutcrackers, which is the desired exhaustive participation inference.

(84) a. EXH EXH Every nut was cracked by Scrat, Acorn or Waggs

b. **Predicted implicatures:**

⇝ Scrat cracked at least one nut.

⇝ Acorn cracked at least one nut.

⇝ Waggs cracked at least one nut.

2.5.5 Summary

This section proposed a formal analysis of exhaustive participation inferences and consequently completed our basic account of cumulative reading of *every*. Based on the analogy with Free Choice and distributive implicatures discussed in section 2.4, I presented the recursive exhaustification account of these inferences in terms of Fox (2007) and Bar-Lev and Fox (2016). The recursive exhaustification account does justice to the exceptional nature of these inferences - they are inclusive -. This account was then translated as an account of exhaustive participation inferences in non-cumulative sentences and cumulative reading of *every*. In the next section, I will draw the consequences of the account for cumulative sentences specifically.

Before I turn to that, I want to mention one tangential point. The use of recursive exhaustification as an account of inclusive inferences, like Free Choice, may strike one as surprising, given recent work on *Innocent Inclusion Exhaustification* (Bar-Lev, 2018a; Bar-Lev and Fox, 2017). The choice of this approach would be very natural here since it has been used to derive homogeneity in sentences like "*the dancers smiled*" (Bar-Lev, 2018a,b). However, as far as I can tell, Innocent Inclusion, as currently stated, cannot derive the distributive implicatures and consequently the cumulative reading of *every*.

M. Bar-Lev (p.c.) tells me that he may be able to derive these inferences using Innocent Inclusion making assumptions about pruning. For my local concerns (i.e. *cumulativity*), the choice of recursive exhaustification or Innocent Inclusion exhaustification is indifferent and so his account could be transposed here.

2.6 Cumulative sentences

In the last section, I have presented an analysis of Free Choice and distributive implicatures and extended it to a simple non-cumulative sentence and cumulative reading of *every*. We assumed recursive exhaustification happening at the root of the tree and that alternatives were constructed following the principles below.

Assumptions about alternatives

1. $[\![\text{the NP}]\!]$ has as alternatives all pluralities X, such that $X \prec [\![\text{the NP}]\!]$
2. There is no ∀-VP alternative to ∃-VP.
3. "*every*" has *some* as an alternative

We saw that this derived the exhaustive participation inferences in non-cumulative and cumulative sentences with *every*:

(85) a. EXH EXH The dancers smiled.
⇝ *every dancer smiled.*

b. EXH EXH The squirrels cracked every nut.
⇝ *every squirrel cracked a nut.*

This section is devoted to more intricate predictions. First, we will turn to other quantifiers than *every* ; we will try to spell out generalizations about which quantifiers give rise to exhaustive participation inferences and distributive implicatures. We will compare this with the prediction of recursive exhaustification. Second, we will then turn to an important topic which I have not mentioned so far: the asymmetries in cumulative readings of *every*. Fleshing out our assumptions somewhat more, we will see that these asymmetries follow from sensible restrictions on the placement of recursive exhaustification.

2.6.1 What about other quantifiers?

Upward-entailingness entails participation. So far, we considered a limited portion of our dataset. As the other elements of our dataset (repeated in (86)) attest, exhaustive participation inferences extend to many other quantifiers and even multiple quantifier:

(86) a. The ten squirrels cracked most nuts.

b. The ten squirrels cracked many nuts.

c. The ten video-games taught every quarterback two new plays.

As we discussed in section 2.4, these exhaustive participation inferences mirror the distributive implicatures of the corresponding sentences:

(87) a. Most nuts were cracked by Scrat, Acorn or Waggs.
$\rightsquigarrow$ *Scrat cracked a nut*
...

b. Many nuts were cracked by Scrat, Acorn or Waggs.
$\rightsquigarrow$ *Scrat cracked a nut*
...

c. Every quarterback were taught two new plays by video-game 1, video-game 2 or video-game 3.
$\rightsquigarrow$ *Video-game 1 taught some quarterback some play*
...

Because recursive exhaustification is so heavily dependent on what the alternatives and the prejacent are, it is not *prima facie* obvious that hte exhaustive participation inferences of other quantifiers than *every* are predicted. If the case of *every* is any clue, a necessary condition for deriving these inferences for other quantifiers will be that these quantifiers have an existential alternative, e.g. *some*. As we saw with *every*, the existential alternatives both blocks Crnič et al. (2015)'s problematic distributive implicatures and in the second round of exhaustification brings about the attested distributive implicatures.

As it turns out, one can prove a general mathematical guarantee that recursive exhaustification will derive the right result for most quantifiers, provided this condition and others are met:

The "*UE entails participation*" guarantee.

Let $\mathcal{Q}$ be a non-trivial quantifier, $\exists_C$ an existential quantifier with sub-domain alternatives.

If the following conditions hold:

- $\mathcal{Q}$ is upward-entailing,
- $\mathcal{Q}$ has *some* as its *only* alternative

then $\text{E}\textsc{xh}\ \text{E}\textsc{xh}(\mathcal{Q}x, \exists_C y, R(x,y))$ will be equivalent to the conjunction of the prejacent and the exhaustive participation inference that $\forall y, \exists x, R(x,y)$

The appendix gives the formal proof of the result. However, we can see why it holds on the particular case of *most*, as in (88).

(88) a. EXH EXH The squirrels ∃-cracked most nuts [nb]

b. **Alternatives:**

- EXH (Scrat and Waggs cracked most nuts)

  ≈ *most nuts were cracked by Scrat and Waggs and none by Acorn*

- EXH (Acorn and Waggs cracked most nuts)

- ...

- EXH (Scrat and Waggs cracked some nuts)

- ...

Consider what would happen if Acorn, one of the squirrels, didn't crack any nut. Then it would be true that most nuts were cracked by Scrat or Waggs, since the prejacent assert that most nuts were cracked by one of the squirrels and we know Acorn didn't contribute to the collective effort. That would make the first alternative of (89b) true. Because this alternative is innocently excludable, we know that it can't possibly be true. By *reductio ad absurdum*, we show that Acorn must have cracked a nut. By symmetry, all squirrels must have cracked a nut.

Provided we ignore other alternatives these quantifiers might have, we then do predict that all of the sentences in (89) will have exhaustive participation inferences:

(89) a. The squirrels cracked most nuts.

b. The squirrels cracked many nuts.

Outside the guarantee's jurisdiction: downward-entailing quantifiers. The "*UE entails participation*" guarantee has clauses and it is natural to wonder what happens when one of these clauses is not met. For instance, what about exhaustive participation inferences with quantifiers which are not upward entailing?

For the case of "*no*", exhaustive participation inferences are not attested ; these inferences would in any case contradict the assertion[18]. But we can capture this case without the guarantee. As one can readily observe, the prejacent's meaning in (90b) is stronger than all of the alternatives and exclusion is impossible.

[18] As foreshadowed in section 2.2.2, this explains why the "*exhaustive participation inference*" does not hold in generality.

(90) a. The three squirrels cracked no nuts

$\not\rightsquigarrow$ *Acorn cracked a nut*

b. **Underlying meaning:**

$\neg\exists x \in \mathsf{nut}, \exists y \prec \mathsf{scrat} + \mathsf{acorn} + \mathsf{waggs}, \mathsf{cracked}(x)(y)$

c. **Alternatives:**

- Scrat and Waggs cracked no nuts

  $\rightsquigarrow \neg\exists x \in \mathsf{nut}, \exists y \prec \mathsf{scrat} + \mathsf{waggs}, \mathsf{cracked}(x)(y)$

- ...

For the case of downward-entailing quantifiers such as *less than 10*, the empirical picture is more difficult. (Bayer, 2013, p. 198) reports that (91) does not have a exhaustive participation inference ; it can be uttered even when Michael didn't wash a car.

(91) Michael and LaToya (together) washed fewer than three cars.

$\overset{?}{\rightsquigarrow}$ *Michael washed a car.*

Correspondingly, whether these quantifiers do give rise to distributive implicatures is not clear:

(92) Less than 10 ambassadors speak Arabic, English or Mandarin.

$\overset{?}{\rightsquigarrow}$ *one ambassador speaks Arabic*

What does the recursive exhaustification analysis predict for these cases? Here, if we assume "*less than 3 nuts*" has "*some nuts*" as an alternative, as we did for upward-entailing quantifiers, we run into a problem. On the first round of exhaustification, all alternatives containing *some*, i.e. the first three alternatives of (93b), can be negated. This is because *fewer than 3 cars* is compatible with "*no cars*".

(93) a. Michael and LaToya (together) washed fewer than three cars.

$\not\rightsquigarrow$ *Michael washed a car.*

b. **Underlying meaning:**

$< 3\ x \in \mathsf{car}, \exists y \prec \mathsf{michael} + \mathsf{latoya}, \mathsf{cracked}(x)(y)$

c. **Alternatives:**

- Michael and LaToya washed some cars.

  $\exists x \in \mathsf{car}, \exists y \prec \mathsf{michael} + \mathsf{latoya}, \mathsf{cracked}(x)(y)$

- LaToya washed some cars.

  $\exists x \in \mathsf{car}, \mathsf{cracked}(x)(\mathsf{michael})$

- Michael washed some cars.

  $\exists x \in \mathsf{car}, \mathsf{cracked}(x)(\mathsf{latoya})$

- LaToya washed fewer than 3 cars.

  $\exists x \in \mathsf{car}, \mathsf{cracked}(x)(\mathsf{latoya})$

- Michael washed fewer than 3 cars.

  $\exists x \in \mathsf{car}, \mathsf{cracked}(x)(\mathsf{michael})$

- ...

The problem however is quite general. It arises outside of cumulative sentences as well, in simple sentences like (94a). Here too, any putative existential alternative could be negated.

(94) Fewer than 3 dancers smiled.

To avoid this problem, I assume that quantifiers can only have quantifiers of the same monotonicity as alternatives, yielding the following set of assumptions about alternatives:

Assumptions about alternatives

1. $[\![\text{the NP}]\!]$ has as alternatives all pluralities X, such that $X \prec [\![\text{the NP}]\!]$
2. There is no ∀-VP alternative to ∃-VP.
3. "*every*", *many*, *most* have *some* as an alternative.
4. quantifiers' alternatives must be of the same monotonicity.

If *some* is not alternative to *less than 3 cars*, then all the remaining alternatives, listed below in (95) are entailed by the prejacent. Recursive exhaustification stalls at the first step.

(95) **Alternatives:**

- LaToya washed fewer than 3 cars.
  $\exists x \in \mathsf{car}, \mathsf{cracked}(x)(\mathsf{latoya})$
- Michael washed fewer than 3 cars.
  $\exists x \in \mathsf{car}, \mathsf{cracked}(x)(\mathsf{michael})$
- ...

Most of this discussion is tentative but the following points emerge. First, downward-entailing quantifiers do not seem to give rise to exhaustive participation inferences, following Bayer (2013). Second, the recursive exhaustification mechanism can derive this result, assuming that quantifiers only have alternatives of the same monotonicity.

Outside the guarantee's jurisdiction: other scalar alternatives. Another limitation of the "*UE entails participation*" guarantee is that it does not apply if any other alternatives are considered beyond the existential alternative of the quantifier $\mathscr{Q}$ and the subdomain alternatives of the plural-referring expression. Yet, other alternatives sometimes have to be considered. Indeed cumulative sentences do give rise to scalar implicatures beyond the exhaustive participation inferences. For instance, (96) gives rise to the implicature that *not all* nuts were cracked:

(96) The ten squirrels cracked most of the nuts.
implicates: *not all of the nuts were cracked by a squirrel.*
implicates: *every squirrel cracked a nut.*

There is only so much one can prove with such generality so the lack of mathematical guarantees in such cases is to be expected. However, the computational tools of the package Exh (Chatain, 2019a) provide reasons for optimism. We can for instance computationally determine what the predicted meaning of (96) is, with recursive exhaustification (cf (97)). It matches the attested reading of (96).

(97) a. EXH EXH The ten squirrels cracked most of the nuts. [nb]

b. **Computed result**:

$\text{Most } x \in \text{nut}, \exists y \in \text{squirrel}, \text{cracked}(x)(y)$

$\wedge \neg \forall x \in \text{nut}, \exists y \in \text{squirrel}, \text{cracked}(x)(y)$ (*not all* implicature)

$\wedge \forall y \in \text{squirrel}, \exists x \in \text{nut}, \text{cracked}(x)(y)$ (exhaustive participation)

Although this would need to be shown in all generality, everything proceeds in this case as if the generation of regular implicatures did not interfere with the generation of exhaustive participation inferences.

Outside the guarantee's jurisdiction: multiple quantifiers. The final case to consider is what the theory predicts for the video-game example, repeated below in (98). In (98), two quantifiers are used, not just one. The mathematical guarantee "*UE entails participation*", which only considers the effect of one quantifier, is not applicable in such cases.

(98) The ten video-games taught every quarterback two new plays.
$\rightsquigarrow$ *every video-game taught some quarterback some play*

Where mathematical guarantees are unattainable, the numerical simulations of Exh come to the rescue. The result for a version of Schein's sentences are given below[19,20].

(99) a. EXH EXH The ten video-games taught every quarterback two new plays.
$\rightsquigarrow$ *every video-game taught some quarterback some play*

b. **Computed result** [nb]:

$\forall x \in \text{quarterback}, \exists 2\ y \in \text{plays}, \exists z \prec \iota\text{video-games}, \text{taught}(x)(y)(z)$

$\wedge \forall z \prec \iota\text{video-games}, \exists x \in \text{quarterback}, \exists y \in \text{plays}, \text{taught}(x)(y)(z)$

= *exhaustive participation inference*

[19] Computational complexity skyrockets in the video-game example so the simulation was performed on small domains.

[20] Here is a reason to see why this should hold. Consider how the pair *every video-game - two new plays* is formally equivalent to a quantifier over pairs. Seen in this light, this quantifier over pairs has existential entailments and has an existential over pair as an alternative. As a result, the "*existence entails participation*" guarantee and its strengthened version discussed in appendix **??** is almost applicable.

Summary and outlook. The results of this sub-section conclude our investigation of the dataset introduced in 2.1. Before we move beyond it, let me recap the analysis so far. In section 2.3, we introduced existential meanings into verbs, e.g. ∃-cracked, ∃-taught, etc. I showed how this simple assumption immediately predicted the truth-conditions of the negative version of the sentences of the dataset:

(100) a. The squirrels didn't crack every nut.
$\rightsquigarrow$ $[\![$not [the squirrels ∃-crack every nut]$]\!] = \neg\forall x \in \mathsf{nut}, \exists y \prec \iota\mathsf{squirrels}, \mathsf{crack}(x)(y)$

b. The squirrels didn't crack most nuts.

c. The ten video-games didn't teach every quarterback two new plays.

Building on an analogy with Free Choice and Distributive Implicatures, I motivated the recursive exhaustification of Fox (2007) as a way to derive exhaustive participation inferences in positive environment. Recursive exhaustification only occurs in positive environment, preserving the prediction of (100). It computes strengthenings to the prejacent by comparing it with alternatives formed from the sentence by one of the following scalar substitutions: 1) substituting a quantifier with an existential, 2) substituting a plural-referring expression with a sub-plurality. Although the exact extent to which exhaustive participation inferences are derived could not be determined by procedure, numerical simulations show that these inferences are at least derived for all the sentences in the dataset.

(101) a. The squirrels cracked every nut.
$\rightsquigarrow$ $[\![$Exh Exh the squirrels ∃-crack every nut$]\!]$
$= \forall x \in \mathsf{nut}, \exists y \prec \iota\mathsf{squirrels}, \mathsf{crack}(x)(y)$
$\wedge \forall y \prec \iota\mathsf{squirrels}, \exists x \in \mathsf{nut}, \mathsf{crack}(x)(y)$

b. The squirrels cracked most nuts.

c. The ten video-games taught every quarterback two new plays.

The following box summarizes the analysis:

Assumptions

1. **assumptions about composition**
   - verbs have existential meanings (e.g. ∃-*cracked*)
   - recursive EXH in positive environment at root.
2. **assumptions about alternatives**
   - ⟦the NP⟧ has as alternatives all pluralities X, such that $X \prec$ ⟦the NP⟧
   - There is no ∀-VP alternative to ∃-VP.
   - "*every*", *many*, *most* have *some* as an alternative.
   - quantifiers' alternatives must be of the same monotonicity.

2.6.2 Asymmetries in cumulative readings

Asymmetries with *every*: the data We are now ready to move beyond the dataset. A famous property of cumulative sentences with *every* is that they exhibit subject/object asymmetries[21] (Champollion, 2010; Ferreira, 2005; Haslinger and Schmitt, 2018; Ivlieva, 2013; Kratzer, 2003). Consider (102a) and (102b): while (102a) has a sensible cumulative reading, (102b) seems to require every squirrel to have cracked every nut (a doubly-distributive reading)

(102) a. Every squirrel cracked the ten nuts. (#cumulative)

b. The ten squirrels cracked every nut. (✓ cumulative)

Although Kratzer (2003) initially described the asymmetry as an asymmery in thematic positions, Champollion (2010); Zweig (2008) shows that the asymmetry is one of c-command: a cumulative reading with *every* is only possible when *every* is c-commanded by a plural-referring expression. We can appreciate the truth of this fact by comparing all argument

[21] As far as I understand, Kratzer (2003) was the first to notice the pattern although cumulative reading of *every* were presented at least as early as Schein (1993).

positions of a ditransitive predicate (examples from Chatain (2020)):

(103) AGENT/THEME

a. The twelve challenges taught Hercules every cardinal virtue. (cumulative)

b. Every challenge taught Hercules the four cardinal virtues. (#cumulative)

(104) AGENT/GOAL

a. The ten servers sent every customer an e-mail. (cumulative)

b. Every server sent the ten customers an e-mail. (#cumulative)

(105) GOAL/THEME

a. Anya gave the ten charities in Boxborough every penny she had earned.[22] (cumulative)

b. Anya gave every charity in Boxborough the fifteen checks she had earned. (#cumulative)

An important component of the mystery of the asymmetries is that movement operations do not license cumulative readings: if a cumulative reading was unavailable before movement, it remains unavailable after it, even if said movement has scopal effects. In Chatain (2020), I demonstrate this on *wh*-questions, passives and Russian scrambling.

Below, I repeat the evidence from Russian. Russian quantifier *kazhdyj* behaves like its English counterpart *every*; it gives rise to cumulative reading in object position (106), not in subject position (107).

(106) **Cumulative reading is possible when *kazhdyj* is in object position**

Kazhdyj	*povar*	*otrkyl*	*ustricy*
every	cook.NOM.M.SG	open.PERF	oyster.PL.ACC

"*Every cook opened the oysters*[23]." (#background)

[23]Given that the object is not marked for definiteness in Russian, one may wonder why the Russian sentence cannot be read as "*every cook opened some oysters*". Under that reading, the sentence would not conflict with background knowledge. This is due to the presence of the perfective, which forces definite reading on bare plural objects (Krifka, 1992).

(107) **Cumulative reading is impossible when *kazhdyj* is in subject position**

Povara *otrkyli* *kazhduju* *ustricu*
cook.NOM.PL open.PERF every oyster.SG.F.ACC

"*The cooks opened every oyster*" (✓ background)

As (108) shows, scrambling the object DP above the subject DP in (107) does not give rise to a cumulative reading, even though that Russian scrambling makes the object c-commands the subject and usually has scopal effects (Antonyuk, 2006; Ionin, 2001; Stoops and Ionin, 2013).

(108) *Ustricy* *kazhdyj* *povar* *otrkyl*
oyster.PL.ACC every cook.NOM.M.SG open.**Perf**

"*Every cook opened the oysters*" (#background)

Compiling the data from English and Russian, I form the following generalization:

Generalization

A cumulative reading between *every* and a plural-referring expression is only available when *every* is c-commanded by the plural-referring expression's base position.

Analysis. Let us first focus on the case of *every*. Within the theory of this chapter, the underlying meanings of sentences with *every* in subject position and the sentences with *every* in object position are parallel: the plural-referring expression, translated as an existential, takes scope under the universal quantifier.

(109) a. Every squirrel ∃-cracked the three nuts.

b. **Underlying meaning:**
$\forall y \in \mathsf{squirrel}, \exists x \prec \iota \mathsf{nuts}, \mathsf{crack}(x)(y)$

(110) a. The three squirrels ∃-cracked every nut.

b. **Underlying meaning:**

$\forall y \in \mathsf{nut}, \exists x \prec \iota\mathsf{squirrels}, \mathsf{crack}(y)(x)$

If the goal is to find asymmetries, such a parallel in truth-conditions is worrying. But recall that the underlying meaning is only ever seen in negative environments. This means that we expect the truth-conditions of the negation of (109) and (110) to behave in a parallel manner. This prediction is borne out: as reported in Križ and Chemla (2015), the negation of (109) has the truth-conditions in (111). These truth-conditions mirror[24] the truth-conditions of the negation of (110), which we already discussed in section 2.3.

(112) a. Not every squirrel cracked the three nuts.

=*not every squirrel cracked a nut*

=*some squirrel cracked no nut*

b. The three squirrels didn't crack every nut.

=*not every nut was cracked by a squirrel*

=*some nut wasn't cracked by any squirrel*

The parallel in underlying meanings suggest that any difference between subject *every* sentences and object *every* sentences is due to the way the two sentences are strengthened in positive environments.

Problematically, using the recursive exhaustification at root that we have been using so far, as in (113), is bound to deliver the same strengthening for both sentences. (I will use the symbol $\textsc{Exh}^2$for recursive exhaustification). Indeed, these sentences have the

[24] Interestingly, these sentences seem to differ in their implicatures. While (111a) implicates that some squirrel cracked the three nuts, (111b) implicates that some squirrels cracked some nuts. If the treatment of exhaustive participation inferences that I propose is correct, these implicatures would parallel the strengthened indirect implicature of (111):

(111) I didn't show every boy some of my paintings. ⇝ *I showed every boy some but not all of my paintings.*

To my knowledge, these types of implicatures are not accounted for, or discussed by previous literature.

same underlying meaning and identical alternatives. Both sentences, as it stands, will receive a cumulative reading, contrary to fact.

(113) a. $\textsc{Exh}^2$Every squirrel ∃-cracked the three nuts.

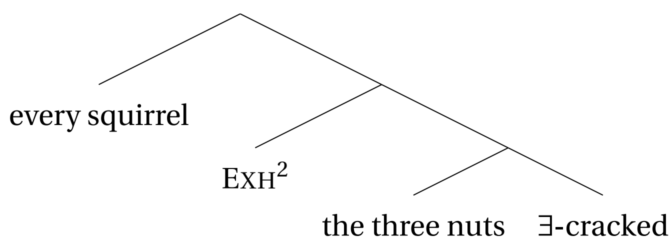
$\rightsquigarrow$ *every squirrel cracked a nut and every nut was cracked by a squirrel.*

b. $\textsc{Exh}^2$The three squirrels ∃-cracked every nut.

$\rightsquigarrow$ *every squirrel cracked a nut and every nut was cracked by a squirrel*

The reason for the asymmetry stems, I contend, from the scope of exhaustivity. So far, I have assumed that all exhaustification happens at root. Consider what would happen for different placements of $\textsc{Exh}^2$. When *every* is in subject position, $\textsc{Exh}^2$can be inserted in the scope of *every*, while still c-commanding *the three nuts*, as shown in (114).

(114)



In this position, $\textsc{Exh}^2$applies directly to the existential over parts of the nuts. As we saw in section 2.5, this is precisely the configuration in which a Free Choice-like inference is generated. Concretely, this means that *the three nuts* is strengthened to a universal ; the sentence receives a doubly-distributive reading[nb].

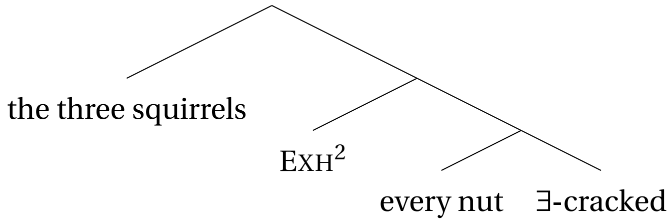
(115) $$[\![(114a)]\!] = \forall y \in \mathsf{squirrel},\ \textsc{Exh}^2(\exists x \prec \mathsf{nut}_1 + \mathsf{nut}_2 + \mathsf{nut}_3,\ \mathsf{cracked}(x)(y))$$

$$\textbf{alts: } \exists y \prec \mathsf{nut}_1 + \mathsf{nut}_2,\ \mathsf{cracked}(x)(y)), \ldots$$

$$= \forall x \in \mathsf{squirrel}, \forall y \prec \mathsf{nut}_1 + \mathsf{nut}_2 + \mathsf{nut}_3,\ \mathsf{cracked}(x)(y)$$

By contrast, when *every* is in a object position, there is no position where $\textsc{Exh}^2$can be placed in which it both c-commands the plural and is c-commanded by *every*. There are embedded position but they fail to c-command the plural-referring expressions *the three squirrels*. Failing to c-command *the three squirrels* means that the alternatives which $\textsc{Exh}$ compares will not contain any sub-domain alternatives ; no cumulative strengthening is derived. This is illustrated in (116).

(116) a.



b. $[\![(115a)]\!] = \iota\text{squirrels}\ \lambda y.\ \text{EXH}^2(\forall x \in \text{nuts},\ \text{cracked}(x)(y))$

$\textbf{alts: } \exists y \in [\![\text{nut}]\!],\ \text{cracked}(x)(y))$

$= \iota\text{squirrels}\ \lambda y.\ \forall x \in \text{nuts},\ \text{cracked}(x)(y)$

The following chart summarizes our discussion so far:

	subject *every*	object *every*
root EXH^2	cumulative	cumulative
embedded EXH^2	doubly-distributive	vacuous

From this chart, I make the following simple proposal: EXH^{2}must apply at all positions (Magri, 2011). This type of structure is summarized in (117) below. With object *every*, this assumption is innocuous because embedded EXH^{2}does not result in strengthening. The composition proceeds as if there was only a root EXH^2; as we saw, this is how the cumulative reading is generated. With subject *every*, embedded EXH^2 results in the attested doubly-distributive reading. The root EXH^{2}cannot strengthen the meaning beyond further.

(117) a. EXH^{2}the three squirrels EXH^2∃-cracked every nut. [nb]

b. EXH^{2}every squirrel EXH^2∃-cracked the three nuts. [nb]

In short, the asymmetry between the cumulative reading of object *every* and the doubly-distributive reading of subject *every* is that only in the latter case, there is a position below the quantifier where the sub-domain alternatives are visible and strengthening can happen. Assuming that strengthening not only can but must happen, through the postulate that exhaustification applies in all positions, creates the split between subject and object *every* in positive environment.

The assumption that recursive exhaustification must apply in all positions is the last assumption that I will make in this chapter about cumulativity. Adding it to the list of assumptions, we arrive at the following final theory:

Assumptions

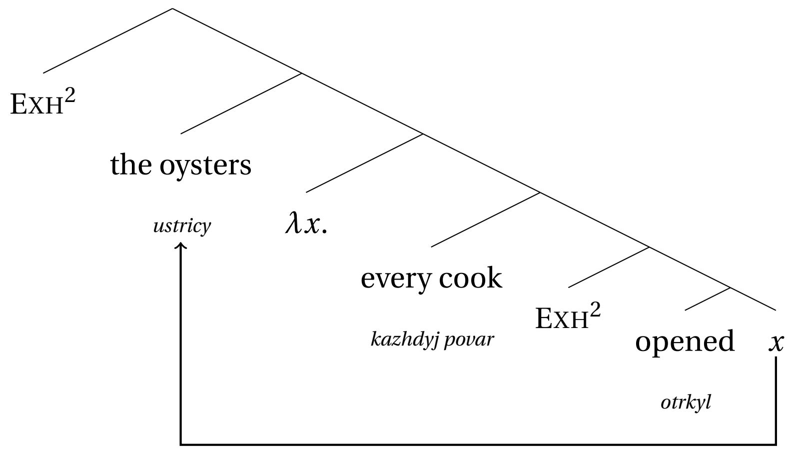
1. **assumptions about composition**
   - verbs have existential meanings (e.g. ∃-*cracked*)
   - recursive Exh in positive environment *in all positions.*.
2. **assumptions about alternatives**
   - ⟦the NP⟧ has as alternatives all pluralities X, such that $X \prec$ ⟦the NP⟧
   - There is no ∀-VP alternative to ∃-VP.
   - "*every*", *many, most* have *some* as an alternative.
   - quantifiers' alternatives must be of the same monotonicity.

In the last part of the section, I turn to the other two facts about asymmetries that I outlined in the introduction: 1) that movement does not create new cumulative readings, 2) that quantifiers over pluralities do not give rise to asymmetries (cumulative readings available from both positions) - such as partitive quantifiers - but quantifiers over singularities do - non-partitive quantifiers -.

The effect of *movement*. Descriptively, cumulative readings will arise when *every* is c-commanded by the base position of a plural-referring expression and a doubly-distributive reading will otherwise arise. This analysis developed above allows for a more precise statement: as we discussed earlier, a doubly-distributive reading will arise whenever there is a position in the scope of the quantifier where sub-domain alternatives of the plural-referring expression are visible to Exh^2 ; otherwise, a cumulative reading is generated.

This refined generalization helps us understand why movement would not create new cumulative readings. Consider the structure of (118) for the Russian sentence corresponding to *every cook opened the oysters*, where the object scrambles above the subject.

(118)



While the movement does alter the c-command hierarchy, it leaves a trace in its base position. This means that despite movement, there is still a position within the scope of the quantifier where sub-domain alternatives - the sub-domain alternatives to the trace - can lead to strengthening. The doubly-distributive reading is still generated.

2.6.3 Ordinary cumulative readings

At last, we are ready to tackle ordinary cumulative sentences, like (119). Ordinary cumulative sentences do not raise particular issues for the theory, but the full set of assumptions made in this chapter are necessary to account for it.

(119) a. The ten squirrels cracked the fifteen nuts.

b. The ten squirrels didn't crack the fifteen nuts.

The negative case in (119b) is the simplest. In the scope of negation, no strengthening through EXH^{2}occurs ; both plural-referring expressions are interpreted as existential over parts of their denotation in the scope of negation. The predicted meaning matches the attested meaning: *no squirrel cracked any nut.*

(120) a. not [the ten squirrels ∃-cracked the fifteen nuts]

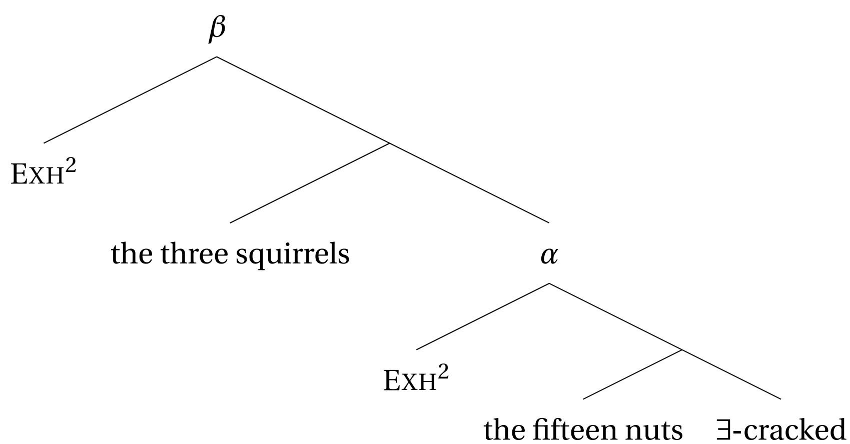
b. $[\![(120a)]\!] = \neg\exists x \prec \iota\text{squirrels}, \exists y \prec \iota\text{nuts}, \text{cracked}(y)(x)$

$\nleftrightarrow$ *no squirrel cracked any nut*

In the positive case of (121a), exhaustification is active. As seen in the last section, we need to include one EXH^{2}in all positions.

(121) a. The ten squirrels cracked the fifteen nuts.

b.



c.

The computation is arduous [nb], but we can develop a simple intuition for how it will run. In the embedded position α, EXH^2 operates over the sub-domain alternatives of the existential represented by *the nuts*, cf (122). Because there is no intervening quantifier, *the nuts* will be strengthened to a universal (i.e. a Free Choice-like inference), cf (122a).

(122) $[\![\alpha]\!] = \lambda X.\ \text{EXH}^2(\exists y \prec \iota\text{nuts}, \exists x \prec X, \text{cracked}(y)(x))$

alts: $\exists y \in \text{nut}_1 + \text{nut}_2, \exists x \prec X\ \text{cracked}(y)(x)), \ldots$

$= \forall y \prec \iota\text{nuts}, \exists x \prec X, \text{cracked}(y)(x)$

$\leftrightarrow$ *every nut was cracked by one of X*

In the root position β, EXH^{2}operates over the sub-domain alternatives of *the squirrels*[25]. Here however, the existential represented by *the squirrels* finds itself in the scope of the universal corresponding to *the nuts* which was created by the first strengthening. The

[25] In addition to the sub-domain alternatives of *the nuts*.

situation is entirely parallel to the case of cumulative readings of *every* ; EXH^2 will generate a distributive-like implicature. Together with the prejacent, this will create the cumulative reading.

(123) a. $[\![\beta]\!] = \text{EXH}^2(\forall y \prec \iota\text{nuts}, \exists x \prec \iota\text{squirrels cracked}(y)(x))$

$$\textbf{alts: } \exists y \in [\![\text{nut}]\!], \exists x \prec \iota\text{scrat} + \text{waggs cracked}(y)(x)), \ldots$$

$$= \forall y \prec \iota\text{nuts}, \exists x \prec \iota\text{squirrels}, \text{ cracked}(x)(y)$$

$$\wedge \forall x \prec \iota\text{squirrels}, \exists y \prec \iota\text{nuts}, \text{ cracked}(y)(x)$$

$\leftrightarrow$ *cumulative reading*

All in all, the computation raises no particular issue. The object is first strengthened to a universal meaning ; from then on, the situation is entirely parallel to the case of cumulative readings of *every*.

Conclusion and further puzzles.

This chapter laid the foundations of a theory of cumulativity. This theory of cumulativity is special in that it does justice to the homogeneity properties of cumulative readings and gives an account of the truth-conditions of negative sentences, not frequently addressed by previous approaches (cf chapters 5 and 9). More than that, I hope to have shown that two generalizations about the meaning of cumulative sentences can only be discovered by carefully comparing cumulative sentences in positive and negative environments. The first generalization claims that the part of the meaning which is common to both positive and negative environments is obtained by translating all plural-referring expressions by low-scope existentials. The second generalization asserts that the part of the meaning which only occurs in positive environments asserts all individuals in the plurals exhaustively took part in the action described by the verb.

The theory, whose assumptions are repeated in the box below, builds at its core existential quantification over parts in the meaning of the verb. With this assumption alone, the negative versions of all sentences in (123) are all covered. Then, I proceeded to identify the exhaustive participation inferences of positive sentences with Free Choice/distributive implicatures, which independently require an account. I argued that recursive exhaustification provides such an account. While the prediction of this account may sometimes be intractable, I showed that it delivered correct results as far as our dataset is concerned. Furthermore, it provided an understanding of the asymmetries in cumulative reading.

Assumptions

1. verbs have existential meanings (e.g. ∃-*cracked*).
2. recursive EXH in positive environment *in all positions..*
3. each sub-plurality is an alternative to a plural-referring expression.
4. existential alternatives to quantifiers.

There are some gaps in the theory of this chapter which later chapters will fill. First, this chapter has unabashedly ignored the possibility of collective action. The sentence (124a) is still true if for every nut, it took multiple squirrels to crack it, each squirrel gnawing at one side of the nut, and all squirrels participated in one cracking. In this context however, the predicted (124b) would wrongly come out false since for no nut n can we find a squirrel s of which it is true that s cracked n. In chapter 6, I remedy this deficit of the theory.

(124) a. The squirrels cracked the nuts

b. $\forall x \prec \iota\text{squirrels}, \exists y \prec \iota\text{nuts}, \text{cracked}(y)(x)$
$\wedge \forall y \prec \iota\text{nuts}, \exists x \prec \iota\text{squirrels}, \text{cracked}(y)(x)$

Another limitation of the theory is that it currently does not predict the possibility of phrasal distributivity. For instance, (125) is only predicted to mean (125a), whereas it can also mean (125b).

(125) The squirrels cracked at least 4 nuts.

a. **Collective/Cumulative:**

the number of nuts cracked by any squirrels exceeds 4 and all squirrel cracked some nuts

b. **Distributive:**
for every squirrel, that squirrel cracked more than 3 nuts

From the perspective of the theory, those readings could be achieved if, contrary to my generalizations, the existentials associated with the interpretation of plural-referring expressions could take a higher scope. For instance, if we identified the operator of distributivity with the existential interpretation of plurals and allowed the latter to have free-scope, as in Bar-Lev (2018b)'s theory.

But I find reasons to distinguish the existential meanings needed for cumulative readings from those needed for distributive readings. As Champollion (2016a,b) argues, phrasal distributivity is typically atomic, unless context makes a cover available, whereas cumulative reading are typically non-atomic without need for contextual support. Furthermore, items which do not give rise to phrasal distributivity may give rise to cumulative readings (de Vries, 2015), suggesting that distributivity needs a theory of its own. It is the role of chapter 7 to develop this theory.

Chapter 3

Homogeneity and cumulativity: parts and groups

3.1 Homogeneity and cumulativity at large

Up till now, we have taken the question of homogeneity in plurals and in cumulative sentences as a one-of-a-kind phenomenon, restricting the scope of our investigation to these cases only. However, many researchers (Corblin, 2008; Kriz, 2015; Löbner, 2000) have noticed that similar all-or-nothing inferences occur in other circumstances as well. Let me mention several such phenomena.

First, the presupposition of Excluded Middle in conditionals (Higginbotham, 1986). A conditional like (1a) (roughly) conveys that in all worlds where Mary comes, Anna does as well. By contrast, the high negation of (1a) in (1b), constructed here with "*I strongly doubt that …*", conveys that the speaker believes that in no world where Mary comes does Anna come as well. Just as with homogeneity in definite plurals, there are situations such that neither a positive sentence nor a negative sentence can convey: cases where Anna makes her decision about coming independently of Mary's presence.

(1) a. Anna will come if Mary comes.

b. I strongly doubt that Anna will come if Mary comes.

Second, the phenomenon of Neg-Raising (Horn, 2020, and references therein) bears a striking similarity to homogeneity, as discussed by Gajewski (2005). In a positive sentence, a verb like *believe, think* (roughly) conveys that in all worlds that the attitude holder deems possible, its propositional complement holds true. The negative sentences convey by contrast that in no world that she deems possible is the complement true. Yet again, there are situations that fail to be describable by either (2a) or (2b): for instance, Aert could have no strong opinion on the matter of whether it will rain in New York on Sunday or not.

(2) a. Aert thinks that it will rain in New York on Sunday.

b. Aert doesn't think that it will rain in New York on Sunday.

Third, embedded questions also display an "*all-or-nothing*" behavior (Cremers, 2018; Križ, 2015). A positive sentence like (3a) conveys (under one reading) that the magician knows that I have in my hand everything that I do. In a negative sentence like (3b), it conveys that the magician does not know of anything that I have in my hand that it is in my hand. Intermediate situations where the magician has partial knowledge of what is in my hand are not expressible through either forms in (3).

(3) a. The magician knows what I am holding in my hand.

b. The magician doesn't know what I am holding in my hand.

Fourth, generic bare plurals. (4a) asserts that every "*normal*" Martian will have said appendices ; (4b), with its high negation, conveys that no "*normal*" Martian will have them. A case where only Martians of gender ZW normally have tentacles would not be expressible in either of the forms below.

(4) a. Martians have tentacles.

b. I strongly doubt that Martians have tentacles.

This is but a sample. Examples of all-or-nothing inferences are abundant in natural language. Naturally, one wonders whether all of these phenomena have a common source or whether they are explained by different mechanisms. The discussion to follow will not attempt to unify all of these disparate phenomena, exciting though this research avenue may be. My focus will be on two specific categories of all-or-nothing inferences which, as I will argue, are undoubtedly related to the homogeneity effects observed in plurals: the case of part homogeneity and the case of group homogeneity, which were first discussed at length in Löbner (2000). These two cases are illustrated in (5) and (6) respectively.

(5) Part homogeneity

a. The pie was eaten.

⇝ *all (or almost) of the pie was eaten.*

b. The pie wasn't eaten.

⇝ *none (or almost none) of the pie was eaten.*

(6) Group homogeneity

a. The jury smiled.

⇝ *all (or almost) jury members smiled.*

b. The jury didn't smile.

⇝ *no (or almost no) jury members smiled.*

I will discuss both these cases in turn. The claims will be the same in both cases. First, I observe, following predecessors, the objects - materially complex objects or groups - display not only all-or-nothing inferences but they also give rise to cumulative-like readings. As with plurals though, the cumulative-like reading could initially be thought to arise lexically.

Second, I show that these objects give rise to cumulative-like readings with *every*, which a lexical account could not predict. A compositional treatment is therefore required. One idea for such a compositional treatment might be to apply an analysis of plural homogeneity/cumulativity, as proposed in e.g. chapter 2, under the assumption that materially complex objects or groups are, in fact, pluralities.

Third, I show that treating materially complex objects or groups as pluralities is not in general tenable. It would not account for the observed predicate variability or would predict unattested readings across-the-board. This conclusion is more controversial for groups than it is for material objects. More ink will therefore be spilled on the latter case than on the former one.

This chapter is divided in two sections. Section 3.2 focuses on part homogeneity and cumulativity: first, I present the main data points and literature on the topic. I then move on to explain why a lexical treatment will fail to account for cumulative readings of *every*, motivating a compositional treatment. Finally, I show that material objects may not meaningfully be treated as pluralities, motivating a new compositional treatment. Section 3.3 focuses on group homogeneity and cumulativity with the same structure: the main data is introduced. The lexical account is criticized by reference to cumulative readings of *every*. Finally, I state my arguments that group nouns combining with singular predicates denote singularities (following Barker (1992); de Vries (2015); Schwarzschild (1996)) and not pluralities (*pace* Magri (2012); Pearson (2011)).

3.2 Part homogeneity/cumulativity

3.2.1 Part homogeneity

As Löbner (2000) first noted (on similar sentences), the sentences in (7) only describe two extremes: (7a) is typically used to mean that the speaker ate the whole pie, (7b) is typically used to mean they ate none of it. Speakers find it difficult to assert either (7a) or (7b) in case they ate half of the pie.

(7) a. I ate the pie.
 $\rightsquigarrow$ *all parts of the pie were eaten by me.*

b. I didn't eat the pie.
 $\rightsquigarrow$ *no parts of the pie were eaten by me.*

The phenomenology of part homogeneity entirely mirrors the phenomenology of plural homogeneity. In particular, contextual pressures can modulate the acceptability of either sentence in intermediate situations where some but not all of the pie was eaten (i.e. the phenomenon of non-maximality, cf 1).

For instance, if I serve a spinach pie to a guest and discover some time later, one half of it in the garbage bin, I may well say (8a), even if it is likely that my guest ate that half of the spinach pie not found in the bin. If on the other hand, after a meal at the restaurant where we shared our dishes, most of my party falls sick, I can exonerate the spinach pie that we ordered for the table by uttering (8b), even if I did not eat the whole pie myself.

(8) a. You didn't eat the pie!

b. I ate the pie and I didn't fall sick.

This variability mirrors the variability of acceptability found with plurals in intermediate situations. We can, for instance, swap *the pie* for *the peas* in the sentences and contexts above. The same pattern of acceptability is found in these cases as well.

(9) a. You didn't eat the peas!

b. I ate the peas and I didn't fall sick.

This pattern of all-or-nothing inferences which affects parts of an object is found with many other predicates besides *eat*. See some of the predicates listed below:

(10) *paint the wall*

a. I painted the wall.
$\rightsquigarrow$ *all parts of the wall were covered in paint.*

b. I didn't paint the wall.
$\rightsquigarrow$ *no parts of the wall were covered in paint.*

(11) *read the book*

a. I read the book.

$\rightsquigarrow$ *all parts of the book were read.*

b. I didn't read the book.

$\rightsquigarrow$ *no parts of the book were read.*

(12) *erase the graffiti*

a. I erased the graffiti.

$\rightsquigarrow$ *all parts of the graffiti were erased.*

b. I didn't erase the graffiti.

$\rightsquigarrow$ *no parts of the graffiti were erased.*

This illustrates the basic phenomenon of part homogeneity. The rest of this section discusses two relevant aspects of the phenomenon. First, I will show that not all predicates give rise to part homogeneity and discuss what the potential generalization behind this may be. Second, I will show that not all part-homogeneous readings are alike.The data and discussion in both cases will draw heavily on Löbner (2000), although I will distance myself from some parts of his description.

Summativity and Löbner's generalization The first and most important observation is that not all predicate-singular arguments yield such a part homogeneity effect. For instance, there does not seem to be intermediate situations[1] between (13a) and (13b): either Valentine plugged the computer in or Valentine didn't. Same goes for (14a) and (14b): either I touched the ceiling or I didn't.

[1] In fact, there are some situations which may described as intermediate. If the robotic arm that I am operating through my tablet a thousand miles away from it touches the ceiling, both (14a) and (14b) may be unutterable (or both could be uttered!). In both of these strange circumstances, the meaning of ordinary verbs seems to be under-specified in such a way that there is no truth of the matter whether Valentine is talking to me or whether I did indeed touch the ceiling. This limbo between the positive and the negative, at the edge of the meaning of ordinary verbs, does not seem to be an all-or-nothing inference *properly speaking*, since the positive and the negative cannot be adequately paraphrased by a positive and negative universal respectively, whereas our previous examples all seemed to.

(13) a. Valentine plugged the computer in.

b. Valentine didn't plug the computer in.

(14) a. I touched the ceiling.

b. I didn't touch the ceiling.

(15) a. I visited Austria.

b. I didn't visit Austria.

(16) a. I entered the room.

b. I didn't enter the room.

The discrepancy between the predicate-singular-argument which do yield all-or-nothing inferences and those which don't immediately raises the question of what delineates the two classes. For instance, it seems clear the nature of the singular argument alone does not suffice to determine whether a predicate has homogeneity or not. The sentences in (17) share an argument and yet, one is homogeneous (17a) while the other isn't (17b).

(17) a. I ate the pie.

b. I touched the pie.

Rather, it seems that the nature of the predicate alone suffices to determine whether a predication will show part homogeneity or not[2]. The question of what makes part-homogeneous predication becomes the question of what makes a part-homogeneous predicate.

The answer to the latter question is somehow implicit in the paraphrase we gave to the sentences, repeated below in (18).

[2]To qualify that assertion somewhat, R. Schwarzschild (p.c.) notes that in the limiting case where the argument has no parts, there is no homogeneity. Hence, *the bromine compound absorbed the electron* will not be homogeneous, since electrons do not have parts to the best of our knowledge, but *the atom of bromine absorbed the proton* is part-homogeneous with respect to the quarks that make it up.

(18) a. I ate the pie.

I ate all parts of the pie.

b. I didn't eat the pie.

I didn't eat any parts of the pie.

It is not a property of all predicates that they can be paraphrased as "*I V'ed all parts of* ..." in the positive or as "*I didn't V any parts of* ..." in the negative. Note that the same paraphrase would fail in (19):

(19) a. The restaurant charged me.

≠ *#the restaurant charged all parts of me.*

b. I touched the wall.

≠ *I touched all parts of the wall.*

At an intuitive level, part-homogeneous predicates are those predicates which are true of an object by virtue of being true of all parts of an object.

Löbner (2000) formalized this intuition by developing a broader notion he called *summativity*[3]. I will rather use the term L-summativity for the notion he describes and reserve the word *summativity* for predicates closed under sums. L-summativity is defined as follows:

(20) A predicate p is *L-summative* if it meets the following condition:

p is true of a iff it is true of all parts in some *admissible partition* of a

An *admissible partition* of a is defined as a set of parts of a, mutually disjoint and whose sum is a, which all meet the selectional requirements of the predicate and are "*relevant*". The mention of selectional requirements is meant as a response of the problem of minimal parts: "*I erased the graffiti*" is not taken to entail that I erased every molecule that

[3] I depart from Löbner here. His definition of L-summativity includes both truth- and falsity-conditions of L-summative predicates, which in my opinion is masking the key insight that the two are correlated: a predicate has the truth-conditions described iff it has the falsity-conditions given by Löbner. My presentation tries to highlight an *a priori* unexpected connection between being true of a whole by virtue of being true of its parts and the truth-value gaps.

composes it, because molecules do not meet the selectional restrictions of the predicate (an molecule is not the type of things which are erased). This makes *erase* L-summative. The mention of "*relevant parts*", a context-dependent element, takes care of other types of exceptions: my painting the building in blue will not typically imply my painting the building's windows in blue. This shouldn't be grounds to exclude *paint* from the set of L-summative predicates.

To illustrate the definition, let's observe that the predicate "λx. I ate x" is L-summative. The six slices that formed the pie are an admissible partition partition of the pie. My eating all six slices entails my eating the pie. Reciprocally, my eating the pie entails that we can divide the pie in some set of edible parts such that I ate each of these parts. By contrast, Löbner intends the predicate "λx. x is cheap" to not be L-summative. The fact that a car is cheap does not entail that we can divide the car into price-able relevant parts such that each of them are cheap[4]. Indeed, all these parts could be quite expensive and the car sold at a loss (as in a clearance sale).

This definition allows us to state *Löbner's generalization*[5], which connects part homogeneity to L-summativity:

Löbner's generalization

A predicate is L-summative if and only if it is part-homogeneous. In other words, a predicate p meets 1 if and only if it meets 2:

1. p is true of a iff it is true of all parts in some *admissible partition* of a
2. p is false of a iff it is not true of any parts of any *admissible partition* of a

For example, this generalization predicts that *eat*, being L-summative, would be

[4] The astute reader may notice a glitch here: if {the car} counts as an admissible (albeit trivial) partition of the car, then "*cheap*" will count as an L-summative predicate.

[5] I know of two exceptions to this generalization. The first is the predicate *finish*. *finish* is not part-homogeneous (I either finished or didn't finish the book), but it is L-summative: if I finished the book, I probably finished all relevant parts of it (the chapters). Similarly, *cover* is not L-summative (either the tapestry covers the wall or it does not) but it is L-summative: to cover the walls is to cover all (or nearly all) parts of it. I leave the explanation of these cases as an open puzzle.

part-homogeneous: my not eating any of the six slices entails my not eating the pie. My not eating the pie entails that there is some division of the pie into edible parts such that I ate none of these parts.

Variations on parthood A second more minor observation is that the phenomenon of part homogeneity is both unified and diverse. On the one hand, it would seem that all of the examples above can be paraphrased *almost*[6] correctly using the schema of the b examples of (21) and (23).

(22) a. The apple was eaten.

b. All parts of the apple was eaten

(23) a. The wall was painted.

b. All parts of the wall were painted

Yet, despite my insistence that there is a unified phenomenon of part homogeneity, the paraphrases of part-homogeneous sentences are not *exactly the same*. If I eat a pie, every volume of pie will be ingested. If I paint the wall, it is not the case that every volume of the wall will be painted, as the inside of the wall will presumably remain untouched. Similarly, if I read the book, it makes no sense for me to read every volume that the book is composed of (e.g. the binding, the plastic cover, etc.) but rather, I will likely read every abstract part of it (e.g. every chapter etc.)

Löbner (2000) himself makes brief mention of this variation in the passage below in connection to color predicates (see also (Rothstein, 2008, p. 97) on incremental theme verbs).

> “ The point to be observed here is that colour predicates apply to objects

[6]As discussed in section 3.2.1, one does not want (21) to entail that every electron of the graffiti was erased, as this is presumably non-sensical. This mirrors the *minimal parts* problem discussed in the literature on mass nouns (Gillon, 1992; Moravcsik, 1973; Pelletier and Schubert, 2003, inter alia).

(21) I erased the graffiti.

not directly but via a cognitive process that first selects a certain *dimension* of the object, where dimension is to be taken in a very general sense. ”

This observation underscores an unsuspected variability in the meaning of the meta-language use of “*part of*”. This variability mirrors a variability in the meaning of the English expression *part of.* (For reference on the meaning of *part of,* cf Moltmann (1997); Morzycki (2002); Wągiel (2018a) and references therein.)

(24) a. Part of the sculpture was blue.
⇝ *part of the surface*

b. Part of the sculpture was marble.
⇝ *part of the substance*

This fact may look like a trifle but we will want to make sure that any account considered makes room for the observed variability in meanings of part homogeneity.

3.2.2 Part cumulativity

Having established the two generalizations about part homogeneity, let us now turn to cumulative readings. We observe that when a transitive predicate is part-homogeneous in one of its arguments, this argument, in combination with a plural argument, seems to give rise to interpretations very much like the cumulative interpretations of chapter 2. The fact was noticed and discussed sporadically in Dobrovie-Sorin et al. (2016); Krifka (1992); Landman (2000), and more extensively in Glass (2018).

The sentence (25a), for instance, can adequately be paraphrased as (25b). The paraphrase bears a striking resemblance to one which we may use for an ordinary cumulative sentence like (26).

(25) a. The ten judges ate the pie.

b. **Paraphrase:**
Every judge ate a part of the pie.
Every part of the pie was eaten by a judge.

(26) a. The ten squirrels cracked the nuts.

b. **Paraphrase:**
Every squirrel cracked some of the nuts.
Every nut was cracked by some of the squirrels.

Such cumulative-like readings do not seem to arise with non-part-homogeneous predicates like *touch*, *talk*. The sentences in a below are not equivalent to the putative paraphrases in (27) below (to the extent that they are sensical):

(27) a. The ten children touched the statue.

b. **Paraphrase:**
Every child touched a part of the statue.
Every part of the statue was touched by a child.

(28) a. The ten crew members talked to the alien.

b. **Paraphrase:**
Every crew member talked to a part of the alien.
Every part of the alien was talked to by a crew member.

I will have more to say about cumulative readings of part-homogeneous predicates. For now, suffice to observe that the predicates which give rise to part homogeneity also seems to give rise to cumulative-like readings.

3.2.3 Interim Summary: how does this connect to plurality?

In this section, I have presented part homogeneity and cumulativity and highligthed three key properties of part-homogeneous predicates:

1. A predicate is part-homogeneous if and only if it is L-summative.

2. Not all part-homogeneous readings are exactly the same.

3. Part-homogeneous predicates show cumulative-like readings.

The phenomenon of part homogeneity/cumulativity has some tantalizing similarities with plural homogeneity and cumulativity. First, if the preceding work has shown anything, it is that plurals do also yield cumulative readings. Second, it has been claimed that there is a certain notion of summativity involved with plural predicates (cf Kratzer (2003)'s *Cumulativity Universal*). Many plural predicates validate an entailment pattern like the one from (29a) to (29b).

(29) a. Jane talked to me.
Jane talked to Jeremy.

b. Jane talked to Jeremy and me/the two of us.

Tantalizing though the parallel may be, *summativity* is not L-summativity and plural predicates aren't always L-summative, in the way Löbner defines it. For instance, plural predicates do not (always) have entailments to parts, characteristic of L-summative predicates. This most typically the case with collective/mixed predicates. For instances, (30b) is not a possible paraphrase of (30a).

(30) a. The movers carried a piano.

b. *All parts of the plurality of movers carried a piano.*

This happens even though such predicates do show a form of homogeneity (cf discussion of collective predicates in chapter 6).

(31) The movers didn't carry a piano.
$\rightsquigarrow$ *no mover carried any piano*

In a nutshell, the connection to pluralities is tantalizing but as of now, the descriptions of the two phenomena don't completely match. In light of this parallel and its partial failure, one could adopt one of two extreme positions. The first position would be to take the parallel to justify equating material parts to plural parts. This would easily explain why the same homogeneity-cumulativity behaviors are observed in both cases. The second position would be to maintain the parallel is some sort of accident: while plural cumulativity requires a compositional treatment, part cumulativity may be lexically stipulated. Part homogeneity would arise through independent means. The next two subsections argue against these two possibilities respectively.

3.2.4 Why wholes and plurals are different

So far, I have assumed that the object denoted by plural DPs - *pluralities* - come with its own notion of parthood (plural parthood) and sum (plural sums). Tacitly, I also assumed that the pluralities considered were composed of atoms, parts without proper sub-parts, and that the semantic composition can make reference to these atoms. In chapter 2 for instance, the exhaustive participation inferences of a cumulative sentence like (32), was derived by making reference to individual squirrels, the putative atomic parts of the plurality denoted by "*the squirrels*".

(32) The squirrels cracked every nut.
$\rightsquigarrow$ *every squirrel cracked some nuts.*

Yet, the parallels between material and plural parts with respect to homogeneity/cumulativity invite reconsideration of these assumptions. Perhaps there is no true distinction between plural parts and material parts, plural sums and material sums. Under this view, similar representations underlie the two sentences in (33):

(33) a. Martha is one of the generals.
$\mathsf{Martha} \prec \iota\mathsf{generals}$

b. This branch is part of this tree.
$[\![\text{this branch}]\!] \prec [\![\text{this tree}]\!]$

With a notion of part of that covers plural parts and material parts, any treatment of homogeneity/cumulativity adopted in this work or others for plural sums would then apply, without amendments, to a case like (34): just as "*the children*" denotes the sum of children, "*the pie*" denotes the sum of the crust, the fruits, the filling, etc. The mechanism for deriving cumulative readings in (34) would then apply to pie parts just as it would children members.

(34) The children ate the pie.

Against this possibility, I want to bring up two points which suggest that an account of homogeneity/cumulativity which conflates plural sums and material sums will face increasing difficulty.

The first point concerns predicate variability. Not all predicates are part-homogeneous. As we saw, Löbner's generalization correlated part homogeneity with L-summativity. Likewise, some plural predicates too fail to exhibit plural homogeneity (we will come back to this fact in chapter 6). (35a) and (35b), for instance, have complementary truth-conditions.

(35) a. The potatoes weigh 200kg.

b. The potatoes don't weigh 200kg.

However, the class of homogeneous predicates and the class of part-homogeneous predicates are not matched. For instance, the predicate *turn on* is not part-homogeneous but is definitely plural homogeneous, as the sentences in (36) attests.

(36) a. I turned the radios on.
$\rightsquigarrow$ *I turned on all (or almost all) of the radios*

b. I didn't turn the radios on.
$\rightsquigarrow$ *I turned on none (or almost none) of the radios*

Predicates which have one type of homogeneity but not another strike me as difficult to account for under a view that conflates plural and material sums. To account for *turn on*, some difference between "*the atoms*" (i.e. the individual radios), with respect to which all-or-nothing inferences exist, and the material parts, for which it doesn't, must be reinstated somehow. This seems to negate the whole purpose of the approach.

The first point against the view that part homogeneity can be explained away by equating material sums and plural sums is familiar. Link (1983) has given arguments that some natural language predicates distinguish between an object and the "*stuff that* *makes it up*". For instance, (37a) from (37b) can have different truth-conditions, suggesting that the predicate applies to different entities in both cases.

(37) a. The ring is old.

b. The gold that makes up the ring is old.

Treating all objects as material sums for the purpose of homogeneity leads us to validate equivalences of the sort seen in (37a) and (37b). As seen earlier, an account of cumulativity/homogeneity would probably explain the homogeneity exhibited in pairs like (38) by assuming that "*the pie*" denotes the sum of the bits of pie: the crust, the fruits, the filling, etc.

(38) a. I ate the pie.

b. I didn't eat the pie.

Yet, we can find predicates which yield different truth-values on "*the pie*" and a noun phrase which refer to the sum of the bits of pie:

(39) a. The pie was made just an hour ago.

b. The crust, the filling and the fruits were made just an hour ago.

Similarly, under the theory proposed, pluralities, if they are made of atoms at all, do not have singularities as atoms (Link, 1983). This makes it hard to understand the semantics of operators previously thought to make reference to atoms. To see this, consider a modern art sculpture by Antrios, made of two wooden planks glued to each other. The sculpture is made of the two wooden planks and under the theory considered, *the sculpture* must thus denote the sum of the two wooden planks[7].

The challenge is illustrated by the difference of truth-conditions between (40a) and (40b). In a semantics where *this sculpture and the two wooden planks* denotes a plurality

[7] The theory that we are considering could avoid this problem by assuming that the sculpture is not *the* sum of the two wooden planks but *a* sum of these planks. That way, *the wooden planks* and *the sculpture* do denote different objects but still possess the mereology required for an account of homogeneity to apply to both. The notion of *non-unique sums* assumed will make it hard to understand the semantics of non-Boolean *and*.

of three atoms, it is possible to model (40a) as asserting that each of the three atoms weigh two kilograms and (40b) as asserting that each of the *two* atoms in its denotation weigh two kilograms. Without the reference to the singularities that make up the subject, it appears difficult to even state the expected truth-conditions.

(40) **Binomial *each***

a. The painting and the two wooden planks weigh two kilograms each.

b. The painting and the Antrios sculpture weigh two kilograms each.

From these remarks, I conclude that an account of homogeneity/cumulativity based on conflating plural parts and material parts will face considerable challenges. I therefore espouse the view that plural sums and material sums ought to be strictly distinguished (Link, 1998) and will work under that view.

I should note that this Linkian position is not uncontroversial, either in the linguistic literature (Moltmann, 1997) or in the philosophy literature (Frances, 2006; King, 2006). Specifically, Moltmann (1997, 2005, 2019) present an interesting proposal regarding a situation-relative notion of parts. I leave open whether the arguments above still hold with this more sophisticated proposal (which independently challenge many of the implicit tenets of this work).

3.2.5 Why we should seek unification of part homogeneity and plural homogeneity

The parallel between plural homogeneity/cumulativity and part homogeneity/cumulativity could alternatively be taken to be some form of accident. To understand this view, take the following sentence (repeated from (25)):

(41) a. The ten judges ate the pie.

b. **Paraphrase:**
every judge ate a part of the pie
and every part of the pie was eaten by a judge.

This reading sure looks like a cumulative reading, as I have said earlier. That does not mean that it should be treated as one or require anything like the apparatus developed in chapter 2 for these readings.

Specifically, it may simply be a fact about the lexical meaning of *eat* that it triggers readings of this sort. This view would treat (41a) as a simple predication and attribute any inference obtained to the lexical semantics of *ate*. Here is a toy implementation of this view:

(42) a. $[\![(41a)]\!] = [\![\text{ate}]\!](\iota\text{10-judges})(\iota\text{pie})$

b. $[\![\text{ate}]\!] = \lambda y.\lambda X.$ all element in the plurality X ate a material part of y and every material part of y was eaten by an element of X

This view accounts for the cumulative-like behavior of part-homogeneous predicates. An advocate of this view would have nothing to say about the homogeneity behavior of these predicates. Since a broader understanding of all of the all-or-nothing inferences discussed in section 3.1 is at any rate lacking, it wouldn't be unreasonable to hope for an independent explanation of the homogeneity facts.

Note that the *it's all lexical semantics!* view outlined here closely mirrors the first lexical approach discussed in section 1.2 of chapter 1 and attributed to Roberts (1987) and Partee (1985). In chapter 1, we saw that this lexical view delivers too strong a reading for cumulative sentences with singular quantifiers like *every*, like (43).

(43) The ten squirrels cracked every nut.

I want to claim that a similar challenge can be constructed for the advocate of the lexical view in (42) ; namely, there exists cumulative-like readings of *every* involving parts, with certain part-homogeneous predicates. The strong lexical entry in (42) creates too strong a reading.

Finding subject-part homogeneity predicates. The relevant evidence is however difficult to come by. The relevant example would need to look like (44). As discussed in chapter 2, cumulative readings are not available when *every* stands in subject position.

(44) The NP V'ed every NP'.

where "*The NP*" has parts

Observe now that in order to work, the necessary example would need to involve a predicate which is part-homogeneous in its subject position. Up till now, we only considered predicates like *eat* which are part-homogeneous in their object argument. Agentive predicates like *eat*, which forms the bulk of the predicates used so far, are unfortunately not part-homogeneous in their subject argument: (45b) is not a paraphrase of (45a), (45d) is not a paraphrase of (45c)[8].

(45) a. I ate the apple.

b. All parts of me ate the apple.

c. I didn't eat the apple.

d. No parts of me ate the apple.

Agentive predicates, because they require agents and not all parts of an agent, or any, are themselves agents, won't therefore do. This very significantly reduces the pool of candidates.

Yet, there are still some examples which seem part-homogeneous in their external argument. I will consider 3 examples: the first one is *made*, as it applies to materials and objects that are made out of them, the second one is *went into*, as it applies to money and budget rubrics, the third one is *feed*.

(46) a. The ball of yarn that I bought last week made the alpaca sweater.

b. The $20,000 donation went into the school budget.

c. The pizza fed the kid.

[8]The latter fact may be objected to: surely, if I didn't eat the apple, my arm didn't eat the apple, my mouth didn't eat the apple. Reciprocally, if no (possibly trivial) part of me ate the apple, then I, being a trivial part of myself, must not have eaten the apple. However, I would argue that this equivalence only holds to a limited extent. My arm doesn't eat the apple because my arm cannot eat in worlds most like ours. Some imagination allows us to conjure worlds where my arm has its own agency and the mouth that goes with it. In such worlds, it wouldn't be contradictory to say that *I didn't eat the apple but my arm did*. Compare this to the contradictory **I didn't eat the pie but I ate that part of it*.

The predication in (46) display all-or-nothing inferences inferences. (46a), for instance, suggests that all parts of the ball of yarn contributed to the making of the sweater while (47a), for instance, suggests that no part of the ball of yarn contributed to any part of the alpaca sweater. Similarly, (46b) asserts that all parts of the donation went to said budget while (47b) says that no part of the donation did.

(47) a. The ball of yarn that I bought last week didn't make the alpaca sweater.

b. The $20,000 donation didn't go into the school budget.

c. The pizza didn't feed the kid.

These predicates too display a form of cumulativity. The sentences with plural objects below all seem to have cumulative paraphrases.

(48) a. The ball of yarn you see pictured here made my grandchildren's sweaters.

b. **Possible paraphrase:**
Every one of the sweaters was made by part of the yarn.
Every bit of yarn was made into one of the sweaters.

(49) a. The $20,000 donation went into these 10 budget items.

b. **Possible paraphrase:**
Every one of the budget items received part of the donation.
Every dollar of the donation went into these 10 budget items.

(50) a. The pizza fed the kids.

b. **Possible paraphrase:**
Every one of the kids was fed by part of the pizza.
Every bit of pizza fed some kid.

As before, it is entirely possible to explain both inferences of the paraphrase through one lexical entry. For instance, the denotations in (51) guarantee that the sentences in (48-42) will receive the paraphrases given to them.

(51) a. ⟦made⟧ = $\lambda X.\lambda y$. all elements in the plurality X were made from a material part of y and every material bit of "y" went into the making of an element of X

b. ⟦went-into⟧ = $\lambda X.\lambda y$. all elements in the plurality X were made from a material part of y and every material bit of "y" went into the making of an element of X

c. ⟦feed⟧ = $\lambda X.\lambda y$. all elements in the plurality X were fed by a material part of y and every material bit of "y" fed some of X

Part cumulative readings of *every*. The surprising data from the perspective of this lexical analysis is the possibility of cumulative readings with singular universal quantifiers like *every*. Consider the following sentences ; they give rise to a cumulative-like interpretation:

(52) a. The ten balls of yarn I bought yesterday made every one of the sweaters you see here.

b. The $20,000 donation she made went into every one of these 10 budgets.

c. The pizza fed every one of the kids.

In addition to these constructed examples, scarce Internet examples are found:

(53) a. Your donation went into every chisel and each shaping effort.

b. Grant money went into every state senate district and all but two state house districts.

Similar observations were made in Schein (1993)[9] with a different purpose.

The lexical semantics sketched in (51) makes rather odd predictions on these sentences. The following paraphrases of the expected meaning express these senseless meanings:

[9] I thank R. Schwarzschild for sharing personal correspondence with Schein, which contained examples of that nature.

(54) a. For every one of the sweaters x you see here, the ten balls of yarn made x.

b. For every one of these 10 budgets x, the $20,000 donation went into x.

c. For every one of these kids x, the pizza fed x.

From these observations, I conclude that here too, a strong lexical entry which incorporates exhaustive participation inference (or the equivalent thereof) will be too strong. Following the strategy offered in chapter 1, an account of the cumulative readings could presumably be built from a weaker lexical entry, motivated by homogeneity, along with appropriate mechanisms for strengthening. If this enterprise is successful, then it will provide an additional advantage over the lexical account, which by contrast, does not provide a handle on homogeneity effects independently.

3.2.6 Conclusion

This section established the existence of part homogeneity, an all-or-nothing inference associated with parts of an object. Following Löbner (2000), we critically observed that part homogeneity is not observed with every predicate. Part homogeneity appears with every predicate which is true of a whole by virtue of being true of its parts, a fact formalized by Löbner's generalization.

Importantly to us, part-homogeneous predicates seemed to give rise to cumulative-like interpretations for objects with parts. While most such readings could be attributed to the meaning of the predicate, we saw examples of "*cumulative readings with quantifiers*", which could not be attributed to this lexical hypothesis. In the next section, I will develop exactly the same line of argumentation for group nouns.

3.3 Group homogeneity/cumulativity

Another ontological domain reveals striking similarities with plural homogeneity and cumulativity: group homogeneity and cumulativity. Group nouns are singular nouns which seem to be closely related in meaning to a corresponding plural expressions in (55b).

(55) a. the team, the jury, the committee, the band, the litter, …

b. the members of the team, the members of the jury, the members of the committee, the members of the band, the puppies in the litter, …

In many cases, a group noun is interchangeable with the corresponding plural expression. Examples of this are called cases of predicate sharability.

(56) a. The team is discussing strategy in my office.

b. The members of the team are discussing strategy in my office

(57) a. The jury smiled.

b. The members of the jury smiled.

(58) a. The committee will stay in Boston this Friday. (Landman, 2000)

b. The members of the committee will stay in Boston this Friday.

(59) a. The litter left the basket.

b. The puppies in the litter left the basket.

I will not attempt a more precise delineation of the class of group nouns (see de Vries (2018); Joosten (2010); Pearson (2011)). I will simply assume the nouns above belong to one same class of nouns, the *group nouns*, and restrict my examples to the examples listed in (55a).

There are also cases where a group noun is not interchangeable with the corresponding plurality (predicate non-sharability). Either it is because the predicates that apply to one do not apply to the other, as in (60) and (61), or a predicate applies to both but yields different readings. The latter case is illustrated in (62): if, as part of their *freelance* activity, and independently from each other, the members of the collective painted 20 murals, one may not be disposed to accept (62a) , but may accept (62b). In some cases, the difference in meaning can be quite drastic: while (63a) refers to the age of a particular institution, (63b) can only refer to the age of certain individuals.

(60) Applies to plurals but not group nouns

a. *This committee talked to each other on Friday.

b. The members of this committee talked to each other on Friday.

(61) Applies to group nouns but not plurals (Schwarzschild, 1996, citing Lønning (1987))

a. The committee has five members.

b. The committee was founded in 1925.

c. *The committee members has five members.

d. *The committee members was founded in 1925.

(62) Applies to both, yielding similar but distinct readings

a. The art collective painted 20 murals in this city.

b. The members of the art collective painted 20 murals in this city.

(63) Applies to both, yielding entirely different readings

a. The art collective is 18 years old.

b. The members of the art collective are 18 years old.

The empirical claim I wish to put forward is that when we can find a verb or, more generally, a predicate that does not seem to distinguish between group nouns and plurals in basic positive contexts, group nouns give rise to cumulative readings with this predicate, as already noted by Kratzer (2003, 2007), and will similarly yield homogeneity effects, as noted by Löbner (2000). I will first show this for homogeneity and then for cumulativity.

3.3.1 Homogeneity with group nouns

This section investigates homogeneity with group nouns. The facts discussed here find their origin in Löbner (2000). Typically, predicates involving body parts, which belong to one and no more than one individual, or locations do not distinguish between plural and group nouns. Thus, the sentences in (64a) are equivalent to their counterparts in (64b).

(64) a. The team is asleep.
The jury smiled.
The Clarke family is in my office.

b. The team members are asleep.
The jury members smiled.
The members of the Clarke family are in my office.

The lack of a semantic difference is also illustrated by the contradiction tests below:

(65) a. # The team is asleep but the team members aren't.

b. # Even though the jury smiled, the jury members didn't.

c. # The Clarke family is in my office but I don't know where the members of the Clarke family are.

Thus, it seems like predicates like *smile, be asleep* or *be in my office* are all sharable.

Now observe that with all these predicates, group nouns have the hallmark properties of homogeneity. First, they typically give rise to all-or-nothing inferences:

(66) a. The team is asleep.
$\rightsquigarrow$ *(almost) all members of the team are alseep.*

b. The team isn't asleep.
$\rightsquigarrow$ *(almost) no members of the team are alseep.*

(67) a. The jury smiled.
$\rightsquigarrow$ *(almost) all members of the jury smiled.*

b. The jury didn't smile.
$\rightsquigarrow$ *(almost) no members of the jury smiled.*

(68) a. The Clarke family is in my office.
⇝ *(almost) all members of the team is in my office.*

b. The Clarke family is not in my office.
⇝ *(almost) no members of the team is in my office.*

As cautiously indicated by the paraphrases, these readings are typically not exceptionless, a property shared with plurals, which is referred to as non-maximality (cf chapter 1).

Another way to see homogeneity is that the sentences give rise to oddness feeling when judged in intermediate contexts where the relevant properties hold of only half of the individuals at stake. This is illustrated in (69).

(69) **Context:** *half of the team is asleep, the other half awake*

a. # The team is asleep.

b. # The team isn't asleep.

What these different tests reveal is that group nouns display the same homogeneity effects as plural nouns, provided the predicate used yields the same reading with both in positive contexts. Naturally, one wonders whether homogeneity effects are found when group nouns combine with non-sharable predicates. Take the case of *be 50 years old*. As discussed in Barker (1992), this predicate yields different readings when combined with a group noun than when combined with the corresponding plurality.

(70) a. The team is 50 years old.
⇝ *the team was founded fifty years ago*

b. The team members are 50 years old.
⇝ *the team members' age is 50*

Turning to homogeneity, the two types of noun phrases differ in their homogeneity properties. While there are situations that make neither (71a) and (71b) acceptable (in the case half of the team is 50 and the other half 25), it is difficult to find comparable situations[10] that would make neither sentences in (72) true: either the team was established 50 years ago or it was not.

(71) a. The team members are 50 years old.

b. The team members aren't 50 years old.

(72) a. The team is 50 years old.

b. The team isn't 50 years old.

Thus, homogeneity does not seem to be present when the group noun combines with a predicate which is non-predicate sharability.

We have found yet another instance of all-or-nothing inference, which mirrors the case of homogeneity. As with part homogeneity, I will now show that cumulativity also holds of group nouns.

3.3.2 Cumulativity with group nouns

We now investigate cumulative readings involving group nouns. Some of the facts presented here were offered by Kratzer (2003, 2007) but I will extend her observation to cumulative readings of quantifiers.

Let us start by the observation that the verb *send* is sharable with the group noun *litter*[11]. If I send the kittens of a litter to an animal rescue in Bali, then I sent the litter there[12].

(73) a. I sent the litter to an animal rescue in Bali.

b. I sent the kittens to an animal rescue in Bali.

[10]But see footnote 1.

[11]But it is not sharable with all group nouns. It is possible for *the members of the committee* to be sent to an animal rescue in Bali, without sending *the committee* being sent there, if the members were sent independently of their activities within the committee. The notion of predicate sharability is not simply a matter of predicate but also of the relevant predication.

[12]Kratzer uses the noun *offspring* which, in the dialect of my consultants, behaves like a noun whose number features is silent, like *sheep*, rather than a singular group noun. In particular, whenever plural reference is intended, *offspring* triggers plural agreement and takes plural determiners, like *these* or *those*. Such is not the case with *litter*.

Kratzer (2007) observes that replacing the singular indirect object in (73) with a plural give rise to a cumulative reading with both the group noun and its corresponding plural noun: it places the kittens in the litter in a cumulative relation with the animal rescues.

(74) a. I sent the litter to the five animal rescues in Bali.

b. I sent the kittens to the five animal rescues in Bali.

c. **Reading:**

Every kitten was sent to an animal rescue in Bali.

Every animal rescue received a kitten.

Kratzer's observation extends to cumulative readings of *every* and other quantifiers. Observe that *occupy*, in its physical sense of seating in a place, is sharable: it is not possible for jury members to occupy a row of seats while its members don't.

(75) a. The jury occupied the second row of seats in the back.

b. The jury members occupied the second row of seats in the back.

(76) a. # The jury occupied the second row of seats in the back but the jury members didn't.

b. # The jury members occupied the second row of seats in the back but the jury didn't.

Swapping *the second row of seats in the back* with a quantifier, we observe that both the group noun *jury* and its corresponding plural noun *jury members* yield a cumulative reading with *every* and other quantifiers like *most* and *less than 4*:

(77) a. The jury occupied every seat in the second row.

b. The jury members occupied every seat in the second row.

c. **Reading:**

Every seat is occupied by a jury member.

Every jury member occupies a seat.

(78) a. The jury occupied most seats in the second row.

b. The jury members occupied most seats in the second row.

c. **Reading:**

Most seats are occupied by a jury member.

Every jury member occupies a seat.

(79) a. The jury occupied less than 4 seats in the second row.

b. The jury members occupied less than 4 seats in the second row.

c. **Reading:**

Less than 4 seats were occupied by a jury member.

So group nouns, in combination with a sharable predicate, display cumulative readings with *every* and other quantifiers. This is important: as seen in chapter 1, cumulative readings of quantifiers can typically not be obtained by simply conjoining the truth-conditions of statements of the form in (80a), if the verb receives a strong meaning.

(80) a. The jury occupied seat 2A.
The jury occupied seat 2B.
The jury occupied seat 2C.
...

b. The jury members occupied seat 2A.
The jury members occupied seat 2B.
The jury members occupied seat 2C.
...

In summary, cumulative readings of *every* (as well as other quantifiers) are available and are just as unexpected with group nouns are they are with plurals.

3.3.3 Why this matters

The facts presented in the previous section have proved that the similarities between group nouns and plural nouns extend to homogeneity and cumulativity. This may not come as a surprise, given that group nouns and plural nouns share so many semantic similarities otherwise. I reviewed some similarities in the introduction pertaining to meaning equivalences (with sharable predicates). There are also distributional similarities: plural nouns and group nouns but no other singular nouns can be the predicate in a copular construction with plural subjects, plural and group nouns can combine with collective predicates

(81) Predicate in copular constructions (de Vries, 2015, 2018; Winter, 2001)

a. Joana and Marius are a happy couple.

b. Joana and Marius are happy plumbers.

c. *Joana and Marius are a happy plumber.

(82) Collective predicates (de Vries, 2018; Schwarzschild, 1996)

a. The couple met in Amsterdam.

b. Joana and Marius met in Amsterdam.

c. *Joana met in Amsterdam.

These similarities suggest a simple way to account for the presence of homogeneity and cumulativity with collective nouns: it could be that plural nouns and collective nouns denote the same object, a plurality. If the semantic mechanism which gives rise to either homogeneity and cumulativity depends on the presence of a plurality, it would apply to both in the same way.

The position that group nouns denote pluralities has had defendants (Bennett, 1974; Elbourne, 1999; Magri, 2012; Pearson, 2011) and opponents (Barker, 1992; Schwarzschild, 1996). Debates being rarely polar, we also find a number of proposals which are intermediate or would deny some presuppositions of the debate: (de Vries, 2015; Landman, 2000; Moltmann, 1997; Schwarzschild, 2011). In the sequel, I will review this debate and attempt to motivate my siding with analyses that treat group nouns as denoting singularities, at least when they take singular agreement. The view is compatible with Barker (1992); de Vries (2015); Landman (2000); Schwarzschild (1996) but goes against to Bennett (1974); Elbourne (1999); Magri (2012); Pearson (2011). If this view is correct, then it shows that the treatment of cumulativity and homogeneity truly needs to be generalized beyond pluralities, to cover the case of group nouns.

I will not however discuss Moltmann (1997); Schwarzschild (2011). These views depart in interesting ways from the theory of reference tacitly assumed in this dissertation. This means that the theory of cumulativity/homogeneity of chapter 2 could not be straightforwardly adapted to these theories. Not knowing what this adaptation would look like, it is difficult to say whether they could explain away cumulativity/homogeneity with group nouns simply from the theory of chapter 2.

3.3.4 In favor of identification

To support the theory that group nouns denote pluralities, two types of argument should be provided. First, it should be shown that there are diagnostics for plural denotations which set plural nouns and group nouns apart from singular non-group nouns. Second, it should be shown that wherever a plural noun and a group noun seem to yield distinct readings or different patterns of acceptability, something other than the reference of the noun phrase is at play that explains the discrepancy. I will review these two types of arguments in order.

Diagnostics of plural reference. I will review two main diagnostics for plural reference: count readings of partitives (Pearson, 2011) and plural agreement in British English (Barker, 1992; de Vries, 2015; Pearson, 2011; Schwarzschild, 1996).

Count readings of partitives. One influential diagnostic for plural reference comes from Pearson (2011). Pearson observes that *half*-partitives in combination with group nouns yield readings typical of a plural and unlike that of a singular noun. Specifically, she observes that (83a) can be made true if 50% of the wall is painted yellow, even if some bricks are only partly yellow, but (83b) can only be made true if the number of yellow bricks is half of the total number of bricks. Borrowing terminology from Rothstein (2017), (83a) can have a measure reading while (83b) has a count reading.

(83) Pearson (2011)

a. Half of the wall is yellow.

$\leftsquigarrow$ *50% of the surface of the wall is yellow.*

$\leftsquigarrow$ *5 out of 10 bricks are yellow.*

b. Half of the bricks in the wall are yellow.

$\not\leftsquigarrow$ *50% of the surface of the wall is yellow.*

$\leftsquigarrow$ *5 out of 10 bricks are yellow.*

Pearson notes that in that respect, group nouns[13] are just like plural nouns: they allow a count reading, but do not tolerate a measure reading:

(84) Half of the herd is brown.

$\not\leftsquigarrow$ *50% of the animals' surface is brown.*

$\leftsquigarrow$ *5 out of 10 animals are brown.*

I think that there is reason to think that this test is not picking up on plural reference *per se*. Wągiel (2018b), in his ambitious cross-linguistic study of partitives, provides evidence that partitives are sensitive to the *topology* of the object denoted. Specifically, Wągiel (2018b) shows that across different languages, partitives, including *half*-partitives, impose restrictions on whether they are counting or measuring and whether they are counting connected parts, disconnected parts, "*integrated wholes*" (Moltmann, 1997) or not.

A similar point can be made in English by looking at aggregate nouns (using the terminology of Joosten (2010)). Aggregate nouns are nouns like *cutlery, jewelry, furniture*. Like group nouns, they seem to denote collections of objects. Unlike them, they are not countable and are thus listed typically included in lists of mass nouns.

(85) *several cutleries, *two cutleries, . . .

a lot of cutlery, much cutlery, . . .

[13] She notes that this only applies to what she calls eponymously *committee* nouns, not *collection* nouns. *collection* nouns are outside the purview of this chapter so I will not discuss this subtlety further.

With aggregate nouns, we find that *half* has a count, not a measure reading. This confirms that the topology is what matters.

(86) Half of the cutlery is yellow.
⇝ *half of the forks and knives are yellow*

Of course, it is possible to argue that aggregate nouns, like group nouns have plural reference. But if singular group nouns (singular count), aggregate nouns (mass) and regular plural nouns (plural count) all denote pluralities, explaining their distributional differences become a pressing issue. I will show later that the *group-nouns-denote-pluralities* view is lacking in this respect.

Plural agreement in British English. A second influential argument for plural reference of group comes from the fact that in British English, such nouns optionally trigger plural agreement.

(87) a. The committee is smiling.

b. The committee are smiling.

With plural agreement, the group noun seems interchangeable with the plural expressions. In particular, predicates like *old*, which yielded different readings with the group noun *committee* than did with the corresponding plurality, lose these additional readings with plural agreement.

(88) a. The committee is old.
⇜ the committee was founded a long time ago.
⇜ ? the members of the committee are old[14].

b. The committee are old.
⇜̸ the committee was founded a long time ago.
⇜ the members of the committee are old

[14] Barker (1992) reports judgments that this is not possible, (de Vries, 2015, p. 132, fn. 2) expresses skepticism referring to her own data collection. My consultants sided with Barker (1992). This type of speaker variation is irrelevant so I will not dwell on it.

Furthermore, de Vries (2015); Pearson (2011) note that in British English, plural-agreeing group nouns can antecede reciprocals whereas singular-agreeing group nouns don't (in all dialects).

(89) Can a scientific program really change the way the Diaz family love each other? (Internet example, de Vries (2015))

de Vries (2015) further notes that previously inaccessible phrasally distributive readings become accessible with plural agreement.

(90) de Vries (2015)

a. The class are hiding somewhere.
$\leftsquigarrow$ each child in the class is in a (potentially different) hiding place.
$\leftsquigarrow$ there is a hiding place that the children in the class are in.

b. The class is hiding somewhere.
$\not\leftsquigarrow$ each child in the class is in a (potentially different) hiding place.
$\leftsquigarrow$ there is a hiding place that the children in the class are in.

(91) a. The class is sleeping or drawing.
$\not\leftsquigarrow$ each child in the class is either sleeping or drawing.
$\leftsquigarrow$ either all the children are sleeping or all are drawing.

b. The class are sleeping or drawing.
$\leftsquigarrow$ each child in the class is either sleeping or drawing.
$\leftsquigarrow$ either all the children are sleeping or all are drawing.

I think the evidence stacked up by de Vries (2018); Pearson (2011) unambiguously show that plural-agreeing group nouns in British English denote pluralities. However, every diagnostic used to illustrate this fact illustrates a further difference between plural-agreeing group nouns and singular-agreeing group nouns. This makes it all the harder to believe that both plural-agreeing and singular-agreeing group nouns denote the pluralities.

Faced with the British English facts, we could adopt one of three responses. We could posit that group nouns always denote singularities but can be shifted to denote the plurality of its members in the presence of plural agreement in British English (Barker, 1992; Schwarzschild, 1996). The alternative goes in the opposite direction: we posit that group nouns underlyingly denote pluralities but are shifted to denote singularities in the presence of singular agreement (this is the view defended by de Vries (2015)). For our local concerns, either of the first two responses is acceptable. Both approaches entail that when a group noun combines with a singular-marked predicate, it denotes a singularity. Since all examples of cumulativity and homogeneity we observed with group nouns involve singular-marked predicates, this rules out explaining cases of group homogeneity and cumulativity away by claiming that in each case, the group noun denotes a plurality.

The third response to the British English facts would assert that despite appearances, both singular-agreeing and plural-agreeing group nouns denote pluralities. This strategy would need to explain how and why the differences between the two arise. This explanation is part of a larger discussion on why group nouns ever differ from the corresponding plural nouns. Below, I review some of the explanations that have been proposed about this in the literature.

Identification theories' explanation for the difference between group nouns and plural nouns. Pearson (2011) and Magri (2012) offer two types of reason why certain environments distinguish between group nouns and the corresponding plural nouns.

The first type of reasons is intensionality. While these theories posit that group nouns and plural nouns co-refer, they assume that they differ in their intensions: in a different world or in an alternative situation, their referent might differ. This is extremely reasonable: even sharable predicates, like *sleep*, which give rise to identical truth-conditions in episodic contexts, give rise to different truth-conditions in generic contexts. Thus, (92a) and (92b) make different claims when "*the performances*" is fixed to denote all the performances of all seasons of the show.

(92) **Context:** *in season 5, Joana and Marius are the jury of the show.*

a. The jury of the show always sleeps during the performances.

b. Joana and Marius always sleep during the performances.

Applying this strategy could, for instance, explain the difference between (93a) and (93b). *was founded in 1925* could be assumed to take an intension as an argument. Since *Joana and Marius* and *the committee* differ in their intension, as revealed in (92), this could explain the difference in acceptability between (93a) and (93b):

(93) a. The committee was founded in 1925.

b. # Joana and Marius were founded in 1925.

It may seem odd to treat *be founded in 1925* as an intensional predicate. It is unclear in what sense this predicate is intensional. Despite these initial misgivings, nothing said so far seems to go against that assumption. One problem with this analysis though is that it does not explain why *the committee* and *the members of the committee* should differ in acceptability in (94). What is the intension of *the committee*, if not the function that maps situations the committee members in that situation? Given that, why would this intension differ from the intension of *the members of the committee*[15]?

(96) a. The committee was founded in 1925.

b. # The committee members were founded in 1925.

[15] Interestingly, I think that there is a *De Re* construal of the *the committee members* which is unaccessible to *the committee*.

(94) a. The committee members have been supporting these environmental policies since 1950.

b. **Reading 1:** current committee members have been supporting these environmental policies since 1950 (possibly prior to their appointment as committee members).

c. **Reading 2:** the committee has been supporting these environmental policies since 1950 (current and past members).

(95) a. The committee has been supporting these environmental policies since 1950.

b. **Only reading:** the committee has been supporting these environmental policies since 1950 (current and past members).

This does not affect the argument: so long as one meaning of *the committee members* is intensionally equivalent to *the committee*, it is a mystery why *be founded in 1925* can only apply to the latter but not the former.

The work of Landman (1989) offers a way out of these conundrums for the supporter of identification (see also Asher (2006); Fox (1998, 1993); Zobel (2017)). Landman provides evidence for the existence of *guises*, which are modes of presentation of individuals. Thus, even when two expressions co-refer, they may still give rise to different readings, because they present their referent under different guises. An example from Landman (1989) is given below:

(97) a. The judge earns exactly $50,000.

b. The janitor earns exactly $10,000.

Here, speakers may know that Joana is both the janitor and the judge and utter felicitously (97a) and (97b) without contradiction, if they mean that she earns $50,000 as a judge and $10,000 as a janitor.

This strategy, when applied, to group nouns would go as follows: while the subjects of (98a) and (98b) co-refer, the subject of (98a) conveys a *committee*-guise much more strongly than the subject in (98b). It is only under that guise that the plurality of Joana and Marius can be said to have been founded in 1925, hence the contrast between (98a) and (98b).

(98) a. The committee was founded in 1925.

b. #Joana and Marius were founded in 1925.

However, as noticed by Schwarzschild (1996), there are disanalogies between Landman's prototypical (97) examples and group nouns, which I think makes the whole approach unlikely. While (97b) is most natural under its "*as a janitor*" reading, it is not the case that this is the only reading. Some contextual work or the addition of an *as*-phrase make the other reading available:

(99) a. The janitor earns exactly $50,000 as a judge.

b. _ How much can one make working as a judge?
_ Well, the janitor makes around $50,000. (Oh, you didn't know? She works as a judge on the side.)

However, no amount of contextual work or addition can improve (98b).

(100) a. Joana and Marius, as a committee, were founded in 1925.

b. _ How old are committees in this university?
_ Well, Joana and Marius were founded in 1925. (Oh, you didn't know? They are the members of the Committee for Dinosaur Cloning.)

Distributors. Perhaps the most obvious way in which group nouns differ from the corresponding pluralities is distributivity. Typically, a group noun cannot be used with a distributive item or intending a phrasal distributive reading, or with various forms of quantification over atoms (de Vries, 2015):

(101) Floated distributors

a. #The committee each had one sandwich.

b. The committee members each had one sandwich.

(102) Numerals

a. The two committees had one sandwich.
$\not\Leftrightarrow$ The two committee members had one sandwich.

(103) Binomial *each*

a. The committee had one sandwich each.

b. The committee members had one sandwich each.

(104) Reciprocals

a. The committee is talking to each other.

b. The committee members are talking to each other.

(105) de Vries (2015)

a. The class is hiding somewhere.

$\not\leftsquigarrow$ each child in the class is in a (potentially different) hiding place.

$\leftsquigarrow$ there is a hiding place that the children in the class are in.

b. The children are hiding somewhere.

$\leftsquigarrow$ each child in the class is in a (potentially different) hiding place.

$\leftsquigarrow$ there is a hiding place that the children in the class are in.

I do not know of any work proposing a substantive response to all of the contrasts above while assuming that group nouns have plural reference. However, Magri (2012) has provided a very thorough treatment of (104), which gives an idea of how such a response may go. Following Heim et al. (1991), Magri decomposes *each other* in two components: a distributor akin to *each* and an OTHER operator. Critically, *other* elides a noun identical to the descriptive content of its antecedent.

(106) a. The committee λx. *each* λy. talked to OTHER$_{x,y}$ ⟨~~committee~~⟩

b. The committee members λx. *each* λy. talked to OTHER$_{x,y}$ ⟨~~committee member~~⟩

These logical forms give rise to the truth-conditions informally paraphrased below:

(107) a. **Paraphrase of (106a):**

for each y among the committee, y talked to another committee than y among the committee.

b. **Paraphrase of (106b):**

for each y among the committee, y talked to another committee member than y among the committee members.

The contrast between the paraphrases is glaring. Because OTHER elides "*committee*" in (107a), the universally quantified variable y is presupposed to be a committee and asserted to have talked to another committee among the members of the committee. This makes (107a) a highly strange, possibly non-sensical, assertion. No such problem arises with *committee members* since in that case, the elided noun is *committee member*. This difference is sufficient to explain the contrast between the sentence with the group noun and the one with the corresponding plurality, while assuming that the group nouns and the plural noun co-refer.

This account rides on the assumption that *each other* elides a noun identical to its antecedent. This syntax can be motivated from the fact that reciprocals agree in grammatical gender with their antecedent in languages like French. With Magri's assumption, the agreement between the reciprocal and its antecedent could be attributed to a more local agreement between the reciprocal and the noun that it elides.

(108)	*Les*	*tables*	*se*	*touchent*	*l'une*	*l'autre*
	The	tables.F.PL	SE	touch.PL	the-one.F	the-other

"*The tables touch each other.*"

Magri's account is adequate for the data considered but I think it fails to extend in two ways. First, recall that in British English, plural agreement makes reciprocals acceptable (cf (109), repeated from above). In Magri's account, it is the nature of the elided noun that explains infelicity. It is unclear how the mere choice of agreement on the verb could change the nature of the elided noun.

(109) Can a scientific program really change the way the Diaz family love each other? (Internet example, de Vries (2015))

Second, it is not clear to me how this strategy could extend to all other discrepancies observed between plural and group nouns with respect to distributive quantification. Presumably, Magri's strategy could extend to the case of floated *each* and binomial *each*, assuming these elements elide a noun too.

(110) Floated distributors

a. #The committee each ~~committee~~ had one sandwich.

b. The committee members each ~~member~~ had one sandwich.

(111) Binomial *each*

a. #The committee had one sandwich each ~~committee~~.

b. The committee members had one sandwich each ~~member~~.

It may explain the lack of a phrasal distributive reading, if the covert distributors required to explain this reading are like overt *each* and require an elided noun as well.

(112) de Vries (2015)

a. The class ~~each class~~ is hiding somewhere.

b. The children ~~each child~~ are hiding somewhere.

But this syntax does not seem to help for the other cases. Consider the effect of an NP-internal numeral in (113): with group nouns, the numeral counts the number of committees ; with plural nouns, it counts the number of members.

(113) a. The two committees smiled.

b. The two committee members smiled.

If the plural of *committee* is the closure under sum of its singular counterpart, it must denote, under the *group-nouns-denote-pluralities* view, sums of committee members that form whole committees, as in (114b). If numerals are simple intersective cardinality modifiers, as in (114c), then the denotation in (114b) predicts that committee members are counted in (113a), contrary to fact.

(114) a. $[\![\text{committee}]\!] = \{\mathsf{Alice} + \mathsf{Joana}, \mathsf{Bill} + \mathsf{Bea}\}$

b. $[\![\text{committees}]\!] = \{\mathsf{Alice} + \mathsf{Joana}, \mathsf{Bill} + \mathsf{Bea}, \mathsf{Alice} + \mathsf{Joana} + \mathsf{Bill} + \mathsf{Bea}\}$

c. $[\![\text{two}]\!] = \lambda p_{et}.\lambda x_e.\ p(x) \wedge |x| = 2$

Summary In sections 3.3.1 and 3.3.2, I made the observation that in cases where plural nouns and group nouns seem to be interchangeable, group nouns exhibited the same homogeneity and cumulativity behavior as plurals. If group nouns denote pluralities, this data is unsurprising and not worth our attention. If, on the other hand, they denote some singularity, the data implies that an account of homogeneity/cumulativity effects based solely on pluralities, as in chapter 2, is missing something.

In this section, I hope to have demonstrated that arguments for the view that group nouns denote pluralities are, after close scrutiny, quite fragile. In particular, Magri (2012); Pearson (2011)'s insightful analyses were insufficient to overcome the hurdle of the group-nouns-as-plurality view.

To be fair and tie loose ends, I want to offer a view on how the data seen so far makes sense under the view that group nouns denote singularities. As Barker (1992) and Schwarzschild (1996) propose, group nouns denote singularities related to but not equal to the plurality denoted by the corresponding plurals. Whenever sharable, this is due to *property inheritance*: if certain conditions to be determined are fulfilled, the committee x comes to inherit the properties of its committee members y. This concept is independently motivated from the literature on co-predication (Liebesman and Magidor, 2017). Although the condition on sharability are not specified, this correctly predicts that some but not all predicates are sharable.

The data on British English convincingly shows that when taking plural agreement, committee nouns truly denote the plurality of their members. This may seem surprising but I think it can also be made sense of. Remember that group nouns may antecede plural pronouns, a form of *bridging anaphor*. (115) furthermore shows that group nouns may *bind* plural pronouns ; the sentence must be read as "*x is the only cricket team such that it wonders whether its members are too old for the tournament.*"

(115) **Context:** *to encourage young cricketeers, we are organizing a tournament for cricket teams whose members are below drinking age. We sent out invitations to teams we thought were eligible: one team is unsure whether it qualifies (by sheer luck, all of its members will reach drinking age right in the middle of the tournament). It will be a tough decision to make but we'll only have to make it once because thankfully:*

Only THIS cricket team is wondering whether they are too old for the tournament.

I want to speculate that movement chains in the British English examples where plural agreement occur are akin to the binding relations which American English exhibit in long-distance dependencies.

(116) The committee λx. they$_x$ are smiling

More would need to be said to make this account stand on its feet. But the availability of very local binding of these types of bridging anaphors would also account for the fact that plural agreement is also available in British English for company names:

(117) Facebook are hiring.

If this account were to be untenable, it is still possible to fall back on the alternatives proposed by Barker (1992) or de Vries (2015)[16].

In short, I take to the position that group nouns denote singularities (with singular agreement) to be the most comfortable one. If this is so, the phenomenon of group homogeneity/cumulativity is a genuine challenge and must be tackled with tools beyond what traditional theories of homogeneity/cumulativity focusing on pluralities (e.g. the theory of chapter 2) can offer.

3.4 Can part and group homogeneity/cumulativity be analyzed within an event-less theory?

In the previous sections, I have presented cases of homogeneity/cumulativity which did not involve pluralities. These cases seem at first blush similar to the case of plural homogeneity/cumulativity but I showed that neither groups nor materially complex objects denote pluralities.

[16]de Vries (2015) propose an account in which group nouns denote pluralities but are shifted to singularities in cases where they combine with a plural verb. As I explained earlier, if this is correct, then it does not affect my main point that we need a more general account of cumulativity and homogeneity effects. However, I have one reserve for this account. My worry concerns the possibility of group nouns with the same members, having different properties. de Vries (2015) adopts the *guise* account of Landman (1989) to explain this possibility but I have given my reasons to object to the *guise* approach.

This shows that some generalization of the analysis of homogeneity/cumulativity from chapter 2 is needed. But how drastic does this generalization have to be? Can we keep the basic tenets of chapter 2 to account for these new cases?

This section answers these interrogations ; I find that while the account of chapter 2 may be extended to cases of group and part homogeneity/cumulativity with minimal modifications, these minimal modifications are supported by assumptions which are difficult to justify. A qualitatively different analysis seems desirable ; this is the analysis that I will develop in the next chapter.

Group and part homogeneity in the framework of chapter 2. The analysis of chapter 2 spelled out the general recipe proposed in chapter 1. This recipe has two ingredients. First, underlying existential meanings for predicates are posited (the weak meanings). These weak meanings deliver perfectly adequate truth-conditions as far as negative sentences are concerned. In positive sentences, a context-sensitive inference that all parts of the argument contributed to the action described by the verb (the exhaustive participation inference) needs to be derived. In 2, the weak meaning were simply hardwired into the meaning of the verb. The exhaustive participation inference arose from a form of competition with alternatives, based on recursive exhaustification.

Let us now explore what a naive and straightforward adaptation of chapter 2's analysis looks like. I will argue that such a naive extension is hard to maintain and that we must therefore seek alternative ways to spell out the general recipe of chapter 1.

To apply the analysis of chapter 2 entails finding an appropriate underlying weak meaning required for groups and parts and appropriately incorporate this weak meaning in the recursive exhaustification of chapter 2. For the underlying existential meaning, the starting point is negative sentences (as usual):

(118) a. The pie was not eaten.
$\rightsquigarrow$ *no parts of the pie were eaten.*

b. The jury didn't smile.
$\rightsquigarrow$ *no member of the jury smiled.*

The truth-conditions of these sentences leads us to posit the following denotations for *smile* and *eaten* (for presentational purposes, *eaten* is an undecomposable lexical item).

(119) a. $[\![\exists\text{-eaten}]\!](x) = \exists y \sqsubset x, \mathsf{eaten}(y)$

b. $[\![\exists\text{-smile}]\!](x) = \exists y \prec \mathsf{Members}(x), \mathsf{smile}(y)$

where $\mathsf{Members}$ is a function mapping a group to the plurality of its members

To derive the meanings of the positive sentences in (120), the analysis in chapter 2 uses two operators of exhaustification (hereafter recursive exhaustification), combined here as EXH^2.

(120) a. EXH^2 The pie was eaten. ⇝ *all (or nearly all) parts of the pie were eaten.*

b. EXH^2 The jury smiled. ⇝ *all (or nearly all) members of the jury smiled.*

In essence, recursive exhaustification negates alternatives obtained by replacing pluralities with sub-pluralities *along with the implicatures generated by these alternatives.* The alternatives are depicted in (121b) with their implicatures in gray. Negating all the alternatives in (121b) indeed implies that the smilers must be exactly the set of dancers.

(121) a. **Prejacent:**

The dancers smiled.

b. **Exhaustified alternatives:**

Dancers 1 and 2 smiled and no other dancers smiled.

Dancers 1 and 3 smiled and no other dancers smiled.

Dancers 2 and 3 smiled and no other dancers smiled.

To apply this strategy in (122a) and (123a), we must claim that not only sub-pluralities are alternatives to the subject, but also sub-parts of the subject in the case of part homogeneity in (122b), and sub-groups of the subject's denotation for group homogeneity in (123b).

(122) a. **Prejacent:**

The pie was eaten.

b. **Exhaustified alternatives:**

Slice 1 of the pie was eaten and no other parts of the pie were eaten.

Slice 2 of the pie was eaten and no other parts of the pie were eaten.

Slice 3 of the pie was eaten and no other parts of the pie were eaten.

(123) a. **Prejacent:**

The jury smiled.

b. **Exhaustified alternatives:**

Members 1 and 2 smiled and no other members of the jury smiled.

Members 1 and 3 smiled and no other members of the jury smiled.

Members 2 and 3 smiled and no other members of the jury smiled.

The adaptation of chapter 2's analysis in sum requires two stipulations: an assumption that the weak meaning of *eaten* and *smile* make reference to material parts and members respectively and an assumption that the set of alternatives include not only subpluralities but also material parts and members.

However, these stipulations prove hard to maintain if we look at some further data from the previous sections. Recall indeed that not all predicates give rise to either part homogeneity or group homogeneity. Predicates like "*be on*" and "*be 5 years old*" do not give rise truth-value gaps.

(124) a. The radio is on.

b. The committee is 5 years old.

This behavior is hard to explain under the proposal sketched above. First, to explain the meaning of the negated sentences, it must be that the predicates involved do not have the existential semantics assigned to the part-homogeneous and group-homogeneous predicates above.

(125) a. ⟦is on⟧ = $\lambda x.\ x$ is on

b. ⟦is 5 years old⟧ = $\lambda x.\ x$ is 5 years old

But this assumption alone is insufficient. There is no *a priori* reason to suppose that the alternatives would be different in the case of non-homogeneous predicates than they are with homogeneous predicates. With alternatives mentioning parts of the radio or members of the committee, recursive exhaustification generates invalid inferences: it entails that all parts of the radio are on when the radio is on and that all members of the committee are 5 years old when the committee is 5 years old.

(126) a. **Prejacent:**
The radio is turned on.

b. **Exhaustified alternatives:**
The transistor is on and no other parts of the radio are on.
The LED is on and no other parts of the radio are on.
The speaker is on and no other parts of the radio are on.

(127) a. **Prejacent:**
The committee is five years old.

b. **Exhaustified alternatives:**
Members 1 and 2 are five years old and no other members are five years old.
Members 1 and 2 are five years old and no other members are five years old.
Members 2 and 3 are five years old and no other members are five years old.

To avoid predicting incorrect inferences, we must, under the sketched approach, make two related assumptions: 1) that the verb does not come with a weakened meaning, 2) that the required alternatives are not present when these verbs are used.

In short, a naive extension of chapter 2's analysis must stipulate a necessary connection between the set of alternatives to the sentence and the nature of the predicate involved in the sentence. It is not clear to me how this connection could be derived or justified. This is my main reason for stepping away from the theory of 2 in favor of an event-based analysis, which will be developed in chapter 4. A more thorough comparison between the two approaches will be made in chapter 8.

3.5 Conclusion

This chapter focused on two types of all-or-nothing inferences: part homogeneity for materially complex objects and group homogeneity for group nouns (drawing data from Löbner (2000)). In each case, I made the same 2 claims . First, that in appropriate circumstances, nouns denoting materially complex objects and group nouns exhibit all-or-nothing inferences. Second, that homogeneity is not systematic but contingent on properties of the predicate: L-summativity for materially complex objects and predicate sharability for group nouns. Third, that these nouns also give rise to cumulativity. Fourth, that they give rise to cumulative readings with quantifiers, including *every*, excluding a purely lexical treatment of the cumulativity. Five, that these objects, while sharing with pluralities the property of being made of parts, cannot simply be equated to pluralities.

All of the similarities suggest that group and part cumulativity/homogeneity ought to belong the same class as plural homogeneity/cumulativity and that a unified treatment of these three phenomena is desirable. It also shows that this treatment cannot simply be the account of chapter 2, which was aimed at pluralities, but rather must be an extension of it. The next chapter deals with designing such an extension. In designing such an extension, we will see reasons to use event semantics for cumulativity. However, our event account will prove quite different from traditional accounts of cumulativity in event semantics, as we will see in chapter 5.

Chapter 4

Event parts for homogeneity/cumulativity

Introduction

In the last chapter 3, I showed new cases of cumulativity and homogeneity. In addition to the original examples involving plural-referring expression, we saw cases of part homogeneity and group homogeneity, as in (1-3), and cumulative readings involving plurals, materially complex objects and groups, as in (4). I showed that these cases require a different analysis than that provided in chapter 2 for plural homogeneity and cumulativity.

(1) **Plural homogeneity**

a. The dancers smiled.

b. The dancers didn't smile.

(2) **Part homogeneity**

a. I ate the pie.

b. I didn't eat the pie.

(3) **Group homogeneity**

a. The jury smiled.

b. The jury didn't smile.

(4) *Cumulative readings with* every

a. The dancers occupied every seat on the second row.

b. The jury occupies every seat on the second row.

c. The ten balls of yarn made every one of these sweaters.

This chapter develops an analysis of these cases within event semantics. The theory proposed tries to tie all cases of homogeneity together by appealing to a notion of event parts. Put in simple terms, the generalization is that a homogeneous predicate is an event predicate which give rise to non-trivial part-whole relations.

As with the theory of chapter 2, this theory still divides homogeneity and cumulativity in two components: a weak existential meaning (observed under negation) and strengthening inferences (the exhaustive participation inference). I propose an analysis of the weak existential meanings in terms of the notion of even parts. By referring to event parts, this proposal sheds light on which predicates will give rise to homogeneity and which ones will not. Then, I propose a mechanism for deriving the exhaustive participation inferences of these weak meanings without recourse to recursive exhaustification.

The roadmap is as follows: section 4.1 presents the notion of event parts and how it may be used to derive the weak meanings of event predicates observed under negation. Section 4.2 proposes a new recipe for strengthening based on exhaustification in the scope of event closure. Section 4.3 applies this recipe to cumulative readings of quantifiers like *every*.

4.1 Events strike back: unification in events

This section presents an analysis on the weak meanings of homogeneity/cumulativity (i.e. the first ingredient in chapter 1). I propose a paraphrase of the weak meanings that unifies the truth-conditions of negative sentences across the plural, group and part cases. Armed with this unified description, the subsequent sections will provide a more robust analysis of exhaustive participation inferences (i.e. the second ingredient).

The unified paraphrase of the weak meanings developed in this section is based on events, more precisely event mereology. I propose that what parts events of a certain type have determine what type of homogeneity they give rise to. This proposal helps to understand which predicates give rise to homogeneity and which don't.

4.1.1 The guiding intuition

Before we turn to the formal details, I will first sketch the intuition that underlies the paraphrase of the weak meaning. Consider the homogeneous sentences in (5). These sentences share something in common: the events they describe are made of smaller events of the same type. An event of "*the dancers smiling*", as in (5a), necessarily contain, as a part, a smiling by each of the dancers. The same goes for (5b): an event of the "*the jury laughing*" similarly decomposes into parts which are laughings by members of the jury. Finally, my eating the pie is nothing more the sum of my eating bits of the pie.

(5) a. The dancers smiled.

b. The jury laughed.

c. I ate the pie.

The assumption that the events denoted by these sentences are complex is central in previous works, independently from the homogeneity/cumulativity phenomena. Krifka (1989, 1992), for instance, proposed an analysis of the telicity properties of incremental theme verbs, such as *eat* in (5c), relying on the following properties: for every bit of the pie x, there is a sub-event of my eating the pie where I eat x (*mapping to events* property) and for every sub-event of my eating the pie e', there is a bit of the pie that I eat in e'

(*mapping to objects* property). A similar decomposition was proposed for events whose arguments are group nouns in Kratzer (2003).

Given this observation about positive sentences, let us now compare with the meaning of the negative sentences in (6).

(6) a. The dancers didn't smile.

b. The jury didn't laugh.

c. I didn't eat the pie.

In event terms, the truth-conditions of (6a) require that there does not exist an event of smiling by any of the dancers. To put it differently, the truth of the sentence precludes the existence of events of some dancers smiling. The events precluded by (6a) are precisely the events which are part of an event of the dancers smiling.

The same description applies to (6b) and (6c). (6b) asserts that no events of laughing by members of the jury occurred. Such events are exactly those which compose an event of the jury laughing. Similarly, (6a) asserts that there are no events of me eating of bits of pie. The events of me eating bits of pie were exactly the type of events which were part of an event of my eating the pie.

To summarize, there seems to be a systematic connection between the parts of the event described by the positive sentences and what events are asserted not to exist in negative sentences. Exploiting this connection, we could informally paraphrase the negative sentences in (6) as follows.

(7) **Paraphrase of the negative meanings**

a. There does not exist an event of smiling which could be part of an event of the dancers smiling.

b. There does not exist an event of laughing which could be part of an event of the jury laughing.

c. There does not exist an event of eating which could be part of an event of my eating the pie

Following chapter 1, I take the paraphrases in (7) to be the negation of an underlying weak meaning, which is common to both positive and negative environments. For (7c), this weak underlying meaning would be paraphrased as (8a). By a mechanism yet to be specified, this meaning would then be strengthened to (8b) in positive environments.

(8) a. **Weak existential meaning:**
There exists an event of eating which could be part of an event of my eating the pie

b. **Strong meaning:**
An event of my eating the pie exists.

The connection between homogeneity and event parts represents the leading intuition of the account. This intuition remains to be spelled out formally and this is what I turn to in the next subsection.

4.1.2 Formalizing existential meanings

Different notions of parts.

(9) a. There exists an eating which could be part of an eating of the pie by me.

b. An event of "*I ate the pie*" exists.

The informal intuitions carried by the paraphrases above are difficult to render formally because the notion of *parthood* involved is not standard. In classical extensional mereology (see Champollion and Krifka (2016); Varzi (2010) for reviews), the notion of "*part*" would be rendered as in (10a), with $\sqsubset$ a reflexive transitive anti-symmetric[1] relation between two events representing the notion of "*parts*" of events.

(10) a. $\exists e, \mathsf{eat}(e) \wedge \exists e',\ e \sqsubset e' \wedge \mathsf{eat}(e') \wedge \mathsf{theme}(\iota\mathsf{pie}) \wedge \mathsf{agent}([\![\mathrm{I}]\!])$

To abbeviate:

[1]Technically, if the argument of the previous chapter are correct that a whole is not the plural sum of its parts, anti-symmetry may be undesirable.

$\exists e, \mathsf{eat}(e) \wedge \exists e',\ e \sqsubset e' \wedge \mathsf{eat}^{\mathsf{ag+th}}(e')(\iota\mathsf{pie})(\llbracket \mathrm{I} \rrbracket)$

b. $\exists e, \mathsf{eat}(e) \wedge \mathsf{theme}(\iota\mathsf{pie}) \wedge \mathsf{agent}(\llbracket \mathrm{I} \rrbracket)$

However, this formal rendition is problematic: (10a), which represents the *weak* meaning of the sentence, actually entails that there is an event of my eating the pie, like (10b). By contrast, it seems that the English expression "*part of*", as used in the paraphrase in (9a), does not require the whole to exist[2]. To see this more concretely, consider the less abstract example in (11):

(11) **Context:** *visiting the old Pigeot factory, I stumble across a strange old rusty piece of metal. My friend explains:*
This is one part of a Pigeot car. The company went bankrupt before they could even make one car and this is the only part that they made.

If my friends' words are correct, there never was or ever will be a Pigeot car. But she can still felicitously refer to the incomplete piece as "*part of a Pigeot car*".

This means that the notion of *part of* involved in the paraphrases we are trying to model is different from the notion of "*part of*" in classical extensional mereology (Champollion and Krifka, 2016; Simons, 1987; Varzi, 2010), expressed by the symbol $\sqsubset$. Specifically, the notion of "*part of*" we are interested in is not a relation holding between two existing objects but a relation between one object x and a property P[3], whose extension might be empty in the actual world. I will use the symbol $\triangleleft$ for this notion of *part of*. The simple sentence in (12a) would for instance be formally translated as in (12b):

(12) a. This is one part of a Pigeot car.

b. $\llbracket(12a)\rrbracket = \llbracket\text{this}\rrbracket \triangleleft \lambda x.\lambda w.\text{Pigeot-car}_w(x)$

The part notion of classical extensional mereology which relates two existing entities is also expressed by the same expression "*part of*", as in (13). I will not try to tease apart

[2] This observation was made to me by Roger Schwarzschild (p.c.).

[3] Alternatively, a kind K. For simplicity, I will assume that parts involve properties but since it may be possible to translate back and forth between kinds and properties (Chierchia, 1998), using kinds would not be problematic.

whether this is due to ambiguity or under-specification[4]. In the sequel, I will systematically use the expression m-part (for *modal part*) in the prose to refer to the intensional notion (i.e. $\lhd$), while reserving *part of* for the extensional notion as defined in classical mereology (i.e. $\sqsubset$).

(13) This arm is part of the statue.

There seems to be a connection between the $\lhd$ notion of parthood and the $\sqsubset$ notion of parthood and this relation deserves to be clarified. To help future discussion, I will attempt to spell out the connection.

A first observation is that the notion of parthood expressed by $\lhd$ is intensional. Two properties with the same extension in the world of evaluation may have different parts. Compare *a magic wand* and *a Pigeot car*. Both have an empty extension in the actual world. Yet, what my friend would describe as part of Pigeot car in (12) would probably not count as part of a magic wand.

Turning to the relation between $\sqsubset$ and $\lhd$, we ought to guarantee some intuitive properties. As an example, if in some world w, a metal piece x is a part of my bike y (i.e. $x \sqsubset y$), then x is part of a bike, i.e. $x \lhd \mathsf{bike}$. Formally:

(14) $\forall x, y, P, \big(x \sqsubset y \wedge P(y)\big) \rightarrow x \lhd P$

A sort of converse of (15) ought to hold as well. Intuitively, one would like to state that if some piece of metal x is m-part a bike in the actual world, then it ought to be possible to "*complete*" x, i.e. there must be a world where there is a bike y where x, or something just like it, is part of y. The cautious addition of "*something just like it*" is meant to sidestep the thorny issue of trans-world identity.

Building on these observations, my proposal is to relate $\lhd$ to $\sqsubset$ in the following way: $x \lhd P$ in some world w iff there is some world w' "*accessible*" from w where something with the same material constitution as x is part of a y with property P. The notion of "*material constitution*" is meant to make precise the "*just like it*" of above. It intuitively

[4]Plausibly, the indefinite *a Pigeot car* might signal genericity (R. Schwarzschild, p.c.), so the relevant notion of part might simply be the composition of a generic operator and an extensional notion of part.

describes the matter that x is made of. I represent "*having the same material constitution as*" with the symbol $\sim$.

(15) $x \lhd P \Leftrightarrow \Diamond \big(\exists x', \exists y, P(y) \wedge x \sim x' \wedge x' \sqsubset y\big)$

When transposing the notion of m-parts to events and event predicates, I take the counterpart of the notion of "*material constitution*" to be the "*event constitution*", which encompass event type (an eating must remain an eating) and participants (an eating by Joana is still an eating by Joana) and other characteristics of the predicate (time and place).

I do not specify the nature of possibility modality $\Diamond$ further. In the sequel, I treat it as something, which encompass *a mimima* conceivability: if it is conceivable that an event happened, indepedently of what we know the world to be, then this event might ($\Diamond$) have happened.

Connections to the English progressive. As an aside, let me note that the notion of parts of events developed has intuitive connections to proposals made for the semantics of the English progressive (Dowty, 1977; Landman, 1992; Parsons, 1989; Portner, 1998; Szabó, 2008). An intuition expressed in these works is that the events described by (16a) are incomplete versions of the events that would be described by the simple past example in (16b). Alternatively, one might say that the events described by (16a) are "*part of*" the events described by (16b).

(16) a. I was crossing the street.

b. I crossed the street.

Different accounts would adhere to a paraphrase like in (17). They would chiefly differ on how they choose to spell out the italicized part of (17). Some account treat the notion of *incomplete events* used for the semantics of the progressive as a semantic primitive (Parsons, 1989; Szabó, 2008), or some as a modal notion(). For an example of the modal approach, Dowty (1987) treats (16aa) as true if and only if there is an event e such that in every world where "*things proceed normally*" (inertia world), e is part of ($\sqsubset$) an event of crossing the world.

(17) There is an event e which is <u>an incomplete part of</u> an event of crossing the street.

Although there are some connections to the notion of m-part used here, I don't think an assimilation is possible. For instance, it would seem desirable to say "*my loving coffee*" is an m-part of a loving of tea and coffee by me. This seems intuitively true but as we will see, it is also a critical piece in explaining why *I don't love coffee and tea* implies that *I don't love coffee* (i.e. homogeneity with respect to the atoms). Assuming m-part is the same notion as used in spelling out the progressive, we would then predict that (18) is true if I only love coffee ; in this case, there is an incomplete part of *my loving coffee and tea*. To the extent that (18) is felicitous, it is not merely made true by "*my loving coffee*".

(18) I am loving coffee and tea.

For this reason, I will not assimilate the notion of m-part to the notion of parthood used for the semantics of the progressive.

4.1.3 Formalizing the paraphrases.

If we accept $\lhd$ as a genuine notion of parthood used by natural language, then we can use it to spell out the informal paraphrases in the a. examples (19-21). In (19-21): b. examples translate the informal paraphrases in a. using $\lhd$.

(19) a. There exists an event of smiling part of an event of the dancers smiling.

b. $\exists e, \mathsf{smile}(e) \wedge e \lhd \lambda e'. \mathsf{smile}^{\mathsf{ag}}(e')(\iota\mathsf{dancers})$

(20) a. There exists an event of laughing which is part of an event of the jury laughing.

b. $\exists e, \mathsf{laugh}(e) \wedge e \lhd \lambda e'. \mathsf{laugh}^{\mathsf{ag}}(e')(\iota\mathsf{jury})$

(21) a. There exists an event of eating which is part of an event of my eating the pie

b. $\exists e, \mathsf{eat}(e) \wedge e \lhd \lambda e'. \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota\mathsf{pie})([\![\mathrm{I}]\!])$

A number of observations are in order: first, the logical renditions with $\lhd$ does not entail that there is an event of eating the pie by me, or an event of the dancers smiling or an event of the jury smiling, unlike our earlier attempt using $\sqsubset$. This is because $x \lhd P$ can be true even when P is empty in the world of evaluation. Another important feature of the resulting logical paraphrases is that they are uniform: they look the same for all predicates.

But do these paraphrases capture the correct meaning? Recall that the negation of these weak paraphrases above should model the truth-condition of the negative sentences in (22).

(22) a. The dancers didn't smile.
$\rightsquigarrow$ *no dancer smiled.*

b. The jury didn't laugh.
$\rightsquigarrow$ *no jury member laughed.*

c. I didn't eat the pie.
$\rightsquigarrow$ *I ate no part of the pie.*

What exactly these logical paraphrase mean depends on what parts ($\lhd$) a certain event has. In the sequel, I will show how certain assumptions about the structure of *eating*, *smiling* and *laughing* events can help us express the paraphrases of (19-21) more concisely. In particular, we will see that the provided paraphrases do indeed explain the attested truth-conditions of the sentence in (22).

Parts of eatings and bits of pie. Let us start with (23). To reflect the truth-conditions of (23a), the weak paraphrase of (23b) should assert that I ate some bits of pie.

(23) a. I didn't eat the pie.
$\rightsquigarrow$ *I ate no part of the pie.*

b. **Weak paraphrase:**
$\exists e, \mathsf{eat}(e) \land e \lhd \lambda e'.\, \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota \mathsf{pie})([\![\mathrm{I}]\!])$

There exists an event of eating which is part of an event of my eating the pie

To see why this holds, we must first understand what it takes to be part of an event of eating, under both the $\sqsubset$ and $\lhd$ meaning. For $\sqsubset$, Krifka (1992) assumes that eating events has the "*mapping*" properties in (24). Informally, these properties express that there is a correspondence between eating sub-events of my eating and parts of what I ate: my eating the pie is composed of eatings of bits of pie, every bit of pie is associated with an event of my eating it.

(24) a. **Mapping to objects:** for every e, e',

$e' \sqsubset e \wedge \mathsf{eating}(e') \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e)(\iota\mathsf{pie})([\![\mathrm{I}]\!])$

$\Rightarrow \exists x \sqsubset \iota\mathsf{pie},\ \mathsf{eat}^{\mathsf{ag+thm}}(e')(x)([\![\mathrm{I}]\!])$

Every part of an event of eating the pie is an event of eating part of the pie.

b. **Mapping to events:** for every e,

$x \sqsubset \iota\mathsf{pie} \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e)(\iota\mathsf{pie})([\![\mathrm{I}]\!])$

$\Rightarrow \exists e' \sqsubset e,\ \mathsf{eating}(e') \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e')(x)([\![\mathrm{I}]\!])$

In an event of eating the pie, there corresponds to every bit of pie, a part where I ate that bit of pie.

Given these principles, we can rewrite (21) as (25a), which asserts that in some world, some event which shares e's constitution extends to an event of me eating the pie. The mapping to object property implies that in that world, e' is an event of me eating a bit of the pie, as described in (25b). Since e' and e have the same constitution, e is also an event of eating a bit of the pie in the world of evaluation ; (25c) follows.

(25) a. $\exists e, \mathsf{eat}(e) \wedge \Diamond\big(\exists e', \exists e'',\ e \sim e' \wedge e' \sqsubset e'' \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e'')(\iota\mathsf{pie})([\![\mathrm{I}]\!])\big)$

An eating event e is such that in some world, an event with e's constitution extends to an eating of the pie by me

b. $\Rightarrow \exists e, \mathsf{eat}(e) \wedge \Diamond\big(\exists e', \exists x,\ x \sqsubset \iota\mathsf{pie} \wedge e \sim e' \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e')(x)([\![\mathrm{I}]\!])\big)$

There is an eating event e which has the same constitution as an event e of eating bits of pie in some world

c. $\Rightarrow \exists e, \exists x,\ x \sqsubset \iota\mathsf{pie} \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e)(x)([\![\mathrm{I}]\!])$

There is an event e of me eating a bit of the pie

So the *weak* truth-conditions entail that I ate some bits of pie. But we can see that this is in fact an equivalence: an event e of my eating bit y of pie is always part of ($\lhd$) my eating the pie. Indeed, any world where I eat the whole pie, contains ($\sqsubset$) an event of my eating pie bit y, which therefore has the same constitution as e. This means that if there is an event of my eating a bit of pie, (26a) is satisfied.

In conclusion, (26a) and (26b) are equivalent, as desired. This result is achieved because of the particular structure of *eating* events (Krifka, 1992). The result would similarly extend to other incremental theme verb.

(26) a. $\exists e,\ \mathsf{eat}(e) \wedge e \lhd \left(\lambda e'.\ \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota\mathsf{pie})(\llbracket \mathrm{I} \rrbracket)\right)$

There is an eating event which is part of an event of my eating the pie.

b. $\exists e, \exists x,\ x \sqsubset \iota\mathsf{pie} \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e)(x)(\llbracket \mathrm{I} \rrbracket)$

There is an event of my eating part of the pie.

Parts of smiling. We may now turn to a predicate like *smile* in (27). Can we guarantee, modulo reasonable assumptions about the part-whole relation of smiling events, that the truth-conditions in (27b) will complement the attested truth-conditions of (27b)?

(27) a. The dancers didn't smile.

$\rightsquigarrow$ *no dancer smiled.*

b. **Weak paraphrase:**

$\exists e,\ \mathsf{smile}(e) \wedge e \lhd \left(\lambda e'.\ \mathsf{smile}^{\mathsf{ag}}(e')(\iota\mathsf{dancers})\right)$

There exists an event of smiling which is part of an event of the dancers smiling.

My assumption about the structure of smiling events is the following: I assume that events of smilings by a plurality X contain, as only events of smiling, events of smiling by sub-pluralities of X (in the limit, singularities). This is formally rendered as two mapping properties:

(28) a. **Mapping to objects:** for every e, e', X

$e' \sqsubset e \wedge \mathsf{smile}(e') \wedge \mathsf{smile}^{\mathsf{ag}}(e)(X)$

$\Rightarrow$

$\exists X' \sqsubset X,\ \mathsf{smile}^{\mathsf{ag}}(e')(X')$

b. **Mapping to events:** for every e,

$X' \sqsubset X \wedge \mathsf{smile}^{\mathsf{ag}}(e)(X)$

$\Rightarrow$

$\exists e' \sqsubset e,\ \mathsf{smile}(e') \wedge \mathsf{smile}^{\mathsf{ag}}(e')(X')$

As earlier with the predicate "*eat the pie*", these assumptions about $\sqsubset$ parts of smilings have consequences for $\lhd$ parts of smilings: if a smiling event has the same constitution as an event which is part of a smiling by the dancers, then that event must be a smiling by some of the dancers. The derivation in (29) illustrates:

(29) a. $\exists e, \mathsf{smile}(e) \wedge \Diamond\big(\exists e', \exists e'',\ e \sim e' \wedge e' \sqsubset e'' \wedge \mathsf{smile}^{\mathsf{ag}}(e'')(\iota\mathsf{dancers})\big)$

A smiling event e is such that in some world, an event with e's constitution extends to a smiling of the dancers.

b. $\Rightarrow \exists e, \mathsf{smile}(e) \wedge \Diamond\big(\exists e', \exists x,\ x \prec \iota\mathsf{dancers} \wedge e \sim e' \wedge \mathsf{smile}^{\mathsf{ag}}(e')(x)\big)$

There is a smiling event e which has the same constitution as an event e of some dancers smiling in some world.

c. $\Rightarrow \exists e, \exists x \prec \iota\mathsf{dancers} \wedge \mathsf{eat}^{\mathsf{ag}}(e)(x)$

There is an event e of some dancers smiling.

Conversely, consider an event e of some dancers X smiling. In a world where all the dancers smiled, there is a sub-event e' of the event of all the dancers smiling, corresponding the smiling of X. e' has the same constitution as e ; because e' is part of ($\sqsubset$) an event of smiling by the dancers, e itself must be part of ($\lhd$) an event of the dancers.

(30) a. $\exists e, \mathsf{smile}(e) \wedge e \lhd \lambda e'.\ \mathsf{smile}^{\mathsf{ag}}(e')(\iota\mathsf{dancers})$

There is a smiling event which is part of an event of the dancers smiling.

b. $\exists e, \exists x \sqsubset \iota\mathsf{dancers} \wedge \mathsf{smile}^{\mathsf{ag}}(e)(x)$

There is a smiling event by some of the dancers.

This concludes the case of "*the dancers smile*". There is however something unsatisfactory in this treatment of plural homogeneity. To derive this reading, we had to assume something specific about *smiling* events. Given how widespread plural homogeneity is, one might want a more general account that extends beyond *smiling*s. I will set this point aside and return to it in section 4.1.4.

Predicate sharability and parts of group events. Finally, let us turn to the (31).

(31) a. The jury didn't laugh.
$\rightsquigarrow$ *no jury member laughed.*

b. **Weak paraphrase:**
$\exists e, \mathsf{laugh}(e) \wedge e \lhd \lambda e'.\, \mathsf{laugh}^{\mathsf{ag}}(e')(\iota\mathsf{dancers})$
There exists an event of laughing which is part of an event of the jury laughing.

As seen in chapter 3, *laugh* is sharable: it is entirely equivalent to say "*the jury laughed*" and to say *the jury members laughed*. This equivalence runs deeper: any event-level adverb[5] than can modify "*the jury laughed*" truthfully also modify "*the jury members laughed*" truthfully. (32a) is, for instance, perfectly equivalent to (32b).

(33) a. The jury laughed loudly, politely but halfheartedly.

b. The jury members laughed loudly, politely but halfheartedly.

Let's call this form of stronger predicate sharability *event predicate sharability*. In event semantics, the simplest way to derive event predicate sharability is to assume that the events involved are the same: the events of laughing by the jury and the events of laughing by the jury members are identical (formally expressed in (34)).

[5]R. Schwarzschild (p.c.) notes that this is not true *stricto sensu* since the adverbials in (32) break symmetry. A more cautious statement would say that any event-level modifier, which is not bound or depend in any way on the nature of the arguments, creates equivalence.

(32) a. # The jury laughed, one after the other.

b. The jury members laughed, one after the other.

(34) $\forall e, \mathsf{laugh}^{\mathsf{ag}}(e)(\iota\mathsf{jury}) \leftrightarrow \mathsf{laugh}^{\mathsf{ag}}(e)(\iota\mathsf{jury\text{-}members})$

If this assumption is correct, then the weak paraphrase in (35a) is equivalent to (35b). Consequently, the task of deriving the truth-conditions of "*the jury didn't laugh*" reduces the task of deriving the truth-conditions of "*the jury members didn't laugh*".

(35) a. $\exists e, \mathsf{laugh}(e) \wedge e \lhd \lambda e'. \mathsf{laugh}^{\mathsf{ag}}(e')(\iota\mathsf{dancers})$

There exists an event of laughing which is part of an event of the jury laughing.

b. $\exists e, \mathsf{laugh}(e) \wedge e \lhd \lambda e'. \mathsf{laugh}^{\mathsf{ag}}(e')(\iota\mathsf{jury\text{-}members})$

There exists an event of laughing which is part of an event of the jury members laughing.

We can generalize the observations: any time event predicate sharability is guaranteed, a sentence with a group noun subject and a sentence with the corresponding plurality will exhibit exactly the same homogeneity properties, since they share the same weak and the same strong meaning. This is in line with the observation of the previous chapter about the availability of group homogeneity.

We just need to explicate the weak truth-conditions of "*the jury members laughed*". This case is extremely similar to the case of "*the dancers smiled*". I assume that *laughing*s satisfy the same mapping properties as *smiling*s, namely that part ($\sqsubset$) of a laughing by the jury members is a laughing by some of the jury members.

(36) a. **Mapping to objects:** for every e, e', X

$e' \sqsubset e \wedge \mathsf{laugh}(e') \wedge \mathsf{laugh}^{\mathsf{ag}}(e)(X)$

$\Rightarrow \exists X' \sqsubset X, \ \mathsf{laugh}^{\mathsf{ag}}(e')(X')$

b. **Mapping to events:** for every e,

$X' \sqsubset X \wedge \mathsf{laugh}^{\mathsf{ag}}(e)(X)$

$\Rightarrow \exists e' \sqsubset e, \ \mathsf{laugh}(e') \wedge \mathsf{laugh}^{\mathsf{ag}}(e')(X')$

By the same reasoning used for *smiling,* these mapping assumptions entail that (37a) and (37b) are equivalent. This means that the weak paraphrase correctly predicts that "*the jury didn't smile*" means *no members of the jury smiled,* as is desired.

(37) a. $\exists e, \mathsf{laugh}(e) \wedge e \lhd \lambda e'. \mathsf{laugh}^{\mathsf{ag}}(e')(\iota\mathsf{jury\text{-}members})$

There is a laughing event which is part of an event of the jury members laughing.

b. $\exists e, \exists x \sqsubset \iota\mathsf{jury\text{-}members} \wedge \mathsf{laugh}^{\mathsf{ag}}(e)(x)$

There is a laughing event by some of the jury members.

This account relies on an explanation of event predicate sharability, repeated below in (38).

(38) $\forall e, \mathsf{laugh}^{\mathsf{ag}}(e)(\iota\mathsf{jury}) \leftrightarrow \mathsf{laugh}^{\mathsf{ag}}(e)(\iota\mathsf{jury\text{-}members})$

The assumption in (38) looks plausible but it unfortunately runs counter to a principle of event semantics: Thematic Role Uniqueness (Carlson, 1984), stated below in (39).

(39) **Thematic Role Uniqueness**

$\forall e, \Theta(e)(x) \wedge \Theta(e)(y) \rightarrow x = y$

If two entities bear the same role in an event, they must be the same entity.

If both (38) and the principle of Thematic Role Uniqueness hold, then we are forced to conclude that *the jury* and *the jury members* are the same entity. Chapter 3 presented arguments against this view: *the jury* does not have the same distributivity properties as *the jury members*, not all predicates are sharable, ...

If we give up (38) in order to preserve Thematic Role Uniqueness, we must posit that when the jury laughed, at least two events occur: an event of the jury laughing and an event of the jury members laughing. While different, both events must have exactly the same properties: the events must have the same loudness, the same politeness level, etc. Multiplying events in the absence of semantic contrast seems undesirable.

To get out of the bind, I observe that the motivations for the Thematic Role Uniqueness principle don't warrant stating it quite so strongly. As reviewed by Williams (2015), the thematic role uniqueness principle is meant to guarantee the infelicity of the sentences in (40). The argument goes as follows: without Thematic Role uniqueness, the two sentences in (40a) asserts nothing more than "*Kay was part of the people who killed Mo ; Lee was also part of the people who killed Mo*". (40a) would then be a felicitous way to describe the situation that (40b) describes.

(40) a. Kay killed Mo. Lee also killed Mo.

b. Kay and Lee killed Mo.

A similar problem is raised in Dowty (1987). If "*an attack on Mo by Kay*" only requires Kay to be one of the attackers, then (41) ought to be felicitous, which it isn't.

(41) #The attack on Mo by Kay was made in part by Lee.

However, note that these examples don't extend to events with group arguments. While (41)'s oddness is due to contradiction, (42) only feels redundant.

(42) ?The attack on Mo by the golf team was made by the golfers.

Thus, the Thematic Role Uniqueness needs to be relaxed to allow for these cases. The strong formulation in (39) isn't adequate.

To deal with these examples, one does not need the strong Thematic Role Uniqueness principle as stated in (39). Weaker principles are also possible. For instance, the following principle would in principle do:

(43) **Thematic Role Uniqueness (revised):**

$\forall e, \Theta(e)(x) \wedge \Theta(e)(y) \rightarrow x \sim y$

If two entities bear the same role in an event, they must have the same constitution.

Summary. In this section, I proposed a new weak meaning for homogeneous sentences, based on a modalized notion of part, $\lhd$. This is the first ingredient of the recipe for homogeneity/cumulativity proposed in chapter 1. Because of the ties between $\lhd$ and the traditional notion of $\sqsubset$, this entails that the parthood relations that holds between events are critical to determining what the weak meaning is exactly and effectively "*how weak*" it is.

With *eating the pie* events, whose parts correspond to bits of what was eaten, the weak meanings simply assert that some parts of the pie were eaten. With *the dancers* *smiling* events, whose parts are events of some of the dancers smiling, the weak meanings assert that some of the dancers smiled. Finally, we saw group nouns that are arguments of event-sharable predicates will behave in exactly the same way as their corresponding pluralities, simply because these predicates don't distinguish between a group participant and a plural participant.

How the weak meaning is strengthened in positive sentences (the second ingredient) and how it is compositionally derived has yet to be seen. Before we turn to these questions, let us explore some further consequences of grounding homogeneity in event mereology.

4.1.4 Applications

Lack of homogeneity. As we saw in the last chapter, not all predicates give rise to either group or material homogeneity. (44) and (45) do no exhibit truth-value gap: their truth-conditions are exactly complementary to the truth-conditions of the corresponding positive sentences.

(44) a. I plugged the computer in.

b. I didn't plug the computer in.

(45) a. I formed the committee.

b. I didn't form the committee.

The theory built so far assumes an underlying weak meaning as in (46a) strengthened, according to a yet to be specified mechanism, to (46b). How can the proposal sketched so far validate these generalizations?

(46) a. $\exists e,\ p(e) \wedge e \lhd \lambda e'.\ p(e')(x_1)\ldots(x_n)$

b. $\exists e',\ p(e')(x_1)\ldots(x_n)$

Under the theory pursued, the absence of a gap would be generated when the weak meaning and the strong meaning are equivalent. In this case, the negative sentences, which expresses the negation of the weak meaning, would mean the same as the negation of the strong reading, i.e. the negation of the positive sentence.

As we will see, Lack of homogeneity will occur when p-events do not typically have strict parts ($\lhd$) which are p. This illustrates once more the strong connection between the parthood structure of the events involved in a sentence and whether that sentence will display homogeneity.

Consider (47) and the informal paraphrase of the weak and strong meaning in (48). The paraphrases in (48) are very different. How could they be equivalent?

(47) I plugged the computer in.

(48) a. There exists an event of plugging which is part of an event of me plugging in the computer.

b. An event of me plugging in the computer exists.

To ensure equivalence, let me make a simple assumption about the structure of *plugging in* events: the only event of plugging which is part of ($\sqsubset$) an event e of me plugging the computer y is e itself. This corresponds to the intuition that an action of plugging in is not made up of an action of "*plugging in*" distinct from the latter. "*Plugging-ins*" of single computer are in a sense atomic. This stipulation is expressed formally below:

(49) ***Plugging*'s trivial part-whole structure:**

For all e, e',

$e \sqsubset e' \wedge \textsf{plug-in}(e) \wedge \textsf{plug-in}^{\textsf{ag+thm}}(e')(\iota\textsf{computer})([\![\text{I}]\!]) \Rightarrow e = e'$

To know what this entails about the weak paraphrase in (50a), we must first express $\lhd$ in terms of $\sqsubset$. This is done in (50b). (50b) asserts that the plugging event e has the same constitution as some event e' which is part of an event of plugging the computer in. By the assumption above, e' must itself be an event of plugging the computer in itself (50c). Since e and e' have the same constitution, e must be an event of plugging the computer (50d). The converse is straightforward: an event of plugging the computer in is part of ($\lhd$) an event of plugging the computer in.

(50) a. $\textsf{plug-in}(e) \wedge e \lhd \left(\lambda e'.\textsf{plug-in}^{\textsf{ag+thm}}(e')(\iota\textsf{computer})([\![\text{I}]\!])\right)$

There is a event of plugging in which is part of my plugging in the computer.

b. $\Leftrightarrow \textsf{plug-in}(e) \wedge \Diamond \left(\exists e', \exists e'', e \sqsubset e' \wedge e' \sim e'' \wedge \textsf{plug-in}^{\textsf{ag+thm}}(e'')(\iota\textsf{computer})([\![\text{I}]\!])\right)$ There is a plugging event *e* such that in some world, an event with the same constitution is part of an event of me plugging the computer in.

c. $\Rightarrow \textsf{plug-in}(e) \wedge \Diamond \left(\exists e', e \sim e' \wedge \textsf{plug-in}^{\textsf{ag+thm}}(e')(\iota\textsf{computer})([\![\text{I}]\!])\right)$

d. $\Rightarrow \textsf{plug-in}^{\textsf{ag+thm}}(e)(\iota\textsf{computer})([\![\text{I}]\!])$

This means that the weak and strong paraphrases are exactly equivalent and there is no truth-value gap between the positive sentence and the negative sentence. In short, the trivial part-whole structure of *plugging-ins* entails lack of homogeneity.

A similar explanation is available for the case of (51). Singular events of "*forming the commitee*", I assume, do not have strict "*forming*" subparts. By the same reasoning as above, this entails that it is equivalent to assert that part of ($\lhd$) an event of "*forming the committee*" exists as to assert that an event of forming the committee exists. The weak and strong meanings of (51b) are therefore equivalent or, to put it differently, (51a) and (51b) have complementary truth-conditions. This explains the lack of homogeneity between (51a) and (51b).

(51) a. I formed the committee.

b. I didn't form the committee.

Widespread plural homogeneity and lack thereof. Moving one level higher, observe that while *plugging in* and *forming* do not show homogeneity as far as singularities are concerned, they do not preclude homogeneity with plural arguments. Hence there is a truth-value gap between (52a) and (52b) and between (53a) and (53b).

(52) a. I plugged the two computer<u>s</u> in.

b. I didn't plug the two computer<u>s</u> in.

(53) a. I formed these two committee<u>s</u>.

b. I didn't form these two committee<u>s</u>.

The appearance of homogeneity is evidence of the richer part-whole structure of "*plural*" *plugging-ins* and *formings*: two events of plugging in Computer 1 and 2 add up to a single event of plugging in the two computers, two events of forming Committee 1 and Committee 2 add up to a single event of forming the two committees. This property is what Kratzer (2003); Krifka (1992) refer to as a cumulativity property. To avoid conflations, I will prefer the word summativity.

In the context of an event semantics with thematic roles, summativity can be formally represented by the propositions in (54). These proposition states that event-types are closed under sums, as are thematic roles:

(54) For all e, e', x, y,

a. $p(e) \wedge p(e') \Rightarrow p(e+e')$

b. $\textsc{Agent}(e)(x) \wedge \textsc{Agent}(e')(y) \Rightarrow \textsc{Agent}(e+e')(x+y)$

c. $\textsc{Theme}(e)(x) \wedge \textsc{Theme}(e')(y) \Rightarrow \textsc{Theme}(e+e')(x+y)$

To see how summativity plays out concretely, let's focus on the *plugging-ins* of (52). Consider some world w where there is an event e of me plugging Computer 1 in but no event of me plugging in Computer 2. Now, consider any world w' where an event with e's constitution occurs and in addition, there is an event e' of me plugging Computer 2 in. In w', $e+e'$ is an event of plugging in the two computers by virtue of the summativity property. So in w', e is part of ($\sqsubset$) an event plugging in both computers. Since e and e' have the same constitution, this means that in w, e is part of ($\lhd$) an event of plugging in the computers in w. In other words, the weak paraphrase (55b) is true in w. The strong paraphrase on the other hand is false: w contains no event of plugging all the computers in. This discrepancy between the weak and the strong meaning means that there is a truth-value gap.

(55) a. $\exists e$, $\mathsf{plug}(e) \wedge e \lhd \lambda e'.\, \mathsf{plug}(e')(\iota\mathsf{computers})(\llbracket \mathrm{I} \rrbracket)$

b. $\exists e'$, $\mathsf{plug}(e')(\iota\mathsf{computers})(\llbracket \mathrm{I} \rrbracket)$

Generalizing the reasoning, the weak paraphrase in (55a) will be true in any world where I plugged some computers. This means that the negative sentence in (56a) is predicted to have the truth-conditions given. The prediction is correct.

(56) a. I didn't plug the computers in.
$\rightsquigarrow$ *I plugged none of the computers in.*

b. I plugged the computers in.
$\rightsquigarrow$ *I plugged all of the computers in.*

This result was derived under the assumption that *pluggings* are summative. This richer structure creates a discrepancy between the weak paraphrase and the strong paraphrase. Kratzer (2003) proposed summativity as a universal generalization on lexical meanings in natural language. If this is correct, plural homogeneity should occur with all predicates, contrary to part homogeneity or group homogeneity. This has hitherto been a tacit assumption of this work and it is *mostly* correct.

But there are exceptions. Kriz (2015) notes that the sentences in (57-59) do not seem to display homogeneity, in their collective reading. For instance, speakers can interpret (57a) as claiming that the combined weight of the bottles is 5kg and they can interpret (57b) as claiming that the combined weight of the bottles is not that. There is no truth-value gap. (58) and (59) too do not display any truth-value gap, when taken under their collective meaning.

(57) a. The bottles weigh 5kg.

b. The bottles don't weigh 5kg

(58) a. The children are five in number.

b. The children aren't five in number.

(59) a. The suitcases fit in the trunk.

b. The suitcases do not fit in the trunk.

The homogeneity properties are different under a distributive reading (see Bar-Lev (2020) for a discussion of these facts). The distributive reading of (57a) claims that the weight of each bottle is 5kg, whereas the distributive reading of (57b) claims that the weight of none of the bottles is 5kg. (For understandable reasons, (58) cannot be interpreted distributively.)

We will come back to these cases when we discuss collective predicates in 6. To temporarily quell the discomfort raised by these observations, note that if these predicates were truly summative, then (60a) would be true so long as one could partition the bottles into groups such that each group weighs 5kg. This reading is extremely weak and neither corresponds to the distributive reading of the sentence nor its collective reading, nor to any reading. Thus, (60) does not seem summativity (see Bar-Lev (2020) for similar observations and different conclusions)[6].

(61) The bottles weigh 5kg.

Pending future observations made in chapter 6, I tentatively conclude that cumulativity is not universal but widespread, explaining that plural homogeneity is widespread but not universal.

4.1.5 Summary

This section has developed an event-based weak meanings for simple sentences. The weak meaning is constructed on the basis of m-part, a modal notion of parthood. This notion allows for something to be part of a whole, even when the whole does not exist in

[6]As a counterpoint to this observation and anticipating a discussion to come, note that the summative inference appears valid.

(60) The red bottles weigh 5kg.
The green bottles weigh 15kg.
So the red bottles and the green bottle weigh 5kg and 15kg.

the world of evaluation. The resulting theory creates a strong connection between what parts an certain sort of event has and what homogeneity properties it will have when used in a sentence.

There remains to explain how this weak meaning comes about compositionally and how it comes to be strengthened to the attested strong reading in positive contexts. With the additional details, we will be able to develop an analysis of cumulative readings of *every*. This is what the next section sets out to do.

4.2 Strengthening & Composition

The last section discussed the weak and strong meanings for simple intransitive sentences as in (62). This global approach helped us assess the validity of the event mereological approach on homogeneity at at a high level. For the cumulative case, we will need to be more explicit. We first need to understand how the weak reading comes about compositionally and how it is strengthened to the observed reading.

(62) **Negative sentences:** *negation of the weak paraphrase*

a. The dancers didn't smile.

b. $\neg\exists e, \mathsf{smile}(e) \wedge e \lhd \left(\lambda e'.\mathsf{smile}^{\mathsf{ag}}(e')(\iota\mathsf{dancers})\right)$

(63) **Positive sentences:** *strong paraphrase*

a. The dancers smiled

b. $\exists e, \mathsf{smile}(e)(\iota\mathsf{dancers})$

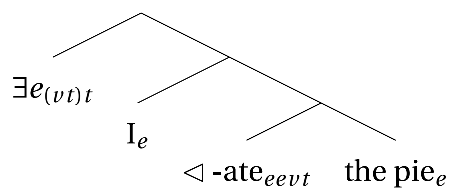
I will start by outlining my assumptions about event composition how the weak meaning comes about. With these foundations in place, I will propose a new mechanism for strengthening. The introduction of an event semantics gives us an opportunity to replace the recursive exhaustification mechanism of chapter 2 and its intricacies with a simpler mechanism. Finally, we will give an analysis of cumulative readings of *every*.

4.2.1 The composition of weak events

I will assume a Davidsonian logical form, as in (64). The verb is a predicate realting one evetn argument to one or more individual arguments. Arguments combine with verb through normal functional application. At the TP level, an event predicate is formed, which is then existentially closed by a covert existential over events, $\exists e$.

(64) a. I ate the pie.

b.



Despite this Davidsonian logical form, I have used and will continue to use thematic roles in my logical paraphrases, as in (65a). This is also out of convenience and the system could be expressed without relying on thematic roles at all. Since thematic roles always co-occur with the event predicate, I will abbreviate the phrase $\mathsf{V}(e) \wedge \textsc{Agent}(e)(\iota\mathsf{pie}) \wedge \textsc{Theme}(e)([\![\mathrm{I}]\!])$ as $V^{\mathsf{ag+thm}}$. (65a) would for instance be given as (65b).

(65) a. $\mathsf{eat}(e) \wedge e \lhd \left(\lambda e'.\, \mathsf{eat}(e') \wedge \mathsf{ag}(e')(\iota\mathsf{pie}) \wedge \mathsf{thm}(e')([\![\mathrm{I}]\!])\right)$

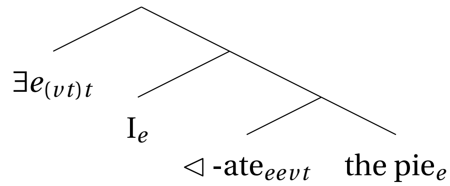
b. Abbreviation:
$\mathsf{eat}(e) \wedge e \lhd \left(\lambda e'.\, \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota\mathsf{pie})([\![\mathrm{I}]\!])\right)$

(65a) is the weak truth-conditions aimed for. Just as in chapter 2, the weak meaning is assumed to arise as part of the meaning of the verb itself. To make clear that we are dealing with a weak meaning of the verb, I prefix the verb with and $\lhd$ operator. Specifically, abstracting lexical material away from our weak logical paraphrases, we form the meaning in (66):

(66) $[\![\lhd\text{ -ate}]\!] = \lambda x_e.\lambda y_e.\lambda e_v.\, \mathsf{eat}(e) \wedge e \lhd \lambda e'.\, \mathsf{eat}^{\mathsf{ag+thm}}(e')(y)(x)$

With these assumption, the composition raises no particular difficulties. (67) illustrates:

(67) a.



b. $[\![\text{ate the pie}]\!] = \lambda y.\, \exists e,\ \mathsf{eat}(e) \wedge e \lhd \left(\lambda e'.\, \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota\text{pie})(y)\right)$

$[\![\text{I ate the pie}]\!] = \lambda e.\, \mathsf{eat}(e) \wedge e \lhd \left(\lambda e'.\, \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota\text{pie})([\![\text{I}]\!])\right)$

$[\![\text{(67a)}]\!] = \exists e,\ \mathsf{eat}(e) \wedge e \lhd \left(\lambda e'.\, \mathsf{eat}^{\mathsf{ag+thm}}(e')(\iota\text{pie})([\![\text{I}]\!])\right)$

This derives the weak truth-conditions that were abundantly discussed in the last section. As we saw there, these truth-conditions are equivalent to asserting that there is an event of me eating bits of pie. They adequately model the meaning of the negative sentence.

4.2.2 Exhaustive participation: why did you mention them?

The attested truth-conditions of (68) add to the underlying meaning derived earlier a exhaustive participation inference that every bit of the pie in fact "*participated*" in the eating ; in other words, all bits of pie were eaten.

(68) I ate the pie.

In chapter 2, an explanation of exhaustive participation inference was obtained by analogy with Free Choice, following Bar-Lev (2018b), and Distributive Implicatures. There, I followed one strand of the literature in assuming these implicatures stem from recursive exhaustification.

The analogy still holds and recursive exhaustification could still be used in the event case. However, the introduction of events in our semantics allow for another derivation of exhaustive participation inferences, which is inspired by a similar mechanism of strengthening proposed by Zweig (2008).

This derivation will temporarily look unfaithful to the analogy with Distributive Implicatures/Free Choice motivated by chapter 2. At the same time, it will be simpler, more robust and its predictions easier to track. In the section 4.5, I will show that this account does not in fact stray very far from the analogy with Distributive Implicatures ; the same mechanics used here can be exploited to offer a different account of Distributive Implicatures.

First pass with a simple exhaustification. Consider (69a) and its underlying weak meaning in (69b).

(69) a. The dancers smiled.

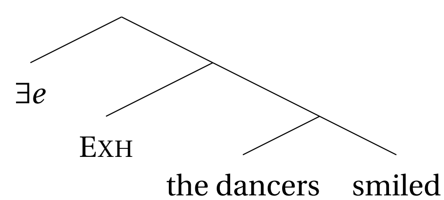
b. **LF:**
$\exists e$, the dancers $\lhd$ -smiled

c. $[\![(69a)]\!] = \exists e, \mathsf{smiled}(e) \wedge e \lhd \lambda e'.\, \mathsf{smiled}(e')(\iota\mathsf{dancers})$

As seen in section 4.1, the weak meaning expresses that some dancers smiled. But the composition is more complex than the simple truth-conditions suggest. With the addition of events, the sentence also references, at some level of composition, an event in which some dancers smiled (i.e. which is part of ($\lhd$) an event of the dancers smiling).

The event contains precisely those dancers who participated in the smiling. To assert *exhaustive participation inference*, I then propose that this event predicate itself is strengthened by comparison with alternatives involving less dancers. The proposed LF is given in (70a). I assume provisionally the same set of alternatives as in the 2: alternatives obtained by replacing the dancers by sub-pluralities. If Joana and Marius are the only dancers, the set of alternatives are as in (70b):

(70) a.



b. **Prejacent:** Exh the dancers $\lhd$ -smiled

Alternatives: – Exh Joana $\lhd$ -smiled

– Exh Marius $\lhd$ -smiled

Applying a single dose of exhaustification, we derive the following truth-conditions, whose informal paraphrase is given in (71b).

(71) a. $\exists e, \quad \mathsf{smiled}(e) \wedge e \lhd \lambda e'.\, \mathsf{smiled}(e')(\iota\mathsf{dancers})$

$$\wedge \neg \big(\mathsf{smiled}(e) \wedge e \lhd \lambda e'.\, \mathsf{smiled}(e')(\mathsf{Joana})\big)$$

$$\wedge \neg \big(\mathsf{smiled}(e) \wedge e \lhd \lambda e'.\, \mathsf{smiled}(e')(\mathsf{Marius})\big)$$

b. There is an event *e* s.t.:

- It is a smiling event *e*
- It is part of an event of the dancers smiling.
- It is not part of an event of Joana smiling.
- It is not part of an event of Marius smiling.

The weak meaning of the prejacent, studied in the last section, already guarantees that the event *e* is an event of smiling by Joana or Marius or both. Because *e* is not a part of an event of Marius smiling, it cannot be an event of Marius smiling (since $e \lhd e$ for every e). By the same reasoning, it cannot be an event of Joana smiling either. The only way to meet these requirement is if *e* is an event of both Joana and Marius smiling. Such an event would indeed meet all the requirements in (72c). Overall then, the sentence is predicted to mean that both Joana and Marius smiled, the intended result.

Second pass: more alternatives. The result is correct and requires minimal tooling to derive. But we can do better: in chapter 2, the assumption that plural-referring expressions *only* have their sub-pluralities as alternatives was a necessary but unexplained stipulation. With the new procedure for strengthening, this assumption becomes superfluous. We can assume that all pluralities can serve as alternatives to the plural-referring expression *Joana and Marius.*

With this assumption, the set of alternatives now additionally includes superset alternatives (like *Joana, Marius and Isobel*) and overlapping alternatives (like *Joana and Isobel*). Not all of the alternatives in that set can be negated without contradiction. Indeed, a smiling event cannot be part of Joana and Marius smiling without being part of an event of Joana, Marius and Isobel smiling. Superset alternatives are therefore not negatable. All the other alternatives on the other hand can be negated without contradictions.

(72)

Prejacent:		EXH the dancers	$\lhd$ -smiled	
Alternatives:	–	EXH Joana	$\lhd$ -smiled	(subset)
	–	EXH Marius	$\lhd$ -smiled	(subset)
	–	EXH Joana, Marius and Isobel	$\lhd$ -smiled	(superset)
	–	EXH Joana and Isobel	$\lhd$ -smiled	(overlapping)

The resulting truth-conditions are informally paraphrased in (73). These truth-conditions involve more negative clauses than before, because the negation of overlap alternatives is now included. It is now required that the event described by the sentence is not part of an event of Joana and Isobel smiling. But events of Joana and Marius smiling will never be part of such an event. Hence these additional clauses do not restrict the event predicate further: only events of both Joana and Marius smiling can fulfill the conditions imposed by (73). In summary, the sentence still asserts that both Joana and Marius smiled, the desired result.

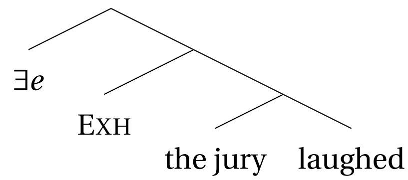
(73) There is an event *e* s.t.:

- It is a smiling event *e*
- It is part of an event of the dancers smiling.
- It is not part of an event of Joana smiling.
- It is not part of an event of Marius smiling.
- It is not part of an event of Joana and Isobel smiling.

Part homogeneity and group homogeneity. This analysis straightforwardly extends to group-homogeneous and part-homogeneous predicates. Here too, exhaustification takes place on the event predicate and alternatives are obtained by replacing the referring expression with alternative-referring expressions of the same type.

For instance, the derivation of the strong reading of (74a) is given in (74b-d). In its weak form, (74a) asserts that there is an event of some member of the jury laughing. In its strong form, (74a) assert (74c), which means that there is an event of some members of the jury laughing which is not part of events where only some sub-part of the jury laughed. For this to hold, the event described must be an event of all of the jury laughing.

(74) a. The jury laughed.

b. 

c. **Prejacent:** EXH the jury ∃-laughed

Alternatives:
– EXH Joana ∃-laughed
– EXH Marius ∃-laughed
– EXH Marius and Barnaby ∃-laughed
– EXH Joana, Marius and Barnaby ∃-laughed

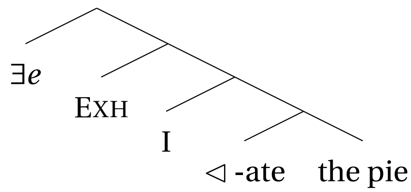
d. There is an event *e* s.t.:

- It is a laughing event *e*
- It is part of an event of the jury laughing.
- It is not part of an event of Joana laughing.
- It is not part of an event of Marius laughing.
- It is not part of an event of Marius and Barnaby laughing.

Similarly, the derivation of the strong reading of the part-homogeneous sentence in (75a) is given in (75b-d). In its weak form, (75a) asserts that there is an event of my eating some bit of the pie. In its strong form, (75a) asserts in addition to the latter, that this event is not part of an event of eating any strict subpart of the pie. So *a fortiori*, it is not an event of eating any strict subpart of the pie. This can only be true if in that event, all the pie was eaten.

(75) a. The jury laughed.

b.



c. **Prejacent:** EXH I $\lhd$ -ate the pie

Alternatives:
– EXH I $\lhd$ -ate the pie
– EXH I $\lhd$ -ate slice 1
– EXH I $\lhd$ -ate slice 2
– EXH I $\lhd$ -ate slice 1 and the pizza

d. There is an event *e* s.t.:
- It is a eating event *e*
- It is part of an event of my eating the pie.
- It is not part of an event of my eating slice 1.
- It is not part of an event of my eating slice 2.
- It is not part of an event of my eating slice 1 and the pizza.

Note that to derive the strengthening in case of part homogeneity and group homogeneity, it must be critically assumed that there are more alternatives than just sub-plurality alternatives. The correct reading is indeed derived by negating alternatives formed by replacing singularities with their material parts or their group members.

By contrast, as I discussed in section 3.4 of chapter 3, the theory of 2 can only hope to cover the cases of part homogeneity and group homogeneity by requiring the set of alternatives to be conditioned on the type of predicates. No such assumptions is necessary in the new approach presented here.

4.3 Cumulative readings and cumulative readings of *every*

I have given the composition of the weak truth-conditions and a way to derive strengthening of these truth-conditions. We are now in a position to tackle more complex sentences like cumulative sentences.

(76) Ordinary cumulative sentence

a. The squirrels cracked the nuts.

b. The jury occupies the seats on the second row.

c. The ten balls of yarn made these sweaters.

(77) Cumulative readings with *every*

a. The squirrels cracked every nut.

b. The jury occupies every seat on the second row.

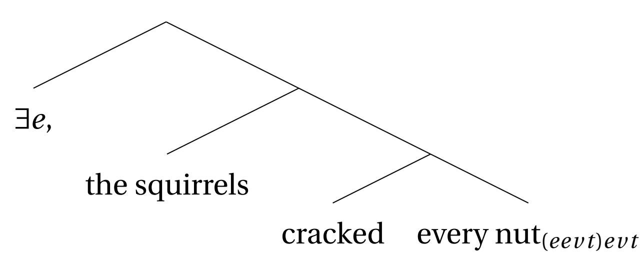
c. The ten balls of yarn made every one of these sweaters.

Following the strategy of chapter 2, I will start with the cumulative reading of *every* in (77), which turns out to be the simpler case.

4.3.1 Cumulative readings of *every*

I will assume that in cumulative sentences like (78), the plural out-scopes *every* at LF, as in e.g. (78). This assumption is motivated by the facts seen in 2 that the cumulative reading is absent if the order of the two arguments is reversed or when the quantifier is made to scope above the plural element.

(78)



This assumption implies another one: *every nut* combines within in the event domain ; this means that the semantics of *every nut* must be able to combine with events. I will adopt the denotation in (79a), a simplification of Champollion (2016b), and type-raised versions thereof, as in (79b), adequate for combining *every* with elements lower down the event spine.

(79) a. $[\![\text{every nut}]\!] = \lambda p.\lambda e'.\ (\iota\mathsf{nuts}, e) \in {}^*\left(\lambda x_e.\lambda e_v.\ \mathsf{Atom}(x) \wedge p(x)(e')\right)$
where ${}^*p$ is the smallest summative relation containing p.

b. $[\![\text{every nut}]\!] = \lambda p.\lambda y.\lambda e'.(\iota\mathsf{nuts}, e) \in {}^*\lambda x_e.\lambda e'_v.\ \mathsf{Atom}(x) \wedge p(x)(y)(e')$

To understand this denotation, consider the simple (80a). Let's assume, for presentation purposes, that *squeaked* denotes a relation between squirrels and events, as in the first line of (80b). *every* first gathers all pairs of atomic squirrels and the squeakings in which they were involved. All (component-wise) sum of such pairs are formed. If in the new set of pairs formed in this way, some pair has all the squirrels in its first component, then the event component of that pair (i.e. squeakings done by all the squirrels) will be in the event predicate formed by *every*. In effect, *every* constructs a sum of events of squeaking, containing at least one squeaking for each squirrel.

(80) a. Every squirrel squeaked.

b. $[\![\text{squeaked}]\!] = \left\{(\mathsf{Scrat}, e_1), (\mathsf{Acorn}, e_2), (\mathsf{Bambi}, e_3)\right\}$

c. $${}^*[\![\text{squeaked}]\!] = \left\{\begin{array}{ccc} (\mathsf{Scrat}, e_1), & (\mathsf{Acorn}, e_2), & (\mathsf{Bambi}, e_3) \\ (\mathsf{Scrat}+\mathsf{Bambi}, e_2+e_3), & (\mathsf{Acorn}+\mathsf{Bambi}, e_1+e_3), & (\mathsf{Scrat}+\mathsf{Acorn}, e_1+e_2), \\ & (\mathsf{Scrat}+\mathsf{Acorn}+\mathsf{Bambi}, e_1+e_2+e_3) & \end{array}\right\}$$

d. If Scrat and Acorn are the only squirrels, then:
$[\![\text{every squirrel squeaked}]\!] = \{e_1 + e_2\}$

Note that my adoption of an event denotation for *every* seems to go against my criticism of event accounts in chapter 5. These accounts relied on precisely the denotation which I am assuming here. But recall that the criticism of 5 was targeted at event accounts relying on thematic role separation ; contrary to these accounts, the logical form presented in (78) makes no use of thematic role separation. This is why, as we'll see, the account will be impervious to the challenge raised in chapter 5.

Cumulative readings of *every*: the negative case. We can first compose the LF, assuming no strengthening whatsoever. To simplify the computation, we first need to understand the meaning of ◁-*crack*, our existential meaning of the verb, given in (81a).

(81) $[\![\lhd\text{-cracked}]\!] = \lambda x.\lambda y.\lambda e.\ \mathsf{crack}(e) \wedge e \lhd \lambda e'.\mathsf{cracked}^{\mathsf{ag+th}}(x)(y)(e')$

The meaning of ◁-*crack* depend on the part-whole relation of cracking events: focusing on single nuts, what does it take for an event to be part of a cracking of single nut y by a plurality X? Assuming *crack* is summative, a cracking of y by X is either a collective cracking of nut y by the group X or a sum of several crackings of y by subgroups of X which together add up to X. The latter sum of event is one that does not occur in typical worlds, since nuts can only be cracked once. But we will only be looking at parts of this type of events ; wholes need not exist in the world of evaluation with the m-parts that the weak reading makes reference to.

In worlds where an event of this type occurs, its parts ($\sqsubset$) are sums of crackings of y by squirrels among X. The m-parts of an event of cracking y by X will have the same constitution as these events: they will be crackings of y by some of X. In other words, (81) is equivalent to (82).

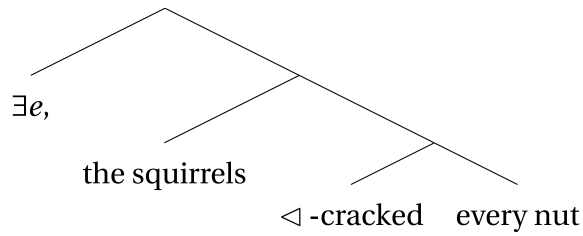
(82) $[\![\lhd\text{-cracked}]\!] = \lambda y.\lambda X.\lambda e.\ \exists X' \prec X, \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e')$

$\lambda y.\lambda X.\lambda e.$ e is an event of cracking y by some of X

Note that the meaning in (83) is almost the same as the existential meaning assumed in chapter 2. The two main differences are: 1) the meaning is now couched in an event semantics, 2) I no longer neglect the possibility of squirrels teaming to crack an individual nut. Armed with this denotation, let us compose (83b). The detailed composition is given in (83c).

(83) a. The squirrels cracked every nut.

b.



c. $[\![\triangleleft\text{-cracked}]\!] = \lambda X.\lambda y.\lambda e.\ \exists X' \prec X,\ \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e)$

$\lambda X.\lambda y.\lambda e.$ e is an event of cracking y by some of X

$[\![\triangleleft\text{-cracked every nut}]\!] = \lambda X.\lambda e.\ (\iota\mathsf{nuts}, e) \in {}^{*}\left(\lambda y.\lambda e'.\ \mathsf{Atom}(y) \wedge \exists X' \prec X, \mathsf{cracked}(X')(y)(e')\right)$

$\lambda X.\lambda e.$ e is a sum containing for every nut y, an event of cracking y by some of X

$[\![\text{the squirrels} \triangleleft\text{-cracked every nut}]\!]$
$= \lambda e.\ (\iota\mathsf{nuts}, e) \in {}^{*}\left(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \prec \iota\mathsf{squirrels}, \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e')\right)$

$\lambda e.$ e is a sum containing for every nut y, an event of cracking of y by some of the squirrels.

$[\![\text{the squirrels} \triangleleft\text{-cracked every nut}]\!]$
$= \exists e,\ (\iota\mathsf{nuts}, e) \in {}^{*}\left(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \prec \iota\mathsf{squirrels}, \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e')\right)$

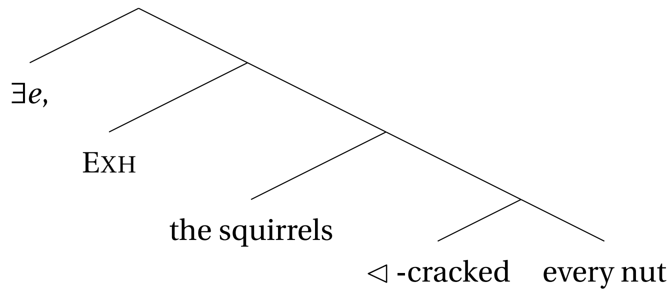
There is an event which is a sum containing for every nut y, an event of cracking of y by some of the squirrels.

Suppressing event talk, the truth-conditions assert that every nut was cracked by some squirrels. The truth-conditions obtained are thus the truth-conditions of the cumulative reading, minus the exhaustive participation inference that every squirrel participated to a nut cracking. This meaning is, as we saw, exactly suited to the negative cumulative sentence with *every* in (84).

(84) The squirrels didn't crack every nut.
=It's not the case that every nut was cracked by some squirrels.

Strengthening. Strengthening is needed to derive the correct truth-conditions of the positive sentence. To derive the exhaustive participation inference in simple intransitive sentences earlier, I made use of a single exhaustification operator applying within the event domain. The same mechanism can be used to derive exhaustive participation inferences in cumulative sentences with *every*. Consider the LF in (85):

(85)



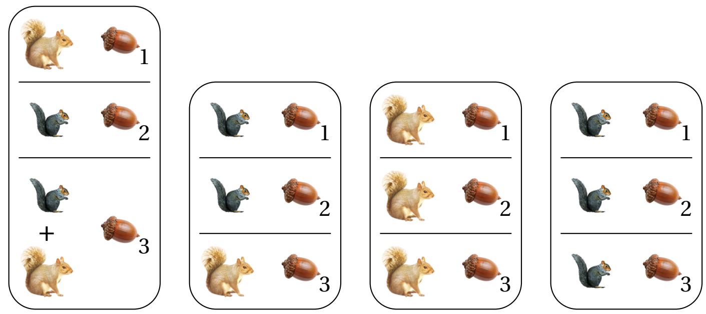
As before, all alternatives to *the squirrels* are considered. Taking Scrat and Acorn to be the only squirrels, this includes sub-plurality alternatives (*Scrat*, *Acorn*), super-plurality alternatives (*Scrat, Acorn and Bambi*) and overlapping pluralities (*Acorn and Bambi*).

The prejacent is a predicate true of events containing for every nut, a cracking by one of the two squirrels. To visualize which alternatives can be consistently negated with this prejacent, consider the representative sample of events in the denotation of the prejacent in (86). I depict events as follows: each box is one event in the extension of the prejacent and each row in a box corresponds to a particular sub-event of cracking involving some squirrel and some nut.

(86) a.

Prejacent:	the squirrels	$\lhd$ -cracked every nut.	←prejacent
Alternatives:	Scrat	$\lhd$ -cracked every nut.	←alt_1
	Acorn	$\lhd$ -cracked every nut.	←alt_2
	Acorn and Bambi	$\lhd$ -cracked every nut.	←alt_3
	Scrat, Acorn and Bambi	$\lhd$ -cracked every nut.	←alt_4

b.  = Scrat  = Acorn



	e_1	e_2	e_3	e_4
alt_1	false	false	true	false
alt_2	false	false	false	true
alt_3	false	false	true	false
alt_4	true	true	true	true

Which alternatives can be negated consistently against that set? alt_1 is true only of events of cracking every nut performed by Scrat ; it is only true of e_3. Therefore negating this alternative would not incur any contradiction. Same goes for alt_2; negating this alternative only rules out e_4.

The "*overlap*" alternative alt_3 is only true of sums of cracking events performed by either Scrat or Bambi. Negating this alternative only rules out e_3, so it too can be negated consistently with the prejacent.

On the other hand, the "*super-plurality*" alternative alt_4 is true of events which are sums, containing for every nut, an event of cracking that nut by either Scrat, Acorn or Bambi. All the events depicted in (86b) and indeed all events in the extension of the prejacent meet that description. Negating alt_4 would therefore give rise to a contradiction.

Negating all the alternatives which can consistently be negated with the prejacent rules out events like e_3 and e_4 where one of the two squirrels cracked all the nuts. After these alternatives are negated, only events like e_1 and e_2 where each squirrel participated in cracking at least one nut, remain. Asserting that such events exist implies that all squirrels participated in cracking a nut, which the desired exhaustive participation inference. The formal details are given in (87).

(87) a. $\textsc{Exh}\Big((\iota\text{nuts}, e) \in {}^{*}\Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' < \iota\text{squirrels}, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)\Big)$

Alternatives:

$(\iota\text{nuts}, e) \in {}^* \Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec X, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)$, for all $X \in D_e$

Negatable alternatives:

$(\iota\text{nuts}, e) \in {}^* \Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec X, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)$

where X overlaps ιsquirrels

b. $$\begin{aligned}\exists e\ & \Big((\iota\text{nuts}, e) \in {}^* \Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \iota\text{squirrels}, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)\Big) \\ & \wedge \neg \Big((\iota\text{nuts}, e) \in {}^* \Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \text{Acorn}, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)\Big) \\ & \wedge \neg \Big((\iota\text{nuts}, e) \in {}^* \Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \text{Scrat}, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)\Big) \\ & \wedge \neg \Big((\iota\text{nuts}, e) \in {}^* \Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \text{Scrat} + \text{Bambi}, \text{cracked}^{\text{ag+th}}(X')(y)(e')\Big)\Big) \\ & \ldots\end{aligned}$$

c. There is an event e s.t.:

- e is the sum, for every nut x, of an event of Scrat or Acorn or both cracking x.
- e is not the sum, for every nut x, of an event of Scrat cracking x.
- e is not the sum, for every nut x, of an event of Acorn cracking x.
- e is not the sum, for every nut x, of an event of Scrat and Bambi cracking x.

To recap, the strengthening operation sieves out from the set of events those sum events which were carried out by only one of the two squirrels. This is done by comparing the prejacent to alternatives which involve less participants.

Group and part cumulativity The same analysis can be carried for cases of part and group cumulativity. The only difference is the structure of the events in the extension of the predicate. Consider the verbs involved in the cumulative sentences in (88). The weak meanings of these verbs would be as in (89).

(88) a. The jury occupies every seat in the second row.

b. The ball of yarn made every one of these sweaters.

(89) a. $[\![\lhd\text{-occupy}]\!] = \lambda x.\lambda y.\lambda e.\ \mathsf{occupy}(e) \wedge e \lhd \lambda e'.\ \mathsf{occupy}(x)(y)(e')$

b. $[\![\lhd\text{-made}]\!] = \lambda x.\lambda y.\lambda e.\ \mathsf{made}(e) \wedge e \lhd \lambda e'.\mathsf{made}(x)(y)(e')$

To simplify the composition, we must first ask: what kind of events are parts of an event of a jury occupying a seat? What kind of events are parts of an event of a ball of yarn make an individual sweater? (I use the word *event* in the most general sense ; the word *state* may be more appropriate for the predicates described.)

The case of *a jury occupying a seat* requires imagining an event of a whole jury seating in one seat. This could be an event where each jury member occupies a corner of the seat. An event of this type therefore seems decomposable into a sum of events of individual jury members occupying a corner of the seat. This means that events which are parts of an event of the jury occupying the seats will have the same constitution as these events: they will be events of one or more jury members occupying a corner of a seat.

Events where *a ball of yarn makes a sweater* describe a constitution relation: the "*stuff*" that makes the ball of yarn also makes the sweater. This constitution relation can in turn be broken down into smaller constitution relations: that smaller bit of yarn made that bit of sweater, etc. I propose then to treat an event of *a ball of yarn making a sweater* as the sum of events of bits of yarn making bits of sweater. Consequently, in any world, a event that is part of (◁) an event of making the sweater would have the same constitution as these events: they are events where bits of yarn makes bits of sweater.

The principles in (90) summarize our discussion:

(90) a. For every seat x,

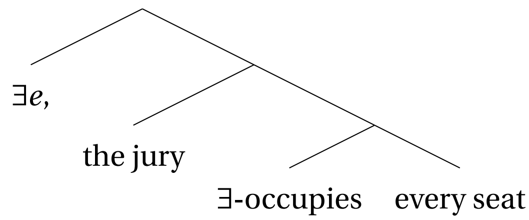
$[\![\lhd\text{-occupy}]\!]\,(x)(\iota\mathsf{jury}) = \lambda e.\ \exists x' \sqsubset x, \exists j \prec \mathsf{members}(\iota\mathsf{jury}),\ \mathsf{occupy}^{\mathsf{holder+thm}}(x')(j')(e)$

b. For every sweater x,

$[\![\lhd\text{-made}]\!]\,(x)(\iota\mathsf{ball\text{-}of\text{-}yarn}) = \lambda e.\ \exists x' \sqsubset x, \exists y \sqsubset \iota\mathsf{ball\text{-}of\text{-}yarn},\ \mathsf{made}^{\mathsf{holder+thm}}(x')(y)(e)$

Applying these principles, let us now first compose the assumed LFs without exhaustification:

(91) a.



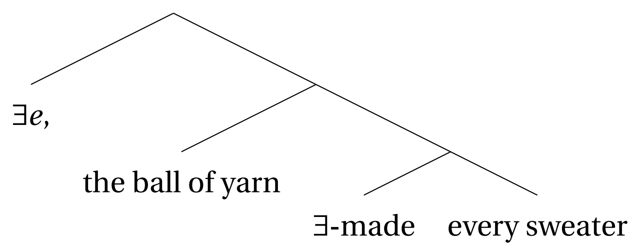
b. $[\![(91a)]\!]$

$= \exists e, (\iota\text{seats}, e) \in {}^*\lambda x.\lambda e.\ \text{Atom}(x) \wedge [\![\lhd\text{-occupy}]\!](x)(\iota\text{jury})$

$= \exists e, (\iota\text{seats}, e) \in {}^*\lambda x.\lambda e.\ \text{Atom}(x) \wedge \exists x' \sqsubset x, \exists j \prec \text{members}(\iota\text{jury}),\ \text{occupy}^{\text{holder+thm}}(x')(j')(e)$

There is an event which is a sum containing for every seat x, an event of occupying part of x by one or more jury members.

(92) a.



b. $[\![(92a)]\!]$

$= \exists e, (\iota\text{sweaters}, e) \in {}^*\lambda x.\lambda e.\ \text{Atom}(x) \wedge [\![\lhd\text{-made}]\!](x)(\iota\text{ball-of-yarn})$

$= \exists e, (\iota\text{sweaters}, e) \in {}^*\lambda x.\lambda e.\ \text{Atom}(x) \wedge \exists x' \sqsubset x, \exists y \sqsubset \iota\text{ball-of-yarn},\ \text{made}^{\text{holder+thm}}(x')(y)(e)$

There is an event which is a sum containing for every sweater x, an event of making x by a bit of yarn y.

As is familiar by now, the unstrengthened LF correspond to what is found under negation. The negation of the truth-conditions in (92) should therefore match the truth-conditions of the negative sentences. For (93a), this means that we predict the negative to be true if there is no event which is a sum containing for every seat, an event of occupying this seat by one or more jury members. In other words, at least one of the seats should not be occupied by any of the jury members in *any* of its corners. The seat should be *completely* free (of jury members).

For (93b) to be true, there should be no event which is a sum containing for every sweater, a bit of yarn making that sweater. In other words, the material of one of the sweaters does not contain any bit of yarn from the ball of yarn.

(93) a. The jury doesn't occupy every seat.

b. The yarn didn't make every sweater.

The predictions seem to match speakers' intuitions.

Strengthening. We derive strengthening as in the plural case by exhaustifying the referring expression against alternative entities in the event domain. As before, the alternatives include any referring expression and we can divide these alternatives in 3 categories: the sub-group alternatives, i.e. expressions referring to pluralities of jury members, the overlap alternatives, i.e. expressions referring to some jury members as well as outsiders, the super-group alternatives, i.e. expressions referring to super-group of jury members.

(94) a.

Prejacent:	The jury	∃-occupied every seat.	←prejacent
Alternatives:	Jury member 1	∃-occupied every seat.	←alt_1
	Jury member 2	∃-occupied every seat.	←alt_2
	Jury member 1 & Joana	∃-occupied every seat.	←alt_3
	Jury members 1 & 2 and Joana	∃-occupied every seat.	←alt_4

As seen earlier, the event predicate is true of events which contain for every seat, an occupying of that seat by some jury members. Relatedly, the alternatives to this predicate are true of events containing for every seat, an occupying of that seat by some of X, where X may either be a sub-group, a super-group, or an overlapping group.

(95) a. $[\![(95a)]\!]$

$= \exists e, (\iota\text{seats}, e) \in {}^*\lambda x.\lambda e.\, \mathsf{Atom}(x) \wedge \exists x' \sqsubset x, \exists j \prec \mathsf{members}(\iota\mathsf{jury}),\ \mathsf{occupy}^{\mathsf{holder+thm}}(x')(j)(e)$

There is an event which is a sum containing for every seat x, an event of occupying part of x by one or more jury members.

b. **Alternatives:**

$[\![(95a)]\!]$

$= \exists e, (\iota\text{seats}, e) \in {}^*\lambda x.\lambda e.\ \text{Atom}(x) \wedge \exists x' \sqsubset x, \exists Y' \prec Y,\ \text{occupy}^{\text{holder+thm}}(x')(Y')(e)$

There is an event which is a sum containing for every seat x, an event of occupying part of x by one or more jury members.

The super-group alternatives, given the nature of the prejacent, cannot be negated without contradictions. The overlap and sub-group alternatives, on the other hand, can. This is just as we saw with the plural case. The predicate that results from negating the negatable alternatives is true of sum of events containing for every seat, an event of one or more of the jury members occupying that seat but which are not sums of such seating by any smaller group of jury members. This can only be true if all jury members have seats, the desired exhaustive participation inference.

(96) a. $\text{EXH}\left((\iota\text{seats}, e) \in {}^*\left(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \iota\text{jury}, \text{occupy}^{\text{ag+th}}(X')(y)(e')\right)\right)$

Alternatives:

$(\iota\text{seats}, e) \in {}^*\left(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec X, \text{occupy}^{\text{ag+th}}(X')(y)(e')\right)$

Negatable alternatives:

$(\iota\text{seats}, e) \in {}^*\left(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec X, \text{occupy}^{\text{ag+th}}(X')(y)(e')\right)$

where X overlaps ιjury

b. $\exists e \quad \Big((\iota\text{seats}, e) \in {}^*\Big(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \iota\text{jury}, \text{occupied}^{\text{ag+th}}(X')(y)(e')\Big)\Big)$

$\wedge \neg\left((\iota\text{seats}, e) \in {}^*\left(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \text{jury member 1}, \text{occupy}^{\text{ag+th}}(X')(y)(e')\right)\right)$

$\wedge \neg\left((\iota\text{seats}, e) \in {}^*\left(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \text{jury-member 2}, \text{occupy}^{\text{ag+th}}(X')(y)(e')\right)\right)$

$\wedge \neg\left((\iota\text{seats}, e) \in {}^*\left(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \exists X' \prec \text{jury-member 2} + \text{Joana}, \text{occupy}^{\text{ag+th}}(X')(y)(e')\right)\right)$

$\ldots$

c. There is an event e s.t.:

- e is the sum, for every seat x, of an event of jury member 2 or jury member 1 or both occupying x.
- e is not the sum, for every seat x, of an event of jury member 2 occupying x.
- e is not the sum, for every seat x, of an event of jury member 1 occupying x.
- e is not the sum, for every seat x, of an event of jury member 2 and Joana occupying x.

Exhaustive participation inference can similarly be derived for the yarn example in (97a).

Here, the relevant negatable alternatives are alternatives where the yarn is replaced by appropriate bits of yarn. Here too, the equivalent of super-group alternatives (alternatives replacing *the yarn* with *the yarn and the silk*) are not negatable. The overlap alternatives (*yarn bit 1 and the silk*) and the sub-atomic alternatives (*yarn bit 1*) are all negatable.

Similarly to above, negating these alternatives ensures that in the events described, all bits of yarn contributed to the making of the sweaters, which is the desired exhaustive participation inference.

(97) a. The ball of yarn made every one of the sweaters.

b. $\textsc{Exh}\Big((\iota\mathsf{sweaters}, e) \in {}^{*}\Big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset \iota\mathsf{yarn}, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\Big)\Big)$

Alternatives:

$(\iota\mathsf{sweaters}, e) \in {}^{*}\Big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset X, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\Big)$

Negatable alternatives:

$(\iota\mathsf{sweaters}, e) \in {}^{*}\Big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset X, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\Big)$

where X overlaps $\iota\mathsf{yarn}$

c. $\exists e \quad \Big((\iota\mathsf{sweaters}, e) \in {}^*\big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset \iota\mathsf{yarn}, \exists y' \sqsubset y, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\big)\Big)$
$\wedge\neg\Big((\iota\mathsf{sweaters}, e) \in {}^*\big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset \mathsf{yarn\text{-}bit\text{-}1}, \exists y' \sqsubset y, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\big)\Big)$
$\wedge\neg\Big((\iota\mathsf{sweaters}, e) \in {}^*\big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset \mathsf{yarn\text{-}bit\text{-}2}, \exists y' \sqsubset y, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\big)\Big)$
$\wedge\neg\Big((\iota\mathsf{sweaters}, e) \in {}^*\big(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \exists X' \sqsubset \mathsf{yarn\text{-}bit\text{-}2} + \mathsf{silk}, \exists y' \sqsubset y, \mathsf{made}^{\mathsf{ag+th}}(X')(y)(e')\big)$
$\ldots$

d. There is an event *e* s.t.:
- *e* is the sum, for every seat *x*, of an event of some bits of the yarn making *x*.
- *e* is not the sum, for every sweater *x*, of an event of yarn bit 1 making *x*.
- *e* is not the sum, for every sweater *x*, of an event of yarn bit 2 making *x*.
- *e* is not the sum, for every sweater *x*, of an event of yarn bit 2 and the silk making *x*.

In summary, the same strategy of strengthening adopted for the cumulative readings of *every* containing pluralities extend to the group and material part case. This concludes the various examples of cumulative readings of *every* from chapter 3.

4.3.2 Ordinary cumulative readings

Having studied the various cases of cumulative readings of *every*, we now turn to ordinary cumulative sentences, like (98).

(98) a. The squirrels cracked the nuts.

b. The squirrels didn't crack the nuts.

To start with these cases, let us consider the weak meaning of *crack*. As already discussed in 4.3.1, the mereology of *crack* events makes the weak meaning of *crack* in (99a) reducible to (99b).

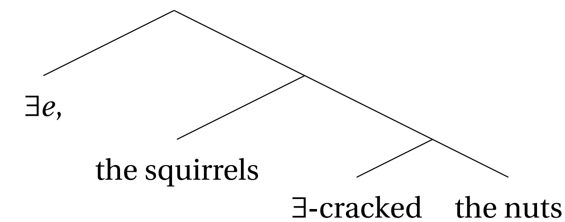
(99) a. $[\![\exists\text{-crack}]\!] = \lambda X.\lambda Y.\lambda e.\ \mathsf{crack}(e) \wedge e \lhd \lambda e'.\mathsf{crack}(X)(Y)(e')$

b. $[\![\exists\text{-crack}]\!] = \lambda X.\lambda Y.\lambda e.\ \exists X' \prec X, \exists Y' \prec Y,\ \mathsf{crack}(X')(Y')(e)$

$\lambda X.\lambda Y.\lambda e.$ e is cracking of some of Y by some of X

Concretely, this means that the truth-conditions of the structure in (100a) prior to any strengthening are as in (100b): they assert that some of the squirrels cracked some of the nuts.

(100) a.



b. $[\![(100\text{a})]\!] = \exists e, X' \prec \iota\mathsf{nuts}, \exists Y' \prec \iota\mathsf{squirrels}, \mathsf{crack}(X')(Y')(e)$

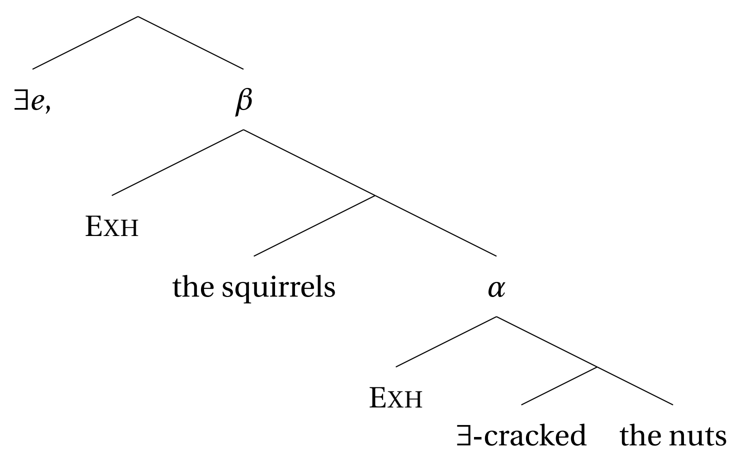
e is a cracking of some of the nuts by some of the squirrels

These truth-conditions explain the truth-conditions of negative cumulative sentences.

(101) The squirrels didn't crack the nuts.

In positive sentences, there are two elements which bear alternatives. This entails that there is more than one position - in fact two - where EXH can meaningfully be applied in the event domain.

(102)



With two EXH, the computation will be arduous but it follows the same general lines as the analysis presented in chapter 2. Starting with the node labelled α, we strengthen the verb phrase through competition with alternatives obtained by replacing the nuts with pluralities (sub-plurality, super-pluralities and overlap pluralities). The prejacent assert that the event under description is an event of cracking of some of the nuts by some of Y (where Y is abstracted over). The alternatives state that the event under description is an event of cracking of some of X by some of Y, with X an alternative plurality. If X contains the nuts, negating the alternative corresponding to X would trigger a contradiction, just as we saw in the case of cumulative readings of *every*. Negating the overlap and sub-plurality creates no contradiction. To see this, it suffice to point out an event which would be true of the prejacent and false of these alternatives. Any event where the nuts were exhaustively cracked meets this description: if an event is an event of cracking of the nuts by some of Y, then it is not an event of cracking of some of X by some of Y, for any X strictly contained in the nuts or overlapping with the nuts. Reciprocally, any event where the nuts were not exhaustively cracked will be true of at least one of these alternatives: if n is the nut not cracked in the event, it suffice to take the alternatives where X denotes "*the nuts that are not "n"*".

(103) a. **Prejacent:**

$\lambda Y.\lambda e.\, \exists X' \prec \iota\mathsf{nuts}, \exists Y' \prec Y,\, \mathsf{crack}(X')(Y')(e)$

b. **Alternatives:**

$\lambda Y.\lambda e.\, \exists X' \prec \mathsf{nut}_1 + \mathsf{nut}_2, \exists Y' \prec Y,\, \mathsf{crack}(X')(Y')(e)$ (sub-plurality)

$\lambda Y.\lambda e.\, \exists X' \prec \mathsf{nut}_1 + \mathsf{cypher}_1, \exists Y' \prec Y,\, \mathsf{crack}(X')(Y')(e)$ (overlap)

$\lambda Y.\lambda e.\, \exists X' \prec \iota\mathsf{nuts} + \mathsf{cypher}_1, \exists Y' \prec Y,\, \mathsf{crack}(X')(Y')(e)$ (super-plurality)

c. **Strengthened meaning:**

$$\begin{aligned} \lambda Y.\lambda e.\quad & \exists X' \prec \mathsf{nut}_1 + \mathsf{nut}_2, \exists Y' \prec Y,\, \mathsf{crack}(X')(Y')(e) \\ & \wedge \forall X \not\succ \iota\mathsf{nuts},\, \neg\exists X' \prec X, \exists Y' \prec Y,\, \mathsf{crack}(X')(Y')(e) \end{aligned}$$
$$= \lambda Y.\lambda e.\, \exists Y' \prec Y,\, \mathsf{crack}(\iota\mathsf{nuts})(Y')(e)$$

Just as in chapter 2, the first EXH is responsible for creating the exhaustive participation inference associated with the object.

The second EXH will bring about the subject's exhaustive participation inferences. To see this, let's look at constituent β and the second EXH operator that heads it. Although both plurals are in scope of this second EXH operator, I will for simplicity start by assuming that only the alternatives to the subject are visible to this second EXH.

The prejacent to this EXH operator asserts that the event under description is a cracking of all the nuts by some of the squirrels (taking into account the earlier result concerning the lower EXH operator). Its alternatives state that the event under description is an event of cracking of all of the nuts by some of X, where X either overlaps, contains or is contained in the squirrels (cf (104b)). Just as above, it is not possible to negate the super-plurality alternatives: any event of cracking all the nuts by some of the squirrels is automatically an event of cracking all the nuts by some of X, for any X that contains the squirrels. Just as above, it is possible to negate all the sub-pluralities and overlapping pluralities without incurring contradictions: the events that remain after operating this negation are those where all the squirrels took part in the cracking.

(104) a. **Prejacent:**

$\lambda e.\, \exists Y' \prec \iota\mathsf{squirrels}, \exists Y' \prec Y,\ \mathsf{crack}^{\mathsf{ag+th}}(\iota\mathsf{nuts})(Y')(e)$

b. **Alternatives:**

$\lambda e.\, \exists Y' \prec \mathsf{Scrat} + \mathsf{Acorn},\ \mathsf{crack}^{\mathsf{ag+th}}(\iota\mathsf{nuts})(Y')(e)$ (sub-plurality)

$\lambda e.\, \exists Y' \prec \mathsf{Scrat} + \mathsf{Felix\text{-}the\text{-}cat},\ \mathsf{crack}^{\mathsf{ag+th}}(\iota\mathsf{nuts})(Y')(e)$ (overlap)

$\lambda e.\, \exists Y' \prec \iota\mathsf{nuts} + \mathsf{Felix\text{-}the\text{-}cat},\ \mathsf{crack}^{\mathsf{ag+th}}(\iota\mathsf{nuts})(Y')(e)$ (super-plurality)

c. **Strengthened meaning:**

$$\begin{aligned} \lambda e.\quad & \exists Y' \prec \iota\mathsf{squirrels},\ \mathsf{crack}^{\mathsf{ag+th}}(\iota\mathsf{nuts})(Y')(e) \\ & \wedge \forall Y \not\succ \iota\mathsf{squirrels},\ \neg\exists Y' \prec Y,\ \mathsf{crack}^{\mathsf{ag+th}}(\iota\mathsf{nuts})(Y')(e) \end{aligned}$$
$$= \lambda e.\, \mathsf{crack}(\iota\mathsf{nuts})(\iota\mathsf{squirrels})(e)$$

This correctly predicts the subject's exhaustive participation inference: all squirrels took part in some nut-cracking. This is the correct result.

As anticipated, this derivation disregards the fact that there are in fact more alternatives, if we consider that *the nuts* is also in the scope of the the higher EXH. The missing alternatives are of the form: e is an event of cracking of all the Y's by some of X, where Y is something else than *the nuts*. However, these alternatives contribute nothing more: since the prejacent already asserts that e is an event of cracking all the nuts, it cannot also be an event of cracking all the Y. In short, the prejacent already entails the negation of the missing alternatives. Nothing is gained or lost by negating them.

4.4 More quantifiers

The core data points were covered in the last section. This section focuses on extending the account to cumulative readings of quantifiers beyond *every*.

4.4.1 The case of non-partitive *most*

Let us start with the case of non-partitive *most* As for *every*, the first point of order to deal with *most* or other quantifiers is to give an event denotation to that quantifier. The denotation must adequately capture the truth-conditions of simple sentences like (105). It must also account for the fact already mentioned in chapter 1, that non-partitive *most* typically yields distributive readings[7].

(105) Most children smiled.

The event semantics I propose is inspired by the event semantics given for *every*. Like *every*, *most* collects pairs of sleeping children and the sleeping event that they are in. Among this set, it picks those events which pair some event sum with a majority of children.

(106) $[\![\text{most}]\!]([\![\text{NP}]\!]) = \lambda p_{evt}.\lambda e.\ \exists X \in [\![\text{NP}]\!], |X| > \frac{1}{2}\left|\iota[\![\text{NP}]\!]\right| \wedge p^*_{\text{AT}}(X)(e)$ where $p^*_{\text{AT}} = \left\{(x,e) \,\middle|\, \mathsf{Atom}(x) \wedge p(x)(e)\right\}$

This denotation gives the right truth-condition, cf derivation in (107). This derivation is made easier by the observation (in (107c)) that since *most* quantifies over atoms, no homogeneity arises from *smiled*: as discussed in section 4.1, I assume that events of sleeping by atomic individuals don't have parts. The denotation yields the right truth-conditions ; there can only be a pair with a majority of children as its first component and their smilings as a second component if a majority of children smiled.

[7] As seen there, it is somewhat of a simplification.

(107) a. Most children smiled

b. $\exists e$ most children $\exists$-smiled

c. $$\begin{aligned} \mathsf{smile}^{*}_{\text{AT}} &= {}^{*}\left\{(x,e) \mid \mathsf{Atom}(x) \wedge [\![\exists\text{-smile}]\!](x)(e)\right\} \\ &= {}^{*}\left\{(x,e) \mid \mathsf{Atom}(x) \wedge \mathsf{smile}(e) \wedge e \lhd \lambda e'.\mathsf{smile}^{\mathsf{ag}}(e')(x)\right\} \\ &= {}^{*}\left\{(x,e) \mid \mathsf{Atom}(x) \wedge \exists x' < x, \mathsf{smile}^{\mathsf{ag}}(e')(x)\right\} && \text{(mereology of } \textit{smile}\text{)} \\ &= {}^{*}\left\{(x,e) \mid \mathsf{Atom}(x) \wedge \mathsf{smile}^{\mathsf{ag}}(e')(x)\right\} && (x \text{ is an atom}) \end{aligned}$$

d. $$\begin{aligned} [\![\text{most children smiled}]\!] &= \exists e, \exists X \in [\![\text{children}]\!], |X| > \tfrac{1}{2}\left|\iota[\![\text{children}]\!]\right| \wedge [\![\exists\text{-smile}]\!]^{*}_{\text{AT}}(X)(e) \\ &= \exists e, \exists X \in [\![\text{children}]\!], |X| > \tfrac{1}{2}\left|\iota[\![\text{children}]\!]\right| \wedge \mathsf{smile}(X)(e) \end{aligned}$$

Weak meanings. With this semantics in place, let us turn to a cumulative sentence. The sentence duet investigated is (108).

(108) a. The squirrels cracked most nuts.

b. The squirrels didn't crack most nuts.

I start by discussing the underlying meaning of (109a) before exhaustification has taken place. As seen in section 4.2, the weak meaning of *crack*, written in its general form in (109a), simplifies to (109b) with the assumed mereology of *cracking* events.

(109) a. $[\![\lhd\text{-cracked}]\!] = \lambda x.\lambda y.\lambda e.\ \mathsf{crack}(e) \wedge e \lhd \lambda e'.\mathsf{cracked}^{\mathsf{ag+th}}(x)(y)(e')$

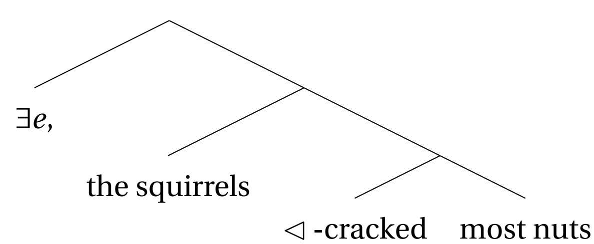
b. $[\![\lhd\text{-cracked}]\!] = \lambda X.\lambda y.\lambda e.\ \exists X' < X,\ \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e')$

$\lambda X.\lambda y.\lambda e.$ e is an event of cracking y by some of X

Reminded of the equivalence in (109), we now turn to composing (110a) without assuming any form of exhaustification is taking place. The derivation is given in (110c).

(110) a. The squirrels cracked most nuts.

b.



c. $[\![\lhd\text{-cracked}]\!] = \lambda X.\lambda y.\lambda e.\ \exists X' \prec X,\ \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e)$

$\lambda X.\lambda y.\lambda e.$ e is an event of cracking y by some of X

$[\![\lhd\text{-cracked most nuts}]\!] = \lambda X.\lambda e.\exists Y \in [\![\text{nuts}]\!], |Y| > \frac{1}{2}\left|\iota [\![\text{nuts}]\!]\right|$
$\wedge (Y,e) \in {}^{*}\left(\lambda y.\lambda e.\ \exists X' \prec X,\ \mathsf{Atom}(y) \wedge \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e)\right)$

$\lambda X.\lambda e.$ e is a sum containing for most nuts y, an event of cracking y by some of X

$[\![\text{the squirrels } \lhd\text{-cracked most nuts}]\!] = \lambda e.\exists Y \in [\![\text{nuts}]\!], |Y| > \frac{1}{2}\left|\iota [\![\text{nuts}]\!]\right|$
$\wedge (Y,e) \in {}^{*}\left(\lambda y.\lambda e.\ \exists X' \prec \iota\mathsf{squirrels},\ \mathsf{Atom}(y) \wedge \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e)\right)$

$\lambda e.$ e is a sum containing for most nuts y, an event of cracking of y by some of the squirrels.

$[\![\exists e, \text{the squirrels } \lhd\text{-cracked most nuts}]\!] = \lambda e.\exists Y \in [\![\text{nuts}]\!], |Y| > \frac{1}{2}\left|\iota [\![\text{nuts}]\!]\right|$
$\wedge (Y,e) \in {}^{*}\left(\lambda y.\lambda e.\ \exists X' \prec \iota\mathsf{squirrels},\ \mathsf{Atom}(y) \wedge \mathsf{cracked}^{\mathsf{ag+th}}(X')(y)(e)\right)$

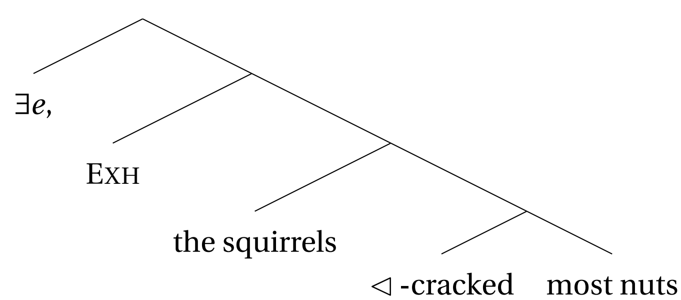
There is an event e which is a sum containing for most nuts y, an event of cracking of y by some of the squirrels.

In a nutshell, the resulting truth-conditions assert that most nuts were cracked by some of the squirrels. As desired, these truth-conditions do not convey the exhaustive participation inferences. They are adequate to capture the meaning of (111).

(111) The squirrels didn't crack most nuts.

In positive sentences, exhaustive participation inference are obtained the same way as with cumulative sentences with *every*: through simple exhaustification in the event domain.

(112)



As before, we can divide the alternatives to the squirrels in three categories: the super-plurality alternatives (e.g. *the squirrels and the beavers*), the overlap alternatives (e.g. *the red squirrels and the beavers*), the sub-plurality alternatives (e.g. *the red squirrels*).

The conclusion will be the same as with *every*: all alternatives but the super-plurality alternatives can be negated without contradiction.

To see this, consider that the prejacent describes a certain set of events: events where most of the nuts were cracked by some of the squirrels. Any events in that set will necessarily be events where most of the squirrels were cracked by some of the squirrels and the beavers, precisely the type of event described by the super-plurality alternative obtained by replacing *the squirrels*. Generalizing, all super-plurality alternatives will not be negatable.

On the other hand, all the other alternatives can be consistently negated with the prejacent. To show this, it is sufficient to show that in some possible world, there are some events in the denotation of the prejacent that do not belong to any of the sub-plurality and overlap alternatives ; this ensures that negating these alternatives will not create a contradiction.

Consider events where most of the nuts cracked by some of the squirrels and all squirrels participated in the cracking of at least one nut. In other words, events involving exhaustive participation of the squirrels. Such events cannot be true of sub-plurality and overlap alternatives, because the latter are true of events where most of the nuts were cracked by some of X, where X does not include all the squirrels.

This ensures that the prejacent is consistent with the negation of these alternatives and that events that involve exhaustive participation of the squirrels will be part of the strengthened meaning. The meaning obtained via exhaustification will in fact only contain such events: if an event e involved less than all the squirrels as its participants (e.g. Scrat wasn't part of any nutcracking in that event), it would be in the denotation of one of the sub-plurality alternatives (i.e. the sub-plurality alternative that replaces *the squirrels* with *the squirrels minus Scrat*).

In a nutshell, with *most* as well, a simple exhaustification will create the inference that all squirrels took part in cracking a nut. This is the desired exhaustive participation inference.

4.5 Consequences for distributive implicatures

In this chapter, the mechanism used for generating exhaustive participation inferences looks very different from the recursive exhaustification mechanism presented in chapter 2. Here, we only made use of one round of exhaustification, performed in the event domain.

The recursive exhaustification mechanism presented in chapter 2 was inspired from a mechanism for distributive implicatures ; this mechanism *prima facie* appears *ad hoc*, suited for one purpose only: deriving the exhaustive participation inference.

In this section, I show that in fact, this mechanism can also be used to derive distributive implicatures. In short, we have lost nothing of the initial parallel between exhaustive participation inferences and distributive implicatures by switching to this event-based account. Before I present how to adapt the strengthening mechanism to distributive implicatures, I want to offer how such an account may naturally be motivated.

Recall that distributive implicatures are the implicatures obtained when a disjunction is embedded in the scope of a quantifier. Sentences of this sort yield an inference that some ambassador speaks English, some ambassador speaks Arabic, some ambassador speaks Mandarin.

(113) Every ambassador speaks English, Arabic or Mandarin.
$\rightsquigarrow$ *some ambassador speaks English.*
$\rightsquigarrow$ *some ambassador speaks Arabic.*
$\rightsquigarrow$ *some ambassador speaks Mandarin.*

These inferences can be understood as a certain strive for parsimony. If indeed, no ambassador spoke English, then the following alternative sentence would seem to be both more parsimonious and more informative:

(114) Every ambassador speaks Arabic or Mandarin.

This intuition may be spelled out in a Gricean framework or in the grammatical tradition I have been following. Either way, deriving distributive implicatures by simply negating the sentence in (115) gives too strong a result. As Crnič et al. (2015) noted, and as we discussed in chapter 2, the inference obtained by this procedure is stronger than the attested inference : it predicts that there are monolingual English speakers, monolingual Arabic speakers, etc.

(115) Every ambassador speaks English, Arabic or Mandarin.
$\not\rightsquigarrow$ *some ambassador <u>only</u> speaks English.*
$\not\rightsquigarrow$ *some ambassador <u>only</u> speaks Arabic.*
$\not\rightsquigarrow$ *some ambassador <u>only</u> speaks Mandarin.*

One takeaway from this discussion is that there is more to parsimony than simply saying that that (116a) cannot be uttered whenever the more parsimonious and more informative (116b) can.

(116) a. Every ambassador speaks English, Arabic or Mandarin.

b. Every ambassador speaks Arabic or Mandarin.

Thankfully, there is a way to look at the puzzle that allows us to preserve the intuition that distributive implicatures are indeed derived from a competition between (117a) and (117b). To do so, we must pay attention to the pieces of information would be needed to show (117a) and (117b) to be true. I can show (117a) to be true by giving for each ambassador a language that she speaks among English, Arabic and Mandarin. Similarly, (116b) can be shown to be true by pointing for each ambassador, which language, of Arabic and English, she speaks.

Consider the case where no ambassador speaks Mandarin but every one is fluent in English or Arabic. In this world, both (116a) and (116b) can be truthfully be uttered (even though speakers prefer to utter (116b)). But this world has another important property: the pieces of information that can be used to show that (117a) and (117b) are true are the same. Namely, I would need to show for each ambassador, that she speaks either English or Arabic, since no ambassadors speaks Mandarin.

In case all ambassadors are bilingual in two out of the three languages and every language is spoken by at least one ambassador, both (116a) and (116b) can be uttered and furthermore felicitous to utter given the implicatures. Yet, the two sentences are not verified by the same pieces of information: we can show (117a) to be true by showing, of the Mandarin-speaking ambassadors, that they speak Mandarin and by showing, of the English-speaking ambassadors, that they speak English. In the world considered, that covers all the ambassadors. But the same pieces of information cannot be used to show (116a) to be true.

In short, there is a contrast between the bilingual case, where only one of the two sentences can be uttered, and the no-Mandarin-speaker case, where both can be. The contrast lies at the level of what pieces of information make the sentence true. This suggests the following rough rule of interpretation: a sentence should not be used if one of its more informative alternatives can be used and that this alternative is verified by the same pieces of information.

To make this a viable account, the notion of "*pieces of information*" needs to be clarified. Sudo (2020)[8] implements his intuition in the framework of Dynamic Semantics. The pieces of information that make a sentence true are simply the assignment functions. As the parallels between event semantics and Dynamic Semantics unraveled in chapter 5 lead us to expect, an isomorphic solution exists in event semantics. Here, the pieces of information that make a sentence true are the events (the counterparts of the assignment functions). As it turns out, this solution is precisely the solution we used to derive exhaustive participation inferences.

Let us spell this out formally. In the event semantics used in this chapter, (116a) and (116b) would have the informal LF in (117a) and (117b) and the meanings in (118a) and (118b). For simplicity, I suppress talk of weak meanings and homogeneity.

(117) a. $\exists e$, every ambassador speaks English, Arabic or Mandarin.

b. $\exists e$, every ambassador speaks English or Arabic.

(118) a. $$\exists e, \big(\iota\mathsf{ambassadors}, e\big) \in {}^*(\lambda y.\lambda e.\ \mathsf{Atom}(y) \wedge \begin{pmatrix} \mathsf{speak}^{\mathsf{ag+th}}(y)(\mathsf{English})(e') \\ \vee\ \mathsf{speak}^{\mathsf{ag+th}}(y)(\mathsf{Arabic})(e') \\ \vee\ \mathsf{speak}^{\mathsf{ag+th}}(y)(\mathsf{Mandarin})(e') \end{pmatrix})$$

[8] Although he may not characterize his system the way I did.

b. $\exists e, (\iota\text{ambassadors}, e) \in {}^*(\lambda y.\lambda e.\ \text{Atom}(y) \wedge \begin{pmatrix} \text{speak}^{\text{ag+th}}(y)(\text{English})(e') \\ \vee\ \text{speak}^{\text{ag+th}}(y)(\text{Arabic})(e') \end{pmatrix})$

According to the truth-conditions given in (118a), the sentence in (118a) is made true by events which are sums, for every ambassador, of a speaking of one of the three languages by that ambassador. On the other hand, (119b) is true for events which are sums, for every ambassador, of a speaking of English or Arabic by that ambassador. The only worlds in which the two event predicates coincide are worlds in which no ambassador speaks Mandarin, which are precisely the worlds ruled out by one of the distributive implicatures.

We can exploit this logic to derive the distributive implicatures: an EXH operator is added within the event domain. This operator strengthens the event predicate denoted by the prejacent against the set of alternatives obtained by replacing the disjunction with smaller disjunctions.

(119) a. $\exists e$, EXH every ambassador speaks English, Arabic or Mandarin.

b. ⟦(119a)⟧ =

$\exists e$, ⟦every ambassador speaks English, Arabic or Mandarin⟧ (e)

$\wedge\neg$ ⟦every ambassador speaks English or Arabic⟧ (e)

$\wedge\neg$ ⟦every ambassador speaks Arabic or Mandarin⟧ (e)

$\wedge\neg$ ⟦every ambassador speaks English or Mandarin⟧ (e)

$\wedge\neg$ ⟦every ambassador speaks English⟧ (e)

$\wedge\neg$ ⟦every ambassador speaks Arabic⟧ (e)

$\wedge\neg$ ⟦every ambassador speaks Mandarin⟧ (e)

Here, all alternatives can be negated without creating contradictions. To see this, consider the truth-conditions obtained in (120): they assert the existence of an event which is a sum, for each ambassador, of an event of them speaking English, Arabic or Mandarin but not a sum, for each ambassador, of an event of speaking English or Mandarin, etc. These truth-conditions are not contradictory ; they are verified when the event described contains, for each language, an event of that ambassador speaking that language. In short, all languages must be spoken, the desired truth-conditions.

This form of exhaustification is faithful to the intuition provided above: a sentence should not be uttered if all the pieces of information (here, the events) that can be used to verify it also verify one of its alternatives.

Looping back to where we started, note that the mechanism (simple EXH within the event domain) used to spell out this intuition is nothing more than the mechanism used to derive exhaustive participation inferences in the cumulative cases. (120) illustrates the correspondance. The only difference is that while exhaustive participation inference used all alternatives, including super-plurality and overlap plurality alternatives, distributive implicatures only make use of alternatives formed by replacing the disjunction with smaller disjuncts. This difference is represented by the "..." ellipsis used in the chart in (120).

(120)

Prejacent:	Every ambassador speaks E, A or M.	S, W and A cracked every nut.
Alternatives:	Every ambassador speaks E or A.	S and W cracked every nut.
	Every ambassador speaks A or M.	S and A cracked every nut.
	Every ambassador speaks E or M.	W and A cracked every nut.
	Every ambassador speaks E.	S cracked every nut.
	Every ambassador speaks A.	W cracked every nut.
	Every ambassador speaks M.	A cracked every nut.
		...
LF:	$\exists e$, EXH every ambassador speaks E, A or M.	$\exists e$, EXH S, W and A $\exists$-cracked every nut.

In summary, the sketch above argues that the current account of exhaustive participation inferences is not *ad hoc*, explains distributive implicatures just as much as the account in terms of recursive exhaustification. Both procedures rest on the intuition that strengthening can apply at the level of "*pieces of information*" (here, events). It is left open in this work whether and how this idea can extend to other forms of implicatures.

4.6 Summary and conclusion

In this chapter, I have presented a unified analysis of homogeneity/cumulativity for plurals, groups and parts based on an event analysis. Following the schema laid down in chapter 1, I proposed a recipe for creating underlying weak meanings based on a modal notion of event parts, the *m*-part. In this system, the presence or absence of weak meanings are correlated with the richness of the mereological structure associated with the predicates.

The event-based analysis allows us to construct a more robust form of strengthening to derive the truth-conditions of positive sentences. This strengthening is based on a single exhaustification in the event domain. No restrictions on the set of alternatives are necessary.

Chapters 6 and 7 all explore consequences, desirable and undesirable, of the analysis. In chapter 6, I show that the homogeneity properties of collective predicates can in part be predicted from their characteristic entailments. In chapter 7, I explore the question of whether the homogeneity properties of phrasal distributivity can be made to follow from the system presented in this chapter.

Chapter 5

Why events for cumulativity?

In the last chapter, I presented a theory of homogeneity and cumulativity in event semantics. This proposal is one of many proposals for cumulative readings and cumulative readings of quantifiers couched in this framework of event semantics(Bayer, 2013; Ferreira, 2005; Kratzer, 2003, 2007; Landman, 2000; Schein, 1993). In the sequel, I will try to distinguish my approach, relying on event parts, weak meanings and strengthening, from other proposals that rely on argument separation.

I will review these previous proposals and how they deal with the problem of cumulative readings in general and cumulative readings of *every* in particular.

The contrast will be illustrated by discussing the case of downward-entailing quantifiers. Both my approach and approaches built on argument separation make incorrect predictions on this case. However, the problem has a different source in each case. In my approach, the problem with downward-entailing quantifiers has to do with strengthening and has connections to similar problems with

The initial motivations behind the introduction of events (Davidson, 1967), i.e. the semantics of adjunction, do not make it obvious why events would have a role to play in cumulativity.

The first contribution of this chapter is to provide an answer to the following question: which assumptions, within the network of assumptions connected to Neo-Davidsonian event semantics, is critical to the analysis of cumulative readings? To answer that question, we will review Schein's argument (Schein, 1993) in light of an event-less semantics, the separated event-free semantics. This semantics shares the logical commitments of event semantics (i.e. the LF and conjunctive semantics it assumes) without its ontological commitments (i.e. that there are such things as events). Because the cumulative readings of *every* and other quantifiers can be analyzed using the separated event-free semantics, I conclude that the logic of argument separation associated with Neo-Davidsonian event semantics is more important to deriving these readings than the ontological commitment to events itself.

Specifically, I will show that the logic of argument separation is extremely similar to the logic of Dynamic Semantics (Dekker, 1993). The event accounts of cumulative readings of *every* found in Kratzer (2003) and Champollion (2016b) have striking formal parallels to the dynamic accounts of these readings in Brasoveanu (2013).

Exploiting these parallels between event semantics and dynamic semantics, the second contribution of this chapter is to construct a challenge to traditional event accounts of cumulativity. I will show that there is a strong incompatibility between 1) an account of cumulative readings in terms of Neo-Davidsonian argument separation, 2) a successful account of downward-entailing quantification. This challenge will directly mirror a similar challenge for the dynamic proposal of Brasoveanu (2013). Although downward-entailing quantification is known to be a thorny issue in event semantics Kratzer (2007); Krifka (1989), the problem is made considerably worse if one insists on an analysis of cumulativity based on Neo-Davidsonian argument separation.

The roadmap of this chapter is as follows. Before turning to event semantics, the focus of this chapter, I make a brief incursion into dynamic semantics, presenting Brasoveanu (2013) and one challenge to it, the counterpart of the challenge later shown to affect event semantics (section I). I then go over event semantics and Schein's argument that Neo-Davidsonian argument separation helps account for cumulative readings of *every*. I will show how this argument can be translated in the separated event-free semantics. Finally, in the last section, I take stock on the formal observation and construct the challenge for an event account of cumulative readings.

5.1 Evaluating the logical underpinnings of Neo-Davidsonian event semantics

Considering the initial motivations for event semantics (e.g. adverbial modification) does not make it obvious that the concept of events is useful in accounting for anything related to cumulativity. More or less vocally, the authors of the afore-mentioned works credit the success of the event approach on questions of cumulativity to what is referred to as *the Neo-Davidsonian assumption* or *argument separation* (I will use both terms interchangeably). This assumption represents a departure from the Davidsonian assumptions, the original set of assumptions of Davidson (1967).

Neo-Davidsonian semantics proposes that syntactic arguments of the verb are not genuine semantic arguments of it[1]. Rather, there are heads in the syntax - the thematic role heads - which mediate between the verb's meaning and its arguments' denotations. By contrast, the semantics of the previous chapter did not assume that thematic roles are entities in the syntax. A central characteristic of the resulting system is that Neo-Davidsonian logical paraphrases are, for the most part, conjunctive, as in (1b) and that each conjunct corresponds to a syntactic constituent.

(1) Joana ate the cake.

a. **Standard/Davidsonian:**
$\exists e, \mathsf{eat}(\mathsf{Joana})(\iota\mathsf{cake})(e)$

b. **Neo-Davidsonian:**
$\exists e, \mathsf{eat}(e) \wedge \mathsf{agent}(\mathsf{Joana}, e) \wedge \mathsf{theme}(\iota\mathsf{cake}, e)$

This section is the briefest introduction to Davidsonian and Neo-Davidsonian event semantics. I will first review some of the historical motivations for events and proceed to give some of the motivations for Neo-Davidsonian event semantics, a semantics in which verbal arguments combine with the verbal predicate indirectly, *via* thematic role heads. By the end of the section, we will have sufficient tools to grasp Schein's argument, which provides hard semantic evidence that the Neo-Davidsonian assumptions help with the account of cumulativity.

5.2 Argument separation for cumulative readings

5.2.1 Events

Kenny (1963) famously observed a pattern of entailments associated with verbal modification, which resembles the pattern of entailments associated with nominal modification. Just as (2c) entails (2a) and (2b), (3c) entails (3b) and (3a). Unlike (2) however, (3a) and (3b) together do not entail (3c) (for Caesar could have been stabbed multiple times).

(2) a. This is a woolly mammoth.

b. This is a gray mammoth.

c. This is a gray woolly mammoth.

(3) a. Brutus stabbed Caesar with a knife.

b. Brutus stabbed Caesar on a Monday.

c. Brutus stabbed Caesar with a knife on a Monday.

Davidson (1967) used this pattern of entailment to argue for a logical rendition of the truth-conditions of the sentences in (3) as (4). Even without specifying the nature of e, one can see that (4c) will entail the conjunction of (4a) and (4b) but not vice-versa, as desired.

(4) a. $\exists e, \mathsf{stab}(\mathsf{Brutus}, \mathsf{Caesar}, e) \wedge \mathsf{with\text{-}a\text{-}knife}(e)$

b. $\exists e, \mathsf{stab}(\mathsf{Brutus}, \mathsf{Caesar}, e) \wedge \mathsf{on\text{-}a\text{-}Monday}(e)$

c. $\exists e, \mathsf{stab}(\mathsf{Brutus}, \mathsf{Caesar}, e) \wedge \mathsf{with\text{-}a\text{-}knife}(e) \wedge \mathsf{on\text{-}a\text{-}Monday}(e)$

The logical rendition of these truth-conditions has two important features: an existentially bound argument e added to the main predicate *stab* and the separation of verbal modifiers into conjuncts, which are *separated* the main verb. It is worth noting that nothing in Kenny (1963)'s facts really establishes the nature of e, a fact noted in Landman (2000); Williams (2015). Following tradition, I call this argument e, the *event argument*.

5.2.2 Neo-Davidsonian semantics.

The separation of syntactic adjuncts in separate conjuncts at the level of truth-conditions can be extended to syntactic arguments, like the subject and the object. (Carlson, 1984; Parsons, 1990, inter alia) propose that we may additionally separate syntactic arguments of the verb at the level of truth-conditions.

(5) a. $\exists e, \mathsf{stab}(e) \wedge \mathsf{agent}(\mathsf{Brutus}, e) \wedge \mathsf{theme}(\mathsf{Caesar}, e) \wedge \mathsf{with\text{-}a\text{-}knife}(e)$

b. $\exists e, \mathsf{stab}(e) \wedge \mathsf{agent}(\mathsf{Brutus}, e) \wedge \mathsf{theme}(\mathsf{Caesar}, e) \wedge \mathsf{on\text{-}a\text{-}Monday}(e)$

c. $\exists e, \mathsf{stab}(e) \wedge \mathsf{agent}(\mathsf{Brutus}, e) \wedge \mathsf{theme}(\mathsf{Caesar}, e) \wedge \mathsf{with\text{-}a\text{-}knife}(e) \wedge \mathsf{on\text{-}a\text{-}Monday}(e)$

According to this view - the Neo-Davidsonian view, the main verb only contributes a predicate of events *stab*. The stabber and the stab-ee are specified by different predicates agent and theme[2], which relate these participants to *e*, the event argument. Some authors furthermore assumes that these predicates correspond to phonologically null syntactic heads, the *thematic role heads*, represented here in small caps as AGENTand THEME. It is this view of Neo-Davidsonian semantics that I will be discussing below.

Note that these new truth-conditions are entirely compatible with the entailment patterns of (3): (5c) entails both (5a) and (5b) while the conjunction of them does not entail (5c). While compatible, the entailment pattern does not provide an argument for the Neo-Davidsonian decomposition beyond the Davidsonian assumption. If the facts presented so far don't motivate it, what might then be the interest of the Neo-Davidsonian decomposition[3]? There are many motivations to be sure (see Williams (2015) for an overview). An important motivation might be conceptual: thematic roles are useful and allows us to express important generalizations across the lexicon about what syntactic positions arguments typically mean. A significant proportion of verbs - e.g. *eat*, *hit*, *carry*, etc - require their subject to be animate in some way, with some amount of volition ; under the Neo-Davidsonian view, this common meaning component to verbs is attributed to a common core concept, that of an agent (see Dowty (1991) for critical discussion of this approach and an alternative proposal). From here on, it is reasonable

[2] For now, no commitments are required as to whether events may have multiple agents or not ; the most general way to express this lack of commitment is to depict agent and theme as predicates.

(albeit not necessary) to turn this concept into a usable meta-language predicate such as agent.

A second motivation, more central to our concerns, is compositional (Schein, 1993). The Neo-Davidsonian view offers more scope possibilities than the standard view. Consider (6). In the Davidsonian view, a quantifier may either scope below or above the existential that binds the event argument: there are only two meaningful scope positions. In the Neo-Davidsonian view on the other hand, a quantifier may scope below the introduction of some of the verb's arguments.

(6) Brutus stabbed Caesar.

a. $\underset{\substack{\uparrow \\ Q}}{} \exists e, \underset{\substack{\uparrow \\ Q}}{} \mathsf{stab}(\mathsf{Brutus}, \mathsf{Caesar}, e)$

b. $\underset{\substack{\uparrow \\ Q}}{} \exists e, \underset{\substack{\uparrow \\ Q}}{} [\mathsf{agent}(\mathsf{Brutus}, e) \wedge [\underset{\substack{\uparrow \\ Q}}{} \mathsf{theme}(\mathsf{Caesar}, e) \wedge \underset{\substack{\uparrow \\ Q}}{} \mathsf{stab}(e)]]$

Is there a case where the additional scope possibilities yield unsuspected readings? Schein (1993) famously argued that such scope positions can help in the analysis of some cumulative sentences. I will now move on to review his argument.

5.2.3 Schein's argument

This section explores Schein (1993)'s influential argument for Neo-Davidsonian logical forms[4]. His argument aims to show that Neo-Davidsonian logical forms are necessary to make sense of the cumulative readings of certain sentences.

Schein's argument is described in chapter 4 of Schein (1993). His point of departure are readings of sentences like the video-game examples, as in (7a) or (7b). The sentences he considers in this chapter have a common structure which is critical to Schein's argument: they are basic clauses with three arguments ; the first two arguments (*the*

[3] There are other arguments for Neo-Davidsonian decomposition specifically, to be sure (cf Williams (2015) for a review). I am mostly interested in understanding whether and how Neo-Davidsonian assumptions can help the account of cumulativity so I will not discuss those.

[4] This argument has been reviewed in previous works as well (Kratzer, 2003; Landman, 2000; Zweig, 2008).

3 video-games and *every quarterback*) are read cumulatively, meaning that they can be paraphrased as the first line of (7b). The third argument (*two new plays*), on the other hand, is read distributively with respect to the second argument.

(7) a. The three video-games taught every quarterback two new plays.

b. **Truth-conditions:**

The video-games taught the quarterbacks (=*cumulative*)

Every quarterback learned two plays (from some of the video-games). (=*distributive*)

Schein does not comment on the peculiar presence of a morphologically singular quantifier in (7) in his sentence, even though, as we saw in chapter 1, this is particularly puzzling from a traditional perspective on cumulativity (e.g. Scha (1984)). All that seems to matter for his argument is that the cumulative-distributive structure exhibited by (7), which he repeats in sentences that do not contain *every*:

(8) a. The three automatic tellers gave the two new members exactly two passwords.

b. **Truth-conditions:**

The tellers gave the members something. (=*cumulative*)

Each member received exactly two passwords (from the tellers). (=*distributive*)

(9) a. Three letters of recommendation from influential figures earned the two new graduates (each) two offers.

b. **Truth-conditions:**

The letters of recommendation earned the graduates something (=*cumulative*)

Every graduate earned two offers (from the recommendation letters). (=*distributive*)

Schein (1993)'s goal in chapter 4 is to demonstrate that the truth-conditions of these sentences may not be accounted for by a Davidsonian logical paraphrase, be they simple ones like (10a) or more refined logical paraphrases with different assumptions about quantification. These examples, he claims, truly require the use of a Neo-Davidsonian logical paraphrase. Schein (1993) provisionally gives an example (given in (10b)) of what such a Neo-Davidsonian logical paraphrase of these sentences would look like but this logical paraphrases is amended in subsequent chapters (we will return to this below).

(10) a. **Davidsonian:**

$\forall qb \in \mathsf{quarterback}, \exists p \in \text{plays}, |p| = 2 \wedge \exists e,\ \mathsf{teach}(\iota\text{video-games}, qb, p, e)$

b. **Neo-Davidsonian:**

$\exists e, \mathsf{agent}(\iota\text{video-games}, e) \wedge \forall qb \in \mathsf{quarterback},$

$\exists p \in \text{plays}, |p| = 2 \wedge \exists e' \prec e,\ \mathsf{teach}(e') \wedge \textsc{Goal}(qb, e') \wedge \mathsf{theme}(p, e')$

The simple Davidsonian rendition of video-game example proposed in (10a) is indeed inadequate. If Rebecca is one of the quarterbacks, then (10a) is predicted to entail (11a). (11a) being the logical paraphrase of (11b), this means that the video-game example should entail (11b), when it doesn't.

(11) a. $\forall qb \in \mathsf{quarterback}, \exists p \in \text{plays}, |p| = 2 \wedge \exists e,\ \mathsf{teach}(\iota\text{video-games}, \text{Rebecca}, p, e)$

b. The three video-games taught Rebecca two new plays.

The Davidsonian paraphrase we just considered is but one of the variations on the Davidsonian LF that Schein analyses. He considers (at least) three types of variations: variations where the existential quantifier over events takes a higher scope than the event variable, variations on what the denotation of *teach* is, and the possibility that *the three video-games* and *every quarterback* form a binary quantifier.

I will not review these variations in full. Suffice it to say that (almost[5]) all variations fail to deliver the expected reading. Giving anything but the lowest scope to the existential quantifier over events typically lead to van Benthem-like problems (Champollion, 2014a), as Schein observes. The variations considered on the meaning on *teach* fail to represent the correct meaning of the sentence.

[5] The binary quantifier option that Schein considers is successful on the video-game example. With a modern outlook, we can recognize in Schein's binary quantifier a cover-based double-star operator (Beck

Why does Neo-Davidsonian semantics fare better? Having mourned the failure of the Davidsonian semantics, we now want to turn to the Neo-Davidsonian logical paraphrase that Schein offers as a meaning of the sentence.The logical paraphrase features two changes from the Davidsonian logical paraphrase considered inadequate. First and foremost, the Neo-Davidsonian separation of syntactic arguments into separate conjuncts. Second, the introduction of an event quantifier over event parts ($\exists e' \prec e$).

(14) $\exists e, \mathsf{agent}(\iota\text{video-games}, e) \wedge \forall qb \in \mathsf{quarterback},$
$\exists p \in \text{plays}, |p| = 2 \wedge \exists e' \prec e,\ \mathsf{teach}(e') \wedge \textsc{Goal}(qb, e') \wedge \mathsf{theme}(p, e')$

Both modifications are important to deliver substantially different truth-conditions. For consider what would happen if (a) the Neo-Davidsonian logical paraphrase didn't contain an existential over parts of events, or if (b) the logical paraphrase remained Davidsonian but a quantifier over event parts were added. These two options are sketched in

and Sauerland, 2000) (cf chapter 9), where the cover of the quarterbacks only includes atoms. Interestingly, this proposal is extremely similar to Champollion (2010)'s proposal for Schein (1993)'s examples, talk of binary quantifiers notwithstanding. Schein's rejection of this analysis comes from the more complex example in (12a). This example is like *the video-game* with an additional adjunct *on a pink slip of paper*.

(12) a. Three automatic tellers gave the two new members exactly two passwords on a pink slip of paper.

b. **Reading:**
Every member was given exactly two passwords by any of the ATMs
Every member was given the passwords on a pink slip of paper
Every ATM give a member at least one password

However, there is something suspicious in Schein's new example, since the reading obtained does not fit the template of cumulative readings of chapter 2. To see this clearly, we can simplify the sentence to (13):

(13) a. I gave you exactly two passwords on a pink slip of paper.

b. **Reading:**
I gave you exactly two passwords.
You were given the passwords on a pink slip of paper.

While attested, this "*fully separated*" reading is specific to adjuncts, as Schein notes later in chapter 7 (Schein, 1993). Since both the Davidsonian and the Neo-Davidsonian recognize the separation of adjuncts from main predicates, the presence of this reading is as expected on the Davidsonian view as it is on the Neo-Davidsonian view. If my reading of Schein (1993) is correct, I am thus inclined to say that this argument has not in fact shown that the Davidsonian logical form could not represent the attested truth-conditions.

(15).

(15) a. **Neo-Davidsonian without existential over parts:**

$\exists e, \text{agent}(\iota\text{video-games}, e) \wedge \forall qb \in \text{quarterback},$
$\exists p \in \text{plays}, |p| = 2 \wedge \text{ teach}(e) \wedge \text{GOAL}(qb, e) \wedge \text{theme}(p, e)$

b. **Davidsonian with existential over parts:**

$\exists e, \forall qb \in \text{quarterback}, \exists p \in \text{plays}, |p| = 2 \wedge \exists e' \prec e, \text{ teach}(e', \iota\text{videogames}, qb, p)$

In the case of (15a), the separation of the agent thematic role is immaterial. By the rules of first-order logic, the logical paraphrase is equivalent to (16a). In (16a), the verb is next to its thematic role head and the difference between it and its Davidsonian counterpart seems simply notational. If the latter fails to represent the truth-conditions of the video-game example, as Schein argues, so will (16a).

(16) a. $\exists e, \forall qb \in \text{quarterback},$
$\exists p \in \text{plays}, |p| = 2 \wedge \underline{\text{agent}(\iota\text{video-games}, e) \wedge \text{teach}(e) \wedge \text{GOAL}(qb, e) \wedge \text{theme}(p, e)}$

b. $\exists e, \forall qb \in \text{quarterback},$
$\exists p \in \text{plays}, |p| = 2 \wedge \underline{\text{teach}(e, \iota\text{video-games}, qb, p)}$

Similarly, using quantification over parts of events does not seem to get the Davidsonian logical paraphrase out of trouble. In fact, quantification over parts of events is vacuous here: since nothing is said about e, beyond its containing all the e' events, we can simply take e to be the sum of all events that there are. The contribution $e' \prec e$ is vacuous and it can be removed from the logical paraphrase.

(17) **Davidsonian with existential over parts:**

$\cancel{\exists e}, \forall qb \in \text{quarterback}, \exists p \in \text{plays}, |p| = 2 \wedge \exists e' \cancel{\prec e}, \text{ teach}(e', \iota\text{videogames}, qb, p)$

The conclusion reached at this stage is that it is not the Neo-Davidsonian assumptions alone that deliver the attested cumulative reading. Extra assumptions are needed ; here, the extra assumption is an existential over event (extensional) parts. This parasitic existential over parts is reminiscent of the existentials assumed in chapter 2 or the event

m-part operators of chapter 4, although the latter has more specific uses in understanding the homogeneity properties of cumulative sentences.

5.2.4 Summary

In this section, I have briefly reviewed some motivation for the introduction of events in the semantics. The assumptions that thematic roles are represented by heads in the syntax did not follow immediately from these original assumptions. I have presented Schein's argument that the use of thematic role heads is useful and in fact necessary to represent the truth-conditions of cumulative readings of quantifiers like *every*. This argument is influential ; following its conclusions, a number of analyses of cumulativity, which I will review, exploit argument separation in event semantics to generate cumulative readings. In the sequel, I will refer to all such analyses which rely on argument separation as separated analyses.

5.3 Exhaustivity inferences in event semantics

5.3.1 The problem of leaks and exhaustive participation inferences

As noted earlier, Schein's paraphrase of the truth-conditions were labeled as "*provisional*". With an eye to the generalizations unraveled in chapter 1, the inadequacy of these truth-conditions (repeated in (18)) is clear: they do not imply the exhaustive participation inference that all the video-games taught something.

(18) $\exists e, \mathsf{agent}(\iota \text{video-games}, e) \wedge \forall qb \in \mathsf{quarterback},$
$\exists p \in \text{plays}, |p| = 2 \wedge \exists e' \prec e,\ \mathsf{teach}(e') \wedge \textsc{Goal}(qb, e') \wedge \mathsf{theme}(p, e')$

The variety of separated analyses that there exist reflects in part the diversity of responses to this problem in the literature. Before we can compare separated analyses to the analysis presented in chapter 4, let us briefly review some main axes of reply to this problem.

Schein (1993)'s original solution, as detailed in chapter 9 of Schein (1993), is to rearrange the LF so that the sentence has roughly the same structure as the following logical paraphrase:

(19) $\exists e$ [the ten video games] λ_1 [some quarterbacks] λ_2 [some plays] λ_3 t_1 taught t_2 to t_3.
pro$_e$ [every quarterback] λ_2 [some plays] λ_3 t_2 was taught to t_3.
There is an event of the video-games teaching some quarterbacks some plays.
In that event e, every quarterback was taught two plays.

This logical paraphrase introduces an event existential in a first clause. This event is then recalled in the second clause using a mechanism *akin* to pronominal reference. Without needing to spell out the compositional details of the proposal, we can see that the first clause effectively spells out an exhaustive participation inference.

However, the drawback of this approach is the transformation needed to reach the correct LF. If one is disposed to accept LF transformations of this sort (determiner replacement, clause copying, etc.), then wouldn't one be equally disposed to accept transformations that simply convert cumulative sentences to the LF of their paraphrase? Since, as Chapter 1 has argued, the paraphrase can systematically be derived from the sentence itself, this transformation would be as systematic as that proposed by Schein (1993). The reference to events would become superfluous.

For this reason, I will not consider Schein (1993)'s proposal further. I will focus my attention on proposals that maintain relatively standard assumptions about LF (scoping via QR, in-scope binding of variables, etc): Kratzer (2003) and Champollion (2016b). These two works have very similar ideas on how to exploit argument separation to generate cumulative readings of *every*. I start by presenting the trailblazing Kratzer (2003). There is however a flaw in Kratzer (2003)'s theory which motivates us to consider Champollion (2016b). Because it is more adequate, I eventually use Champollion (2016b) as a representative example of how a separated can work.

5.3.2 Kratzer (2003): a first attempt at exhaustivity inferences

Kratzer (2003), reviewing Schein's argument, discusses several ways we can cash out the missing exhaustivity inferences. One of her proposals[6] is given below on the simple cumulative sentence with *every* that she considers:

(20) a. The three copy-editors caught every mistake.

b. $\exists e, \mathsf{agent}(\iota\text{copy-editors}, e) \wedge$
$\left(\forall m \in \mathsf{mistake}, \exists e' < e,\ \mathsf{catch}(e') \wedge \mathsf{theme}(m, e')\right) \wedge$
$\underline{\mathsf{catch}(e) \wedge \left\{x \mid \mathsf{theme}(x, e)\right\} \subset \mathsf{mistake}}$

The underlined part is the event representation of the exhaustivity inference ; it asserts that the big event *e* is a catching of mistakes. This makes it impossible for the big event *e* to contain copy-editors who did not catch any mistakes, since they are all asserted to be agents of an event of catching mistakes.

Kratzer's solution is very similar to the schema presented in chapter 1: her logical form decomposes the meaning of the cumulative sentence in an existential meaning, paraphrasable as *every mistake was caught by some copy-editor(s)* and an exhaustive participation inference inference paraphrasable as *the copy-editors caught mistakes* (underlined in (20)).

However, the compositional details differ. In Kratzer's proposal, the exhaustivity inference is a contribution of *every*. This description of the facts allows us to construct a challenge. Contrary to the analysis of chapter 2, the effect of exhaustivity is, in some sense, local, since it is hard-coded in the meaning of *every*. In the analysis of chapter 2, I proposed a generalization about exhaustivity inferences, stated as a wholesale replacement of all quantifiers with existentials. This difference in implementation must yield diagnosable differences in sentences involving multiple quantifiers, such as the video-game example. *Mutatis mutandis*, we obtain the following paraphrase of the video-game example using Kratzer's paraphrase:

[6]For pedagogical reasons, Kratzer discusses several unsuccessful options. In addition, she formulates an alternative in footnote 5, which is very close to Champollion (2016b) and seems to avoid the problem mentioned below.

(21) $\exists e, \text{agent}(\iota\text{video-games}, e) \wedge$

$(\forall qb \in \text{quarterback}, \exists e' < e,\ \text{teach}(e') \wedge \text{theme}(qb, e') \wedge \textsc{Goal}(\cdot, e') \subset \text{2-plays}) \wedge$

$\underline{\text{catch}(e) \wedge \text{theme}(\cdot, e) \subset \text{quarterback} \wedge \textsc{Goal}(\cdot, e) \subset \text{2-plays}}$

"*In an event of video-games teaching quarterbacks two plays, each quarterback was taught two plays*"

The problem here is that the exhaustivity inference (still underlined) asserts that the video-games taught some quarterbacks the same two plays overall. No variation of plays between quarterbacks is possible, but this is precisely the reading needed. In short, this account cannot be the correct account of exhaustive participation inferences. However, it turns out that alternative proposals can capture the right readings, while generating the exhaustivity inferences locally. Kratzer herself foreshadows these developments, as she mentions (fn. 5, chapter 2) an alternative proposal based on *-distributivity which bears resemblance to the account to be presented.

5.3.3 Champollion (2016b)

Champollion (2016b) and its companion Champollion (2016a) set out the ambitious project to give a uniform semantics to distributivity, within the framework of event semantics. Of interest to us is Champollion (2016b)'s account of the semantics of *every*, which improves on the problems pointed out for Kratzer's account above. He proposes the following denotation for *every*:

(22) $[\![\text{every quarterback}_{\textsc{Theme}}]\!]$

$= \lambda P_{vt}.\lambda e.\ \text{theme}(e, \bigoplus\text{quarterback}) \wedge e \in^{*} \left[\lambda e'.\ P(e') \wedge \forall x, \text{theme}(x, e') \rightarrow \text{Atom}(x)\right]$

Explained in simple terms, this meaning for *every* divides the event e under description into smaller events e' where the argument slot occupied by *every* (here, THEME) is atomic. It asserts that e is a sum of many such events.

This denotation has several features which differ from the paraphrases seen so far:

- the denotation of *every* is relativized to a thematic role (or equivalently, takes the thematic role head as its semantic argument)

- It partitions the big event e into smaller events e' by means of sums (and *) rather than existential quantifiers over parts

For illustration, and leaving compositional details aside, let us see this proposal at work on the video-game examples, which eluded Kratzer's earlier proposal.

(23) $\exists e, \mathsf{agent}(\iota\text{video-games}, e)$
$\wedge \mathsf{theme}(\bigoplus \mathsf{quarterback}, e)$
$\wedge e = {}^*\lambda e'. \left[\mathsf{teach}(e') \wedge \mathsf{theme}(\cdot, e') \subset \mathsf{Atom} \wedge \textsc{Goal}(\cdot, e') \subset \text{2-plays})\right]$
"*A teaching event e of video-games to quarterbacks can be decomposed into a sum of teaching events e′ where singularities are taught 2 plays.*"

Contrary to Kratzer (2003)'s proposal, these truth-conditions allow there to be two different plays for each quarterback. The resulting truth-conditions are adequate.

5.3.4 Summary

Schein (1993) proposed that cumulative readings of *every* are derived when *every* takes scope below the introduction of the agent. Compositionally, this situation can only arise if we accept that agents are "*separated*" in the syntax: if there is a head at LF which performs agent introduction. Yet, as we have seen, argument separation on its own is insufficient to explain cumulative readings of *every*; additional assumptions are required.

In this section, we have discussed the two analyses of Champollion (2016b); Kratzer (2003) which aim to spell out these additional assumptions. Both require giving quantifiers like *every* an event denotation. In Champollion (2016b)'s analysis, which avoids problems faced by Kratzer's, *every* is given a "*summative*" semantics: it gathers and adds the event described by its scope while imposing atomicity requirement on the thematic role it binds.

Abstracting away from the differences, all of these accounts rely on argument separation to derive the correct meaning. This strategy is sensibly different from the strategy adopted in chapters 2 and 4. Neither chapter relied on syntactically separated thematic role heads (although thematic roles are used to express the weak meaning of the verb in chapter 4) to derive the correct meaning. The truth-conditions were achieved by a combination of weak meanings and exhaustification. Does this difference amount to concrete differences in predictions and which ones?

There are obvious points of comparison between my approach and the event approach. The empirical scope of the separated analyses is narrower than that considered in this work. No mention is made of the homogeneity properties of these sentences in the separated analysis and they are not predicted. Likewise, the analysis presented in chapter 4 is meant to extend to all other singular quantifiers (including non-partitive *most* and Lebanese Arabic SAT numerals) but the separated analysis focus on the case of *every*. It is possible but not certain that the separated can extend to these cases as well.

In the next section, I will not dwell on these points of comparison. I will focus on a case which is reasonably within the empirical scope of both the analysis of this work and separated analyses: the case of cumulative sentences with downward-entailing quantifiers.

I will argue that there are problems with both types of analyses. However, the problems are of a different nature in each case. The analysis of chapter 4 predicts the correct unstrengthened truth-conditions. However, the mechanism for strengthening seems to over-apply and generates unattested implicatures.

The "*separated*" analyses, on the other hand, face a scope paradox. They cannot derive the attested truth-conditions under any scope assignment. The scope paradox follows directly from the assumption that quantifiers can scope below agent introduction. This suggests

5.4 Challenging cumulativity via argument separation

In this section, I consider the case of downward-entailing quantifiers in cumulative sentences as a comparison between the analysis of chapter 4 and separated analyses.

Downward-entailing quantifiers are interesting because, as Kratzer (2003) notes, *downward-entailing quantifiers are known to require special care in semantic frameworks based on* *events or situations*. Cumulativity aside, downward-entailing quantifiers can be integrated in event semantics in various ways (Bonomi and Casalegno, 1993; Champollion, 2014a; Krifka, 1992; Winter and Zwarts, 2011). When cumulativity is considered, new problems arise. But the problems are different, depending on whether cumulativity is analyzed as in the separated analyses or withing the theory of chapter 4.

Starting with the separated approach, I will first argue that there is fundamental incompatibility between a successful account of downward-entailing quantification and an account of cumulative readings of *every* in terms of argument separation, as Kratzer (2003) and Champollion (2016b) propose. More precisely, accommodating both types of account in event semantics creates conflicting scope requirements in sentences involves both cumulative readings of *every* and downward-entailing quantification, like (24).

(24) a. The video-games taught every quarterback less than 3 plays.

b. The video-games taught every quarterback none of the important plays.

On the one hand, the account of the cumulative reading of *every quarterback* demands that *every quarterback* take scope below agent introduction, as we have seen. On the other hand, successful accounts of downward-entailing quantifiers in event semantics requires them to take high scope over all thematic roles to avoid unattested readings. Since *every quarterback* must take scope above *less than 3 plays* in (24), a scope paradox arises.

In the approach based on weak reading and strengthening of chapter 4, the weak meanings predicted for sentences like (24) or the simpler (25) is exactly the attested truth-conditions. But the mechanism for strengthening predicts unattested implicatures.

(25) a. The squirrels cracked less than 3 nuts.

b. The squirrels cracked none of the chestnuts.

The roadmap is as follows: in section 5.4.1, I will review some ways that downward-entailing quantifiers may be integrated in event semantics. We will see that in virtually all accounts, downward-entailing quantifiers take high scope. In section 5.4.2, I will try to combine these analyses with the separated analysis of Champollion (2016b) and present the scope paradox that it gives rise to. In section 5.4.4, I will present the problem of strengthening for the analysis of chapter 4.

5.4.1 Downward-entailing quantification in event semantics

An old observation (Bäuerle, 1987; Higginbotham, 1985; Krifka, 1989) is that event semantics, both Davidsonian and Neo-Davidsonian, can generate overly weak meaning when downward-entailing quantifiers are allowed to scope under the existential over events. To illustrate, while (26a) seems to convey the correct meaning of (26), (26b) asserts the existence of an event of where no groups of less than 3 lamas sang. Most events satisfy the description in (26b), because most events aren't events of dancing to start with. The sentence in (26b) is almost always true.

(26) Less than 3 lamas sang.

a. $\neg\exists X \in \mathsf{lamas}, |X| \geq 3 \wedge \exists e, \mathsf{agent}(e) = X \wedge sing(e)$

≈ *there does not exist a group of three of more lamas which are the agents of a singing.*

b. $\exists e, \neg\exists X \in \mathsf{lamas}, |X| \geq 3 \wedge \mathsf{agent}(e) = X \wedge sing(e)$

≈ *there exists an event where no group of three of more lamas sang*

Scopal and maximality approaches The reaction to this observation can be classified in several camps. The main two camps we will study are the *scopal approaches* and the *maximality approaches.*

Scopal approaches consider that the issue is one of semantic scope: downward-entailing quantifiers, possibly all quantifiers, must be regimented to scope above event quantification. The naivest such scopal approach would simply take (26b) to be ruled out on the grounds that it is too uninformative ; in this account, a simple pragmatic constraint would enforce the correct scope. A more sophisticated scopal approach is developed by Champollion (2014a): he proposes a continuation-based semantics for events which effectively ensures that no matter how high or low the quantifier *less than 3 lamas* lives at LF, it may not under-scope the existential over events in the logical paraphrase. Similar ideas are developed in de Groote and Winter (2015); Winter and Zwarts (2011), using subtle composition methods afforded by categorial grammars.

(27) a. **Scopal approach:** *at some level of representation, the following scope order is enforced:*
less than 3 lamas $\gg \exists e$

b. **Maximality approach:** *quantifiers have an eventful semantics and the following scope is possible:*
$\exists e \gg$ less than 3 lamas

Another type of approach, labeled *maximality approaches* here, proposes that downward-entailing quantification in the scope of the existential over events is possible, provided we are willing to reconsider our assumptions about the meaning of expressions such as *less than 3 lamas*. A pioneering maximality approach is due to Krifka (1989). He proposes a meaning for *less than 3 lamas* as in (28) (modulo cosmetic adjustments). Effectively, *less than 3 lamas sang* asserts that within the set of events that happened at the relevant time span, one cannot find more than 3 lamas singing.

(28) a. $[\![\text{less than 3 lamas}]\!]\,(p_{evt}) = \lambda e.\ e = \mathsf{MAX} \wedge \neg\exists e' \prec e, \exists X \in \mathsf{lamas}, |X| \geq 3 \wedge p(X)(e')$
where MAX is the sum of all events at the relevant time interval.

b. $[\![\text{less than 3 lamas sang}]\!] =$
$\exists e, e = \mathsf{MAX} \wedge \neg\exists X \in \mathsf{lamas}, \exists e' \prec e, |X| \geq 3 \wedge \mathsf{agent}(e) = X \wedge \mathsf{sing}(e)$

In this approach, the event variable e is left open so that existential quantification over events can apply to it and so, in the logical paraphrase corresponding to the whole sentence, $\exists e$, does take scope above the expression that translates *less than 3 girls*, *pace* the scopal approaches.

Another maximality approach is found in Bonomi and Casalegno (1993) ; it is the event equivalent of a solution proposed by Kratzer (1989). The idea is that *less than 3* *lamas sing* will either denote the sum of lamas' singing events or nothing if there happens to be *less than 3 lamas* singing[7]:

(29) a. $[\![\text{less than 3 lamas}]\!]\,(p_{evt}) = \lambda e.\ \neg\left(\exists e', \exists X \in \mathsf{lamas}, |X| \geq 3 \wedge p(X)(e')\right)$
$\wedge\, e = \Sigma_{X \in \mathsf{lamas}} \left\{e' \mid p(X)(e')\right\}$

b. $[\![\text{less than 3 lamas sang}]\!] = \lambda e$
$\neg\left(\exists e', \exists X \in \mathsf{lamas}, |X| \geq 3 \wedge \mathsf{agent}(e') = X \wedge \mathsf{sing}(e')\right)$
$\wedge\, e = \Sigma_{X \in \mathsf{lamas}} \left\{e' \mid \mathsf{agent}(e') = X \wedge \mathsf{sing}(e')\right\}$

This approach achieves the same result as Krifka (1989), while retaining the idea that the event predicate denotes events of singing by lamas. This may be desirable since event anaphors like *it* in (30) referring to downward-entailing sentences do seem to refer to singing events, rather than any odd event that may have happened in the relevant time span.

(30) Less than 3 lamas sang. I saw it.
$\rightsquigarrow$ *it* $\approx$ the singing by the lamas.
$\rightsquigarrow$ *it* $\neq$ all that happened in the relevant time span.

Other approaches. There are other approaches besides scopal and maximality approaches. Another approach is that of Bernard and Champollion (2018). In this work, a notion of *negative events* is developed. With negative events, it is possible to define a negation operator which can apply in the scope of event closure. Although Bernard and Champollion (2018) do not do so, their negation operator could be used to construct an account of downward-entailing quantification (exploiting equivalences like *less than 3* $\leftrightarrow$ *not more than 4*). However, several aspects of their account are insufficiently spelled out for me to gauge how successful such an approach would be on the cases we'll consider[8].

[7] One hidden complication, inconspicuously hidden in the Σ symbol, is the case when no lamas sang. If we consider it to be compatible with the meaning of *less than 3 lamas sang* that none did, then we have to assume that *less than 3 lamas* picks up a null event in case no lamas sang. The existent of null events is contentious ; no such problem arises for Krifka (1989)'s approach.

[8] I for instance do not know what happens when negation takes scope below the introduction of AGENT, which is a problem for maximality approaches, as I will argue. One such case is presented in the abstract

To summarize the lay of the land, quantification in event semantics can be dealt with by the following four type of approaches. In the sequel, I will only focus on the first two.

- **Scopal approaches:** Champollion (2014a); de Groote and Winter (2015); Winter and Zwarts (2011)
- **Maximality approaches + quantifiers must scope just below $\exists e$:** Krifka (1989), Bonomi and Casalegno (1993)
- **Negative events:** Bernard and Champollion (2018)

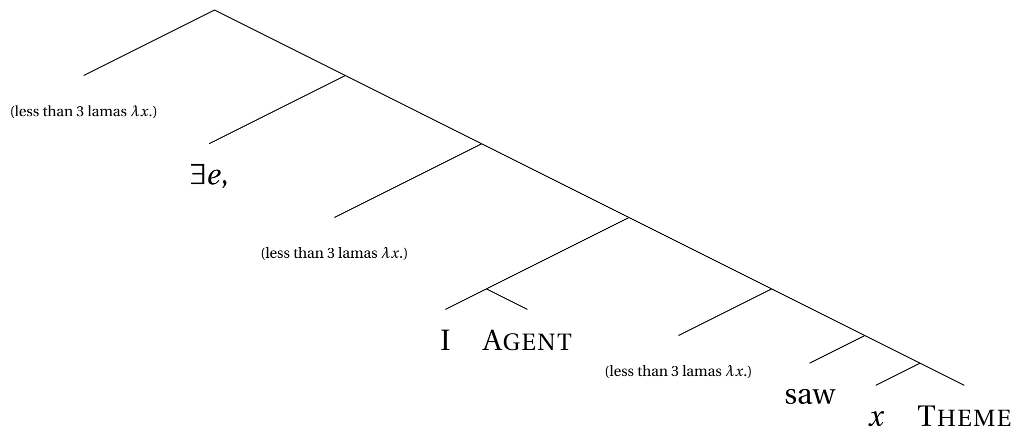
A correction to the maximality approach in the Neo-Davidsonian case. I now want to argue that the thematic role separation assumed by Neo-Davidsonian event semantics creates challenges for maximality approaches. These challenges can only be overcome by assuming a scope stipulation. This makes maximality approaches very similar to their scopal competitor. To see this, consider now a transitive sentence like (31).

(31) I saw less than 3 lamas.

With Neo-Davidsonian separation, *less than 3 lamas* can in principle scope in three places (depicted in the tree in (32)): above existential quantification over events, below it but above agent introduction, below both existential quantification over events and agent introduction. However, given the event-grounded type assumed for *less than 3 lamas* (type $(evt)vt$) in maximality approaches, only the lower two scope positions are type-theoretically valid.

for the corresponding talk (example (5)). However, my understanding is that Bernard and Champollion (2018)'s axioms only guarantee that the truth-conditions they derive for this example entail the right truth-conditions, but the axioms do not guarantee that the derived truth-conditions are equivalent to the attested truth-conditions. In particular, nothing excludes that the truth-conditions they derive are in fact contradictory. More axioms are needed to make a clear prediction in these critical cases but my attempts at finding the needed additional axioms have not been met with success.

(32)



The problem is that the lower scope position generates unattested readings. For the denotation of Krifka (1992)[9], the reading asserts that I was the agent of everything that happened in the relevant timespan, and no more than 3 lamas sightings were done in that time interval. For the denotation of Bonomi and Casalegno, it asserts that no more than 3 lamas were seen and I was the agent of all lama sightings[10].

(34) a. $\exists e, \mathsf{agent}(e) = [\![\mathrm{I}]\!] \wedge e = \mathsf{MAX} \wedge \neg\exists X \in \mathsf{lamas}, \exists e' \prec e, |X| \geq 3 \wedge \mathsf{theme}(e) = X \wedge \mathsf{saw}(e)$

b. $[\![\text{I saw less than 3 lamas}]\!] =$

$\exists e, \mathsf{agent}(e) = [\![\mathrm{I}]\!]$

$\wedge \neg \left(\exists e', \exists X \in \mathsf{lamas}, |X| \geq 3 \wedge \mathsf{theme}(e') = X \wedge \mathsf{saw}(e')\right)$

[9]Krifka (1989), read *verbatim*, is not in fact affected by this challenge. While he recognizes thematic roles, he does not assume that they are *syntactically* separated. Therefore, the scopal position under investigation cannot be achieved within his semantics.

[10]A similar reading was in fact attested in fn. 5. This reading is only observed with adjuncts. As far as my consulting goes, it also requires a substantial prosodic break, here represented with a period:

(33) a. I gave you exactly two passwords. On a pink slip of paper.
Exactly two password were given to you by me. They were given on a pink slip of paper.

b. I wrote exactly two letters. With my fountain pen.
Exactly two letters were written by me. They were written with my fountain pen

c. *Exactly two lamas greeted. Me.
#Exactly two lamas greeted anyone. They greeted me.

Taking this observation at face value, one may argue that Bonomi and Casalegno (1993)'s denotation could be made correct if we adopted a Davidsonian, rather than a Neo-Davidsonian structure.

$$\wedge\, e = \Sigma_{X \in \mathsf{lamas}} \left\{ e' \;\middle|\; \mathsf{theme}(e') = X \wedge \mathsf{saw}(e') \right\}$$

This reading is unattested. In fact, only the position right below the existential over events will deliver the attested reading. To ensure that no undesirable reading are generated, *maximality approaches* must be amended. They must prohibit downward-entailing quantifiers from scoping too low. More precisely, they must stipulate that downward-entailing quantifiers are not scoped below a thematic role head. Adding this stipulation brings these approaches considerably closer to scopal approaches.

Summary. Downward-entailing quantification is not, by itself, an unmanageable problem in event semantics. We have seen two successful accounts of downward-entailing quantification: the scopal approach and the maximality approach. The important caveat is that both accounts must incorporate some form of stipulation regarding the scope of downward-entailing quantifiers, either above $\exists e$ or just below it. Critically, neither account should allow the downward-entailing quantifier to take scope below the thematic role heads.

- **Scopal approaches:**
  Champollion (2014a); de Groote and Winter (2015); Winter and Zwarts (2011)
  - Standard generalized quantifier semantics
  - Syntax or composition ensures that all quantifiers are interpreted outside the scope of event closure
- **Maximality approaches + quantifiers must scope just below $\exists e$:**
  Krifka (1989), Bonomi and Casalegno (1993)
  - Quantifier of primitive type $(evt)vt$
  - Quantifier's type ensures that they take scope *below* event closure
  - Unnamed stipulations ensure that quantifiers takes scope *just* below event closure.

5.4.2 Separated analyses and downward-entailing quantification

This discussion of approaches to quantification in event semantics may seem rather remote. However, it is crucial in understanding the problem faced by separated analyses when dealing with downward-entailing quantifiers.

The problem appears in sentences which combines cumulative readings of *every* with downward-entailing quantification. The sentence in (35) illustrates: in this sentence, *the ten video-games* enters a cumulative reading with *every quarterback* ; in the scope of *every quarterback*, a downward-entailing quantifier is placed. This configuration, I argue, place conflicting requirements on scope.

(35) The ten video-games taught every quarterback less than 3 plays.

Before delving into compositional details, let us understand why it would be so at a high level. First, recall that separated analyses are characterized by the assumption that in order to get a cumulative reading with an agent, *every quarterback* must take scope below the AGENTthematic role head. Second, our earlier discussion has shown that these account of downward-entailing quantification must stipulate that quantification like *less than 3 plays* takes scope either above event closure ($\exists e$), as in the scopal approaches, or immediately below it, as in amended *maximality approaches*.

(36) Conclusion of scope observations:

a. **Neo-Davidsonian assumption:**
$\exists e \gg$ AGENT

b. **Schein (1993)-inspired accounts of cumulativity:**
AGENT $\gg$ *every quarterback*

c. **Downward-entailing quantification in event semantics:**
less than 3 plays $\gg \exists e$ (scopal approaches)
less than 3 plays $\gg$ AGENT (amended maximality approaches)

Together, these facts entail that *less than 3 plays* will have to out-scope *every quarterback*. However, this seems in direct contradiction of what we observe in the paraphrase for (35)

; this sentence clearly has *less than 3 plays* in the scope of *every quarterback*:

(37) **Paraphrase of (35):** *Every quarterback was taught less than 3 plays by any of the video-games*

This, in a nutshell, is the scope paradox. The rest of this section fills in the compositional details. I present several variations on the theories seen above and shows precisely that they do not derive the correct results.

With scopal approaches. Let us for instance assume Champollion (2016b)'s account of cumulative readings of *every* and a scopal approach to *less than 3 plays*. Adopting Champollion (2016b) means assuming that *every quarterback* receives a summative semantics and scopes below the AGENTthematic role head. Adopting a scopal approach means imposing that *less than 3 plays* takes scope above $\exists e$. For simplicity, I assume here that *less than 3 plays* takes scope via QR but the conclusion persists for scopal approaches which derive the scope of *less than 3* semantically (Champollion, 2014a).

Together, these assumptions determine a LF as in (38a). Note that this LF does not have *less than 3 plays* in the scope of *every quarterback*. The truth-conditions this LF gives rise to are given in (38b). As we expect from the scope of the different quantifiers, they are inadequate: they will be satisfied if, for instance, all quarterbacks learned a different set of 5 plays, since there will be less than 3 plays that all of them learned from the video-games.

(38) a. less than 3 plays λX $\exists e$ [the video-games AGENT] taught [every quarterback THEME] [X GOAL]

b. **Predicted truth-conditions:**

$\neg\exists X \in \text{plays}, |X| \geq 3 \wedge$

$\exists e, \text{agent}\left(e, \iota\text{video-games}\right) \wedge \text{theme}\left(e, \Sigma\text{quarterback}\right) \wedge$

$e \in {}^{*}\left(\lambda e'.\text{teach}(e') \wedge \text{theme}(\cdot, e') \subset \text{Atom} \wedge \text{GOAL}(X, e')\right)$

$\rightsquigarrow$ *there aren't 3 or more plays such that the video-games taught every quarterback those plays.*

With unamended maximality approaches. To ensure that *less than 3 plays* properly under-scopes *every quarterback*, we may attempt a leap of faith and adopt a *maximality* approach with unrestricted scope, even though, as we have already seen, such approaches are inadequate if the quantifier's scope is not fixed to be the highest within the event domain. Concretely, this means adopting the LF in (39a) and an event-based denotation for *less than 3 plays*, such as the denotation of Bonomi and Casalegno's denotation in (39b). The truth-conditions, given in (39c) are difficult to scrutinize but some reflection indicates that they are dramatically wrong. They entail, among many more absurd things, that no plays were taught to anyone beyond what the video-games taught to the quarterbacks.

(39) a. $\exists e$ [the video-games AGENT] taught [every quarterback THEME] less than 3 plays λX [X GOAL]

b. $[\![\text{less than 3 plays}]\!]\,(p_{evt}) = \lambda e.\ \neg\left(\exists e', \exists X \in \mathsf{plays}, |X| \geq 3 \wedge p(X)(e')\right)$
$\wedge\, e = \Sigma_{X \in \mathsf{plays}}\left\{e' \;\middle|\; p(X)(e')\right\}$

c. **Predicted truth-conditions:**
$\exists e, \mathsf{agent}\left(e, \iota\mathsf{video\text{-}games}\right) \wedge \mathsf{theme}\left(e, \Sigma\mathsf{quarterback}\right) \wedge$
$e \in {}^*\left(\lambda e'.\mathsf{teach}(e') \wedge \mathsf{theme}(\cdot, e') \subset \mathsf{Atom} \wedge\right.$
$\left.\neg\left(\exists e', \exists X \in \mathsf{plays}, |X| \geq 3 \wedge \mathsf{goal}(X, e')\right) \wedge e = \Sigma_{X \in \mathsf{plays}}\left\{e' \;\middle|\; \mathsf{goal}(X, e')\right\}\right)$
$\rightsquigarrow$ *there are less than 3 plays which were the goal of any event. The sum of events which the plays where the goal of was an event in which the video-games taught every quarterback*

5.4.3 Summary.

The problem of downward-entailing quantification in event semantics is a well-known one. Some works (Champollion, 2014a; de Groote and Winter, 2015; Krifka, 1989; Winter and Zwarts, 2011) have proposed successful integrations of downward-entailing quantification in event semantics. All such approaches must impose that downward-entailing quantifiers do not scope too low in the event domain ; without this restriction, unattested strange readings are generated.

Separated analyses exploit low scope positions made available by argument separation to generate cumulative readings. In sentences where *every* both enters a cumulative relation with a higher argument and has a downward-entailing quantifier in its scope, the requirements of both approach create an unmanageable conflict: on the one hand, *every* must scope low if it is to give rise to a cumulative reading ; on the other hand, downward-entailing quantifiers must scope high if there are to avoid strange unattested readings.

5.4.4 Downward-entailing quantification in the analysis of chapter 4

In contrast to separated analyses, the theory of cumulative readings of *every* developed in chapter 4 does not assume that *every* takes scope below any thematic role head, nor indeed assumes argument separation in the syntax. As a result, this theory should be unaffected by the scope requirements of downward-entailing quantifiers. It is indeed what we will observe in the next section. We can generate perfectly adequate reading for the sentence derived, *so long as no strengthening applies*. The problem is not one of scope. However, there is a problem in the method of exhaustification proposed in chapter 4 ; this procedure generates unattested inferences and there does not seem to be an obvious way to block this undesirable prediction.

Nothing wrong with weak readings. To illustrate how the analysis of chapter 4 deals with downward-entailing quantifiers, consider our challenge sentence in (40b) and its simpler counterpart in (40b).

(40) a. The squirrels cracked less than 5 nuts.

b. The video-games taught every quarterback less than 3 plays.

To determine the truth-conditions of these sentences, the first step is to determine the weak meanings of the verbs involved in (40). For simplicity, I focus on the case where all but the subject argument of these verbs are singularities. This restriction is innocuous for *every quarterback* in (40b), since it is a quantifier over singularities, so the predicate denoted by the verb will only be evaluated with singular arguments. As for *less than*

5 nuts or *less than 3 plays*, I similarly treat them as quantifiers over singularities (and will correspondingly adjust their semantics). This is made in order to avoid discussion of homogeneity with plural quantifiers ; while *less than* can sometimes yield collective readings Buccola and Spector (2016), such readings are not at stake here.

With these simplifying assumptions out of the way, let us turn to the weak meanings of these verbs. We saw in chapter 4 that *crack* has the denotation in (41a), if we assume that crack is summative and not part-homogeneous in any of its arguments. The same assumptions are also reasonable for *teach* and a similar weak denotation can be given, as in (41b).

(41) a. $[\![\lhd\text{-cracked}]\!] = \lambda y.\lambda X.\lambda e.\ \exists X' \prec X,\ \mathsf{crack}^{\mathsf{ag+th}}(X')(y)(e)$

$\lambda y.\lambda X.\lambda e.$ e is an event of cracking y by some of X

b. $[\![\lhd\text{-taught}]\!] = \lambda y.\lambda z.\lambda X.\lambda e.\ \exists X' \prec X,\ \mathsf{teach}^{\mathsf{ag+th}}(y)(z)(X')(e)$

$\lambda y.\lambda z.\lambda X.\lambda e.$ e is an event of teaching z to y by some of X

The second step is to decide on an event semantics for quantifiers, which allows them to take scope within the event domain. As we saw in chapter 4, this is a precondition to allow for a strengthening in the event domain.

In chapter 4, we proposed the denotation for *every* in (42a), which is a simplification of the denotation proposed by Champollion (2016b). This denotation for *every* is repeated in (42).

(42) $[\![\text{every NP}]\!] = \lambda p.\lambda e.\ (\iota[\![\text{NP}]\!], e) \in {}^*\left(\lambda x_e.\lambda e'_v.\ \mathsf{Atom}(x) \wedge p(x)(e')\right)$

where ${}^*p$ is the smallest summative relation containing p.

We similarly need a semantics for *less than 3 nuts*, which allow this quantifier to scope in the event domain. Here, I use Krifka (1989)'s denotation, repeated below in (43), although all maximality approaches would be sufficient.

(43) $[\![\text{less than 3 NP}]\!](p_{evt}) = \lambda e.\ e = \mathsf{MAX} \wedge \neg\exists e' \prec e, \exists X \in [\![\text{NP}]\!], |X| \geq 3 \wedge p(X)(e')$

where MAX is the sum of all events at the relevant time interval.

With these assumptions in place, the weak truth-conditions of the two cumulative sentences with downward-entailing quantification can be derived. By their type, all quantifiers must scope in the event domain. Furthermore, I assume that for (44b), *every quarterback* out-scopes *less than 5*, as we expect from the truth-conditions[11].

The sentences in (44a) and (**??**) a]videogame have the LFs in (44b) and (**??**) b]videogame. These LFs compose to give rise to the truth-conditions in (44c) and (**??**) c]videogame.

(44) a. The squirrels cracked less than 5 nuts.

b. $\exists e$, [less than 5 nuts] λx. [the squirrels] $\exists$-cracked x

c. $[\![(44b)]\!] = \exists e, e = \mathsf{MAX} \wedge \neg\exists e' \prec e, \exists X \in \mathsf{nuts}, |X| \geq 3 \wedge \exists X' \prec \iota\mathsf{squirrels},\ \mathsf{crack}^{\mathsf{ag+th}}(X')(y)(e')$

Among what happened in the relevant time interval, there is no event of some squirrels cracking 5 nuts or more.

(45) a. The video-games taught every quarterback less than 3 plays.

b. $\exists e$, [every quarterback] λx. [less than 3 plays] λy. [the squirrels] $\exists$-taught x y

c. $[\![(45b)]\!]$

$= \exists e.\ (\iota[\![\text{quarterbacks}]\!], e) \in$

${}^{*}(\lambda y_e.\lambda e'_v.\ \mathsf{Atom}(y) \wedge e' = \mathsf{MAX} \wedge$

$\neg\exists e'' \prec e', \exists X \in \mathsf{plays}, |X| \geq 3 \wedge \exists X' \prec \iota\mathsf{video\text{-}games},\ \mathsf{crack}^{\mathsf{ag+th}}(X')(y)(e''))$

$= \exists e,\ e = \mathsf{MAX} \wedge \iota[\![\text{quarterbacks}]\!] \in {}^{*}(\lambda y. \neg\exists e'' \prec e', \exists X \in \mathsf{plays},$

$|X| \geq 3 \wedge \exists X' \prec \iota\mathsf{video\text{-}games},\ \mathsf{crack}^{\mathsf{ag+th}}(X')(y)(e''))$

$= \exists e,\ e = \mathsf{MAX} \wedge \forall y \prec \iota[\![\text{quarterbacks}]\!],\ \neg\exists e'' \prec e, \exists X \in \mathsf{plays}, |X| \geq 3 \wedge \exists X' \prec \iota\mathsf{video\text{-}games},\ \mathsf{crack}^{\mathsf{ag+th}}(X')(y)(e'')$

For no quarterback x is there an event among what happened at the relevant time interval of x being taught 3 plays or more by some of the video-games.

The derived truth-conditions, after simplification, match the intuitions concerning the sentences. For (44), the truth-conditions require that no group of squirrels has cumula-

[11] I have assumed that in both cases, *less than 5 nuts* scopes above *the squirrels.* Since I do not assume argument separation, the difference between the two possible relative scopes does not impact the truth-conditions.

tively amassed more than 4 nuts. For (45), they require that no quarterback was taught more than 2 plays by any group of video-games.

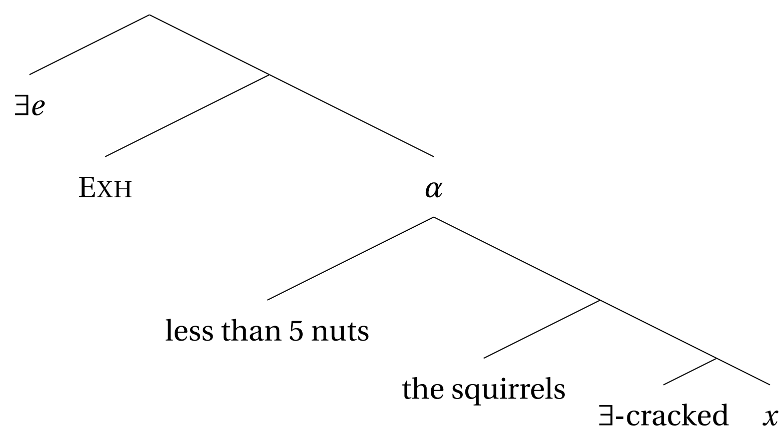
Strengthening. Unlike cumulative readings of *every*, the weak truth-conditions derived for the cumulative readings of downward-entailing quantifiers are entirely adequate without strengthening. As discussed in chapter 2, there does not seem to be exhaustive participation inferences with cumulative readings of downward-entailing quantifiers.

Concomitantly, we hope that the exhaustification procedure proposed in chapter 4 to derive exhaustive participation inference for cumulative readings of *every* would, in the case of downward-entailing quantifiers, be vacuous. Such is unfortunately not the case.

To show this, I will focus on the case of (46a), whose LF with EXH is repeated in (46b). I will assume that *less than 5 nuts* does not have alternatives, an assumption we may revisit later.

(46) a. The squirrels cracked less than 5 nuts.

b.



The prejacent α is a predicate of events true of the event MAX, just in case there are less than 5 nuts cracked by any subgroup of squirrels, false of all events otherwise.

(47) $[\![\alpha]\!] = \lambda e.e = \mathsf{MAX} \wedge \neg\exists e' \prec e, \exists Y \in \mathsf{nuts}, |Y| \geq 3 \wedge \exists Y' \prec \iota\mathsf{squirrels},\ \mathsf{crack}^{\mathsf{ag+th}}(Y')(y)(e')$

Given my assumptions, the alternatives to α are obtained by replacing *the squirrels* with alternative pluralities X. The alternatives are predicates of events true of MAX just in case there were less than 5 nuts cracked by any sub-group of X

(48) $\mathsf{Alt} = \left\{\lambda e.e = \mathsf{MAX} \wedge \neg\exists e' \prec e, \exists Y \in \mathsf{nuts}, |Y| \geq 3 \wedge \exists Y' \prec X,\ \mathsf{crack}^{\mathsf{ag+th}}(Y')(y)(e') \;\middle|\; X \in D_e\right\}$

To understand the effect of EXH, notice that the event predicates denoted by the alternatives and the prejacent have a specific shape: at any given world, they are either empty or only true of max. Which one it is depends on how many nuts were cracked by some plurality X in that world.

(49) $\forall p \in \mathsf{Alt},\ p = \varnothing \vee p = \{\mathsf{MAX}\}$

This means that we can think of these predicates in the same way we think of propositions: at any world, they may be true (i.e. $= \{\mathsf{MAX}\}$) or false (i.e. empty). By this logic, the prejacent corresponds to the proposition that less than 5 nuts were cracked by some squirrels, whereas the alternatives correspond to propositions of the form that less than 5 nuts were cracked by some of X. For the purpose of testing consistency and entailment, we may freely identify the prejacent and its alternatives to the propositions they correspond to.

Having made this observation, let us divide the alternatives to the prejacent α in three categories: the sub-plurality alternatives (alternatives obtained by replacing *the squirrels* with a subgroup of squirrels, like *the red squirrels*), the super-plurality alternatives (alternatives that replace *the squirrels* with *the squirrels and the beavers*), the overlap alternative (alternatives that replace *the squirrels* with *the animals with red fur*).

Which of the alternatives, if any, may be negated along with the prejacent without making it into a contradiction? Negating sub-plurality alternatives will create contradictions: the prejacent corresponds to the proposition that less than 5 nuts were cracked by some of the squirrels. This in particular entails that less than 5 nuts were cracked by some of X, when X is a sub-plurality of squirrels. Consequently, sub-plurality alternatives may not be negated without contradiction.

But all the other alternatives can be negated. It is for instance not contradictory to assert that less than 5 nuts were cracked by some of the squirrels and assert that more than 4 nuts were cracked by some of the squirrels and the beavers (super-plurality alternative). Combining the negation of all super-plurality and overlap alternatives together, we derive the following strengthened statement:

(50) Less than 5 nuts were cracked by some of the squirrels.
$\forall X \not< \iota\mathsf{squirrels}$, more than 4 nuts were cracked by some of X

This statement is true whenever the prejacent is true and each entity which is not a squirrel opened more than 4 nuts. The latter part thus corresponds to the predicted exhaustive participation inference. Needless to say, these predicted exhaustive participation inference do not correspond to a natural reading of the sentence.

Summing up. Just as the separated analyses, the analysis of chapter 4 faces a difficulty with downward-entailing quantifiers. Here, the analysis predicts the correct underlying truth-conditions but does not derive the correct truth-conditions, once implicatures have been factored in.

Chapter 6

Collectivity

In chapter 4, I presented a theory of homogeneity/cumulativity based on a notion of event parts. In this theory, the events denoted by a predicates and the parts these events have in the world of evaluation and other worlds (i.e. the mereology) determine the homogeneity properties of a predicate. In chapter 4, the event mereology was loosely justified on the basis of intuitions about some particular predicates.

This chapter aims to be more systematic and explicit for the case of plural homogeneity, by studying broad classes of predicates:. I will divide predicates in broad classes according to their homogeneity behaviors: some predicates exhibit no homogeneity whatsoever, while others display truth-value gaps of varying "*sizes*". In addition, I will find certain patterns of entailment typical of each class: some predicates exhibit summativity, some downward inferences, some display neither summativity nor downward inferences. The different classes of predicates will be show to partly overlap with traditional typologies of collectivity. These patterns of entailment, I argue, offer indirect evidence for the underlying mereology of events. Using the theory of chapter 4, I try to ground the homogeneity behavior of the different classes of predicates to their entailment patterns.

The first part of this chapter is chiefly empirical. I will present the intricate patterns of homogeneity associated with collective predicates, partly based on Kriz (2015), partly based on new observations. I will show that the typology of homogeneity partially lines up with a traditional typology of collectivity (i.e. *gather*-/*numerous*-type, atom/set).

Having presented the empirical landscape, the second part of this chapter represents the theoretical part. I will apply the theory of the last chapter to these predicates. We will study particular sets of inferences exhibited by the predicates and try to explain these inferences by some principle of mereology. Having established the mereological properties of a certain class of predicates, we will try to deduce its homogeneity properties, based on the theory of chapter 4.

6.1 Traditional typologies of plural predicates

6.1.1 Distributive/Non-distributive

When classifying plural predicates in terms of their semantic properties, the first observed split is the difference between predicates which can receive collective interpretations and those that cannot. Distributive predicates[1] (e.g. *laugh*, *sleep*, *eat*, ...), when combining with plural-referring expression, yield distributive inferences: they are true of a plural just in case they are true of each of its parts (non-maximality notwithstanding).

(1) Joana, Marius and Sue slept.
$\rightsquigarrow$ *Joana slept.*
$\rightsquigarrow$ *Marius slept.*
$\rightsquigarrow$ *Sue slept.*

On the other hand, other predicates (e.g. *be a good team, talk to each other, built a car engine, ...*) *can* yield, in *some* circumstances, a reading which does not entail that the predicate is true of the singularities in the plural. (In (2), I use $\rightsquigarrow$ for "*entails under all readings*").

[1] The lack of collective interpretation may in some cases be derived as a matter of pragmatics, rather than grammar. For instance, in a symbiotic life form, where the task of eating is divided equally between a fungus and an algae, we may well say that *the fungus and the algae ate*, when neither of them did. This stands in contrast with the distributive reading of e.g. *The boys each had one apple*, which isn't open to negotiation.

(2) a. Joana, Marius and Sue are a good team.

$\not\rightsquigarrow$ *Joana is a good team.*

b. Joana, Marius and Sue talk to each other.

$\not\rightsquigarrow$ *Joana talked to each other.*

c. Joana, Marius and Sue built a car engine.

$\not\rightsquigarrow$ *Joana built a car engine.*

6.1.2 Gather/Numerous

Previous literature also finds that predicates which can receive collective interpretations do not form a uniform class. Starting with Dowty (1987), at least two main classes of non-distributive predicates are recognized. I call these two classes *gather*-type and *numerous*-type predicates, following Champollion (2017). Both of these classes can yield collective interpretations in combination with plural-referring expressions.

(3) a. The soldiers were numerous.

b. The soldiers gathered.

Gather-type and *numerous*-type are chiefly distinguished by how they behave in combination with quantifiers such as *all*. The *gather*-type predicates admit collective interpretations with plural quantifiers such as *all*. The *numerous*-type predicates can only be read distributively. (This description of the facts pointed out by Dowty (1987) is due to Winter (2001).)

(4) a. All the armies were numerous.

$\rightsquigarrow$ **distributive:** each is numerous.

$\not\rightsquigarrow$ ~~**collective:** numerous when taken together.~~

b. All the armies gathered.

$\rightsquigarrow$ **distributive:** each gathered.

$\rightsquigarrow$ **collective:** gathered all together

As a consequence, a *numerous*-type predicate p is not felicitous with *all NP* if p cannot meaningfully apply to the singularities in the extension of *NP*, as (5) shows.

(5) Dowty (1987)

a. #All the soldiers were numerous.

b. All the soldiers gathered.

What we have so far is a three-way classification of predicates (Champollion, 2020).

(6)

Predicate type	Collective interpretations	examples
gather	always possible	gather, be similar, meet, disperse, hold hands, fit together, ...
numerous	possible with plural-referring expressions only	be numerous, be a group of ten, form a pyramid/circle, suffice to defeat the army, return a verdict of 'not guilty', be a group of less than ten, ...
distributive	never possible	smiled, laughed, danced, sang, ...

6.1.3 Mixed predicates

One more class needs to be distinguished. The status of some predicates as *gather*- or *numerous*-types is controversial. For instance, there is variation on the felicity of the collective reading of (7): Dowty (1987) and later Križ (2016) accept it, which would make the predicate *gather*-type ; Winter (2001) rejects it and counts the predicate as *numerous*-type.

(7) All of the engineers built a car engine.

collective: ?they built one car engine as a collaborative effort.

Winter (2001) treats this variation as a form of dialectal variation. Kuhn (2020), on the other hand, reports a study showing that the distribution of acceptability of (7) among naive speakers is not bimodal, as would be expected by dialectal variation. Rather, (8) shows a degree of acceptability intermediate between the fully acceptable collective reading of a *gather*-type predicate and the fully unacceptable collective reading of a *numerous*-type predicate. Hence my use of '?' in (7) rather than '%'. These results suggest that predicates like *built a car engine* form a third class of predicates, which I will call *mixed predicates*.

The chart in (8) summarizes the typology of predicates built so far. The example predicates are hand-picked or copied from Champollion (2017) or Kuhn (2020).

(8)

Predicate type	Collective interpretations	Examples
numerous	possible with plural-referring expression only	*be numerous, be a group of ten, form a pyramid/circle, suffice to defeat the army, return a verdict of 'not guilty', be a group of less than ten, ...*
mixed	always possible, degraded with plural quantifiers	*built a raft, carried a beam, wrote a book.*
gather	always possible	*gather, be similar, meet, disperse, hold hands, fit together (jigsaw puzzle pieces), ...*
distributive	never possible	*smiled, laughed, danced, sang, ...*

In a nutshell, predicates are not uniform with respect to how much environments they tolerate collective readings in, ranging from distributive predicates which simply do not yield collective readings all the way to *gather*-type predicates, which allow collective readings in all circumstances, spanning the *numerous*-type and mixed types which chiefly obtain collective readings with plural-referring expressions.

In the sequel, I will not give an explanation for what underlies these different classes of predicates. This typology will serve two purposes. First, it will provide an important comparison point with the typology of homogeneity which I am about to present. Second, some generalizations about the defining properties of these classes of predicates (in particular those drawn by Kuhn (2020)) will be helpful in understanding why certain predicates have the homogeneity properties that they do.

6.2 Typology of plural predicates for homogeneity

Plural predicates are not uniform with respect to their homogeneity properties either. The typology of predicate homogeneity largely overlaps with the traditional typology seen above but not entirely.

6.2.1 No homogeneity.

To start with, consider a numerous-type predicate like *be a group of ten.* In their collective interpretation, these predicates do not seem to yield homogeneity effects. There is no truth-value gap between the a sentences below and the b sentences.

(9) a. These kids are a group of ten.

b. These kids are not a group of ten.

(10) a. The enemies are numerous.

b. The enemies aren't numerous.

(11) a. The books fit in the box

b. The books do not fit in the box.

6.2.2 Downward, upward and sideward homogeneity.

At the other extreme, consider a mixed predicate like *built a raft.* Here, there is a difference between the positive (12a) and the negative (12b).

(12) a. The children built a raft.

b. The children didn't build a raft.

Specifically, (12a) seems to assert that the construction of a raft involved all and only the children. (12b), on the other hand, asserts that no child took part in any raft-building, be it together with other children or with non-children. As Križ (2016) describes it, (12b) can be seen as made of three independent propositions: no raft was built by a subset of or all of the children (*downwards inference*), that no raft was built by a superset of all the children, like the children and the adults, (*upwards inference*), and that no raft was built by a set that overlaps with the children, like the older children and the adults (*sidewards inference*).

Križ (2016)'s motivation for making the distinction between these three classes of inference comes from the fact that adding *all* to the sentences above seems to affect these three classes of inferences differently (cf (13)). In particular, Križ (2016) observes that while *all* "*removes*" downwards homogeneity - meaning (13b) no longer has downward inferences -, it does not remove the other two types of homogeneity - meaning (13b) has both upwards and sidewards inferences: (13b) asserts that no super-group or group overlapping with the children built a raft.

(13) a. ?All of the children built the raft.

b. ?Not all of the children built the raft.

Kriz (2015) describes this pattern of homogeneity as being characteristic of all homogeneous non-distributive predicates. This means that the class of collective predicates is divided in two subsets: the un-homogeneous predicates (e.g. *numerous*-type predicates) and the homogeneous predicates, which have a 3-way form of homogeneity: upwards, sidewards and downwards homogeneity.

This property seems to extend to all mixed predicates.

(14) a. The actors performed *Hamlet*.

b. The actors didn't perform *Hamlet*.

6.2.3 A third pattern of homogeneity.

But the empirical picture is more complex. The negation of *gather*-types predicates *typically* gives rise to downward inferences but never sidewards homogeneity. For instance, (15b) can only be true if no subgroup of painters collaborated (downward inferences) but it is not false because all painters collaborated with a friend sculptor of theirs (no sidewards inferences).

(15) a. The three painters collaborated.

b. The three painters didn't collaborate

Likewise in (16), (16a) asserts that every child is related to every other child and (16b) asserts that no child is related to any other child. Critically, (16b) does not assert that no child is related to anyone else (no sidewards inference).

(16) a. The children are related.

b. The children are not related.

I have avoided discussion of upwards inferences in this initial description. Both (15b) and (16b) yield upward inferences ; (15b) implies that no super-plurality containing the painters collaborated and (16b) implies that no super-plurality of children did. However, the upward inferences here need not be attributed to a general mechanism of *homogeneity* but to the following lexical property of *collaborate*: if $X + X'$ are part of a collaboration, then so is X. By contraposition, if it is not true that X collaborated, then it is not true that $X + X'$ did. This is to say that the upward inferences would be expected even in the absence of a truth-value gap between the positive and the negative.

One reason to think that this is the correct explanation is some gather-type predicates do not have this property and do not yield upward inferences as a consequence. Consider the case of *hold hands* (Kuhn, 2020). If $X + X'$ held hands, it does not follow that X held hands. In the scenario below for instance, the leftmost child and the rightmost child are not holding hands even though the children are holding hands.

(17) 

Under negation, the predicate *hold hands* displays downward inferences but no upward inferences. (18) can only be true if no two children are holding hands. However, there are no upward inferences, since (18b) is non-contradictory (imagine a situation where adults and children are interspersed).

(18) a. The children didn't hold hands.

b. The children didn't hold hands but the children and the adults held hands.

In conclusion, a number of *gather*-type predicates seem to display downward homogeneity but no upward homogeneity: upward inferences, when they arise, are expected on the basis of the positive sentence ; there is no truth-value gap due to upward inferences..

6.2.4 Non-homogeneous collective predicates.

Some *gather*-type predicates, on the other hand, do not seem to display any form of truth-value gaps (similar facts are reported in Bar-Lev (2020)). Predicates like *agree*, *be consistent* (for axioms), *be compatible* are *gather*-type as (19) attests:

(19) a. All the experts agree on this issue.

b. All the axioms are consistent.

Yet, these predicates do not display any form of homogeneity: for (20a) to be true, all professors need to have the same opinion ; in (20b), one dissenting voice is enough.

(20) a. The professors agree on which book to read.

b. The professors do not agree on which book to read.

The same goes for *be consistent*. A certain plurality of axioms is consistent if there is a model that makes all axioms true ; it is inconsistent otherwise. There is no downwards homogeneity ((21b) does not imply that no subset of axioms is consistent), no sidewards homogeneity ((21b) does not imply that no subset of axioms along with a few more axioms are consistent).

(21) a. These axioms are consistent.

b. These axioms are not consistent.

6.2.5 Distributive predicates.

Where do distributive predicates stand with respect to downward, upward and sideward homogeneity? (22b) implies that no sub-plurality of dancers was a group of smilers (downward inference), no super-plurality containing smilers was a group of smilers (upward inference), nor any plurality overlapping with the dancers (sideward inference).

(22) a. The dancers smiled.

b. The dancers didn't smile.

However, similarly to the case of *collaborate* above, upward and sideward inferences follow from the lexical properties of distributive predicates and downward inferences. Indeed, distributive predicates, if any plurality X contains a non-smiler, so will any super-plurality containing X.

6.2.6 Summary.

In summary, we see that the typology of homogeneity includes three types of predicates: predicates which do not yield truth-value gaps, predicates yield only upward and downward inferences under negation, predicates which yield all three forms of inferences. These classes overlap but are not completely identical to known classes of collective predicates.

<table>
<tr><th>Collective type</th><th>Homogeneity type</th><th></th></tr>
<tr><td rowspan="2">Gather</td><td>Downward homogeneity</td><td>gather, collaborate, …</td></tr>
<tr><td rowspan="2">No homogeneity</td><td>agree, be consistent, …</td></tr>
<tr><td>Numerous</td><td>numerous, weigh 5 kg, …</td></tr>
<tr><td>Mixed</td><td rowspan="2">Downward-upward-sideward homogeneity</td><td>build a raft, perform Hamlet, …</td></tr>
<tr><td>Distributive</td><td>smile, laugh, dance, …</td></tr>
</table>

In the next section, I will show how upwards and downward homogeneity follow from the system of chapter 4, as well as their absence with *numerous*-type predicates. This will cover the case of homogeneous *gather*-type predicates, *numerous*-type predicates, and distributive predicates (already treated in the previous chapters). Missing from this treatment will be an understanding of sideward homogeneity and lack of homogeneity with *gather*-type predicates such as *agree*. I will offer suggestions on how sideward homogeneity comes about

6.3 Downward homogeneity and the event structure of collective predicates.

To understand the nature of the truth-value gap in collective predication, we must understand the truth-conditions of each of the negative sentences like (23):

(23) a. The children didn't gather. (homogeneous *gather*-type)

b. The children didn't build a raft. (mixed)

c. The children didn't agree. (non-homogeneous *gather*-type)

d. The children didn't weigh 150 kg. (*numerous*-type)

e. The children didn't smile. (distributive)

In the previous chapter, it was proposed that the truth-conditions of negative sentences could be represented as (24b). In essence, a negative sentence assert that there is no event which could be extended to an event true of the positive sentence.

(24) a. **Positive sentence:**

$\exists e,\ p(e) \wedge \mathsf{agent}(e) = X \wedge \mathsf{theme}(e) = Y \ldots$

There is a p-event with X as an agent, Y as a theme, …

b. **Negative sentence:**

$\neg\exists e,\ p(e) \wedge e \lhd \lambda p(e') \wedge \mathsf{agent}(e') = X \wedge \mathsf{theme}(e') = Y \ldots$

No p-event is part of a p-event with X as an agent, Y as a theme, …

If this view is correct, the truth-conditions of the negative sentences in (23) depends on what parts a gathering, a raft-building, an agreement event, etc has. Because we only have access to truth-conditions, not to event predicates *per se*, it can sometimes be difficult to pinpoint exactly what parts an event has. In the sequel, the strategy will be to examine closely patterns of inference associated to the different predicates *in positive sentences*. I will then provide a simple way to derive these inferences via mereological assumptions. Using these mereological assumptions, I will in turn explain the properties of homogeneity attested *in negative sentences*. The evidence in each case is therefore only indirect.

6.3.1 Distributive predicates

The easiest case is the case of distributive predicates. This case was covered extensively in this work and the conclusions below are also formed in the previous chapter. This will serve as a warm-up to the type of argument deployed for collective predicates.

The defining property of distributive predicates is the following entailment pattern: if the predicate is true of a plural sum, it is true of each singularity in that sum. This is illustrated by the case of *smile* in (25a), or *sleep* in (25b) for instance:

(25) a. The children smiled.

$\rightsquigarrow$ *child 1 smiled*

$\rightsquigarrow$ *child 2 smiled*

$\rightsquigarrow$ …

b. The children slept.

$\rightsquigarrow$ *child 1 slept*

$\rightsquigarrow$ *child 2 slept*

$\rightsquigarrow \ldots$

Translated to their event paraphrases, these inferences could be written as follows:

(26) a. $\exists e, \mathsf{smile}(e) \wedge \mathsf{agent}(e) = \iota \mathsf{children}$

$\Rightarrow \exists e, \mathsf{smile}(e) \wedge \mathsf{agent}(e) = \mathsf{child}_1$

$\Rightarrow \exists e, \mathsf{smile}(e) \wedge \mathsf{agent}(e) = \mathsf{child}_2$

$\Rightarrow \ldots$

b. $\exists e, \mathsf{sleep}(e) \wedge \mathsf{agent}(e) = \iota \mathsf{children}$

$\Rightarrow \exists e, \mathsf{sleep}(e) \wedge \mathsf{agent}(e) = \mathsf{child}_1$

$\Rightarrow \exists e, \mathsf{sleep}(e) \wedge \mathsf{agent}(e) = \mathsf{child}_2$

$\Rightarrow \ldots$

What assumptions about the structure of *smiling*'s and *sleeping*'s and the thematic roles can guarantee that these inferences hold? Let me first assume that thematic roles are summative: the agents of $e_1 + e_2$ is the sum of the agents of e_1 and the agents of e_2, similarly for themes, etc. This is a general assumption that applies to all predicates - distributive and non-distributive.

With this assumption, we can explain the distributive inferences of *smile* and *sleep* by assuming that every event in the extension of the these predicate is always a sum of events performed by singular agents: a smiling by the children is a sum of smiling by each individual child. Formally, this lexical stipulation is represented as in (27):

(27) **Event property of distributive predicates**

a. $[\![\text{smile}]\!](e) \Rightarrow e \in \lambda e'. [\![\text{smile}]\!](e') \wedge \mathsf{Atom}\left(\mathsf{agent}(e')\right)$

b. $[\![\text{sleep}]\!](e) \Rightarrow e \in \lambda e'. [\![\text{sleep}]\!](e') \wedge \mathsf{Atom}\left(\mathsf{agent}(e')\right)$

If this assumption about distributive predicates is correct, then it means the parts of ($\sqsubset$) an event of smiling by the children are events where some of the children smile.

This entails that any event with this constitution - smilings by some of the children - will be part of ($\lhd$) an event of smiling by the children.

This part-whole structure of smiling events can explain the downward inferences observed in negated distributive sentences like (28). According to the theory of the last chapter, (28a) asserts that no smiling events in the actual world is part of ($\lhd$) an event of smiling by the children. According to what we saw above, this means that no sub-group of the children could have smiled (downward inferences).

(28) a. The children didn't smile.

b. $\neg\exists e,\ \mathsf{smile}(e) \wedge e \lhd \mathsf{smile}(e) \wedge \mathsf{agent}(e) = \iota\mathsf{children}$

As already discussed in section 6.2, sideward and downward inferences are simply a consequence of downward inferences for distributive predicates. Indeed, if any group overlapping with or containing the children smiled, then some sub-group of children must have smiled (distributive inference). Since (28a) precludes smilings by sub-groups, it must therefore also preclude smilings by overlapping and supersets of the children. All the homogeneity properties of distributive predicates are correctly predicted.

In summary, the homogeneity properties of distributive predicates can be grounded in the distributive inferences they give rise to. Specifically, the distributive inferences serve to motivate a particular mereological structure which in turn explains the observed reading of the negative sentences.

6.3.2 The case of mixed predicates: the summativity property

The class of mixed predicates gave rise to upward, sideward and downward homogeneity. A sample of such predicates is repeated below in (29).

(29) built a raft, carried a beam, wrote a book, perform Hamlet, …

A striking property of this list is that all the predicates in it are formed from a transitive verb in combination with singular entity. Furthermore, focusing on the verb themselves inside these complex predicates, we find that they all obey some form of summativity:

(30) a. The linguists lifted the beam.

The philosophers the beam.

⇒ The linguists and the philosophers lifted the beam.

b. The editors wrote the first open letter.

The reviewers wrote the second open letter.

⇒ The editors and reviewers wrote the first two letters.

How this summativity property connects to any of the other properties of mixed predicates is a mystery left to future research. For our local purposes, it suffices that summativity holds.

At the level of events, summativity inferences can be explained by assuming that the event predicates themselves are summative: the sum of two carrying's is itself a carrying.

(31) a. $\forall e_1, e_2,\ \mathsf{carry}(e_1) \wedge \mathsf{carry}(e_2) \Rightarrow \mathsf{carry}(e_1 + e_2)$

b. $\forall e_1, e_2,\ \mathsf{write}(e_1) \wedge \mathsf{write}(e_2) \Rightarrow \mathsf{write}(e_1 + e_2)$

In our discussion of distributive predicates, I adopted the assumption that thematic roles are summative. With these two assumptions, the inference in (30a) can be derived as follows:

(32) a. $\exists e_1, \mathsf{carry}(e_1) \wedge \mathsf{agent}(e_1) = \iota\mathsf{linguists} \wedge \mathsf{theme}(e_1) = \mathsf{raft\text{-}1}$

$\exists e_2, \mathsf{carry}(e_2) \wedge \mathsf{agent}(e_2) = \iota\mathsf{linguists} \wedge \mathsf{theme}(e_2) = \mathsf{raft\text{-}2}$

⇒ (summativity)

$\exists e_1, \exists e_2, \mathsf{carry}(e_1 + e_2) \wedge \mathsf{agent}(e_1) = \iota\mathsf{linguists} \wedge \mathsf{theme}(e_1) = \mathsf{raft\text{-}1}$

$\wedge \mathsf{agent}(e_2) = \iota\mathsf{linguists} \wedge \mathsf{theme}(e_2) = \mathsf{raft\text{-}2}$

⇒ (thematic role morphism)

$\exists e_1, \exists e_2, \mathsf{carry}(e_1 + e_2) \wedge \mathsf{agent}(e_1 + e_2) = \iota\mathsf{linguists} + \iota\mathsf{philosophers} \wedge \mathsf{theme}(e_1 + e_2) = \mathsf{raft\text{-}1} + \mathsf{raft\text{-}2}$

The summativity property implies some structure on events of carrying, building, etc. Namely, one can form an event of lifting the beam by the linguists and the philosophers with two parts ($\sqsubset$): an event of lifting the beam by the linguists and an event of lifting the beam by the philosophers. This means that any events of that constitution (events of carrying the beam by the linguists) will be part of ($\lhd$) an event of carrying the beam by the linguists and the philosophers. Generalizing the reasoning, any event of carrying the beam by X is a part of ($\lhd$) any event of carrying the beam by any super-plurality X'.

With this property, we can guarantee that mixed predicates will yield downward inferences under negation. By last chapter's theory, (33) means that no carrying was part of an event of carrying the beam by the linguists. Given the above, this rules out any carrying by a subset of the linguists or the linguists themselves.

(33) The linguists didn't carry the beam.

In sum, summativity implies downward inferences. Problematically, downward inferences are only one of the three inferences that mixed predicates give rise to. As we saw, they also give rise to sideward inferences and upward inferences (no super-set of or set overlapping the linguists carried a beam). I will leave this as an open problem until section **??** where a suggestion is offered.

6.3.3 The case of gather-type predicates

As we saw, one class of *gather*-type predicates gives rise to downward- and upward-homogeneity (cf. (34)), while another (35) does not give rise to homogeneity at all (cf (35)).

(34) a. The ambassadors met.
b. The ambassadors didn't meet.

(35) a. The ambassadors agreed.
b. The ambassadors didn't agree.

As already announced, I will not be able to provide an account of non-homogeneous *gather*-type predicates. One reason for this difficulty is that it is not obvious what semantic property, besides homogeneity, distinguishes between the two classes of predicates[2]. Short of a full theory, I show that the theory of chapter 4 expects *gather*-type

[2] N. Haslinger (p.c.) suggests that the difference between the two classes might be more pragmatic than semantic: in the case of *agree*, speakers are, in typical contexts, interested in whether unanimous agree-

predicates to be downward- and upward-homogeneous. This is the correct prediction for *meet* but incorrect for *agree*. The case of predicates like *agree* will therefore be left as an open problem.

I will show that under the theory of chapter 4,

The semantic properties of the class of *gather*-type predicates as a whole have been well studied. I defined *gather*-type predicates as those which can yield collective readings with all both quantifiers and plural-referring expressions. These predicates also seem united by common patterns of inference. Some work (Champollion, 2017; Dowty, 1987; Kuhn, 2020; Winter, 2001) has gone in determining what makes a *gather*-type predicate so. These predicates seem united by common patterns of inference, just as the classes outlined above.

(36) gather, meet, be related, meet, similar, hold hands, ...

As has been noted, *gather*-type predicates all seem to give rise to *entailment to subpluralities* inferences. If ten people meet, so did any group of 5 among them. If Joana, Marius and Bill are similar, then Joana and Bill are similar. If a group of 100 people gather, it is fair to say that any group of 50 did as well.

As a first pass, following Dowty (1987), we could characterize this *entailment to subpluralities* as in (37). Expressed in terms of *gather*, this property says that if a plurality X gathered, any plurality in X sufficiently large to gather also gathered. What counts as "*sufficiently large*" is a vague threshold, which depends on the predicate. As little as two people can *be related*, but it is probably the case that more than 2 people are needed to *gather*.

(37) Let p be a *gather*-type predicate.
If X is true of p and $Y \prec X$ is "*sufficiently*" large, Y is true of p.

In terms of event representation, the generalization in (37) can be rendered as in (38).

ment is reached. Lacking homogeneity, both sentences in (35) can address this question under discussion. If this is correct, this should lead to the prediction that context manipulation can affect the homogeneity properties of (35).

For *gather* for instance, it asserts that a gathering of Y is a sum of a gathering of all sub-pluralities of Y of size greater than the threshold.

(38) **Event property of *gather*-type predicates** (1st pass)

$C_{\text{predicate}}$ is the cardinality threshold for the predicate.

a. $[\![\text{gather}]\!](e) \Rightarrow e \in \bigoplus_{\substack{X < \textsf{holder}(e) \\ |X| > C_{\text{gather}}}} \left(\lambda e'.\, [\![\text{gather}]\!](e') \wedge \textsf{agent}(e') = X\right)$

b. $[\![\text{related}]\!](e) \Rightarrow e \in \bigoplus_{\substack{X < \textsf{holder}(e) \\ |X| > C_{\text{related}}}} \left(\lambda e'.\, [\![\text{related}]\!](e') \wedge \textsf{holder}(e') = X\right)$

In particular, these assumptions mean that a part ($\sqsubset$) of an event of gathering by the ambassadors is a gathering by a sub-plurality of ambassadors "*large enough to gather*". In turn, this entails that any gathering of a sub-plurality of ambassadors "*large enough to gather*" is a part of ($\lhd$) an event of gathering by the ambassadors.

As before, these conclusions about event mereology translate into predictions for homogeneity. Specifically, downward homogeneity is predicted. Indeed, by the theory of the last chapter, (39a) means that no gathering in the actual world is part of a (potential) gathering by the ambassadors. According to our conclusions above, this must mean that there was no gathering by any sub-plurality of ambassadors "*sufficient large to gather*". The addition of "*sufficient large to gather*" is superfluous here: if a plurality is not large enough to gather, then it could not have gathered. Piecing everything together, we conclude that (39b) means that no sub-plurality of ambassadors gathered.

(39) a. The ambassadors didn't gather.

b. $\neg\exists e,\ \textsf{gather}(e) \wedge e \lhd \lambda e'.\textsf{gather}(e') \wedge \textsf{agent}(e') = \iota\textsf{ambassadors}$

No gathering is part of a gathering with the ambassadors as an agent.

Downward homogeneity is therefore predicted. As we saw, in *gather*-type predicates (as in distributive predicates earlier), upward homogeneity is automatically entailed. If no gathering of the ambassadors took place, no gathering of any larger group could have taken place either, because of the *entailment to sub-pluralities.*

This analysis seems correct but it is only a first approximation. I have assumed that *gather*-type predicates are characterized by *entailment to all sufficiently large plurali-*

ties. This seems correct for *gather, meet, be related*, etc. But there are exceptions (Champollion, 2017; Kuhn, 2020). For instance, both sentences in (40a) and (40b) containing the *gather*-type predicate *hold hands* is true of the children in the scenario depicted in (40c). This holds even though not all sub-plurality large enough to hold hands actually held hands (consider the plurality formed from every other child).

(40) a. The children held hands.

b. All the children held hands.

c. 

This class of *gather*-type predicates does not validate the *entailment to all sufficiently large pluralities* inference pattern. Yet, it does seem that this class of *gather*-type predicates does have some form of entailment to sub-pluralities: there is no way for the sentence to be true if *hold hands* is false of all sub-pluralities of *the children*.

Champollion (2017) and Kuhn (2020) propose a unified description of the semantic properties of all *gather*-type predicates in terms of *stratified reference*. In event-less terms, *stratified reference* is given in (41). A predicate P has stratified reference just in case if it is true of X, it is true of all elements of a cover of X with sufficiently small cells. (A cover of X is a set of pluralities that add to X). The number ϵ, just as C before, is a vague predicate-dependent parameter.

(41) $\forall X,\ P(X) \rightarrow \exists C_{et},\ x = \sum_{X' \in C} X' \wedge \forall X' \in X, |X'| \leq \epsilon \wedge P(X')$

If X is true of P, then it is covered by small pluralities which all meet P.

Gather has stratified reference: as seen earlier, if X gathered, so did all pluralities larger than C_{gather}. So the cover of X that contains all pluralities of size $C_{\text{gather}} + 1$ will only contain *gathering pluralities*. Likewise, *held hands* has stratified reference. If X held hands, we can decompose X into pairs that held hands together. These pairs all meet the *hold hands* predicate.

In event terms, *stratified reference* can be explained by assuming that an event of X gathering/holding hands can be decomposed into events of gathering/holding hands with thematic roles which are elements of the cover. I will say that e has stratified reference with respect to C. The postulate then says: if e is in the extension of the predicate, it has stratified reference with respect to some cover C. Interestingly, Kuhn (2020) provides arguments that this characterization is more robust than the event-less one.

(42) a. $[\![\text{hold-hand}]\!](e) \Rightarrow \exists C, \mathsf{agent}(e) = \sum_{X' \in C} X' \wedge \forall X' \in X, |X'| \leq \epsilon \wedge e \in {}^{*}\big(\lambda e'.\, [\![\text{hold-hand}]\!](e') \wedge \mathsf{agent}(e$

b. $[\![\text{gather}]\!](e) \Rightarrow \exists C, \mathsf{agent}(e) = \sum_{X' \in C} X' \wedge \forall X' \in X, |X'| \leq \epsilon \wedge e \in {}^{*}\big(\lambda e'.\, [\![\text{gather}]\!](e') \wedge \mathsf{agent}(e') \in C\big)$

This postulate guarantees that the parts of ($\sqsubset$) an event of the children holding hands are events of some children holding hands. Events of that constitution (event of some children holding hands) will therefore be parts of ($\lhd$) an event of the children holding hands. This fact entails that *gather*-type predicate will have downward homogeneity. As per the theory of last chapter, (43a) is true if no parts of an event of the children holding hands occurred. This means that no holding hands by any of the children can have occurred.

(43) a. The children didn't hold hands.

b. $\neg\exists e,\ \mathsf{hold\text{-}hand}(e) \wedge e \lhd \lambda e'.\mathsf{hold\text{-}hand}(e') \wedge \mathsf{agent}(e') = \iota\mathsf{children}$

No hand-holding is part of a hand-holding with the children as an agent.

$\neg\exists e,\ \mathsf{hold\text{-}hand}(e) \wedge e \lhd \lambda e'.\mathsf{hold\text{-}hand}(e') \wedge \mathsf{agent}(e') = \iota\mathsf{children}$

No hand-holding is part of a hand-holding with the children as an agent.

This is the desired downward inference. Note that here, no lexical property of *hold hands* predict any upward inferences for that sentence. As we saw in section 6.2, this is a desirable consequence for *hold hands* which does not exhibit upward homogeneity.

6.3.4 The case of *numerous*-type predicates.

Numerous-type predicates (*fit in the trunk*, *weigh 5 kg*[3]) do not give rise to homogeneity. In the theory of this work, this must mean that the weak meanings are equivalent to

[3] I avoid *numerous*. Being a vague adjective, this predicate does give to truth-value gap (compare *the army is numerous* with *the army is not numerous*). But this is plausibly independent from the cases of plural homogeneity investigated here

their strong meaning. Zooming in on the case of *weigh 5kg*, this means that (44a) must be equivalent to (44b). (I follow Kuhn (2020) in my event representation of measure predicates.)

(44) a. $\exists e, \mathsf{weigh}(e) \wedge e \lhd \left(\lambda e'. \mathsf{weigh}(e') \wedge \mu(e') = 5kg \wedge \mathsf{agent}(e) = x\right)$

b. $\exists e,\ \mathsf{weigh}(e) \wedge \mu(e) = 5kg \wedge \mathsf{agent}(e) = x$

This could be guaranteed if events of weighing had no proper weighting parts ($\sqsubset$). In that case, all parts of a weighting e ($\sqsubset$) is e itself. By definition of $\lhd$, this would mean that all parts of ($\lhd$) events of weighing 5kg are events of weighing 5kg, ensuring the equivalence between (44a) and (44b). The property we are looking for is called *quantization* in the terminology of Krifka (1989). It is formally represented as (45):

(45) **Quantization:** for all e and e',

$\mathsf{weigh}(e) \wedge \mathsf{weigh}(e') \wedge e \sqsubset e' \rightarrow e = e'$

How can we motivate quantization? The first empirical observation is that *weigh 5 kg* fails to validate the summativity inferences.

(46) **Context:** *every book is either red or green in color.*

a. The red books weigh 5 kg.
The green books weigh 5 kg.
$\not\Rightarrow$ the books weigh 5 kg.

It is thus undesirable to assume that the sum of two events of *weighing 5kg* is itself an event of *weighing 5 kg*, since a postulate of that sort would validate the inferences in (46).

This motivates the quantization principle as far as events of weighing 5kg are concerned.

(47) **Quantization:** for all e and e',

$\mathsf{weigh}(e) \wedge \mathsf{weigh}(e') \wedge \mu(e) = 5kg \wedge \mu(e') = 5kg \wedge e \sqsubset e' \rightarrow e = e'$

Looking at all different weights, it seems that *weigh* does give rise to summative-like inferences:

(48) The red books weigh 5 kg.
The green books weigh 5 kg.
$\not\Rightarrow$ the books weigh 10 kg.

This pattern of inference is worrying for the quantization principle, because it suggests that *weigh* is in fact governed the a set of principles wholly incompatible with the quantization principle. Indeed, we can capture (48) by assuming that two events of weighing 5kg sum to an event of weighing 10kg or more generally as in (49). (49a) in particular contradicts the quantization principle: if the sum of two weighings is a weighing, then weighing can have strict subparts[4].

(49) For all e, e'

a. $\mathsf{weigh}(e) \wedge \mathsf{weigh}(e') \Rightarrow \mathsf{weigh}(e+e')$

b. $\mu(e) \wedge \mu(e') \Rightarrow \mu(e+e') = \mu(e) + \mu(e')$
where $\mu(e) + \mu(e')$ is the arithmetic sum of the two (e.g. 4kg + 5kg = 9 kg)

c. $\mathsf{agent}(e) \wedge \mathsf{agent}(e') \Rightarrow \mathsf{agent}(e+e') = \mathsf{agent}(e) + \mathsf{agent}(e')$
(this principle is already needed to account for summativity with other predicates.)

The problem is not as daunting as it first seems. This event-mereological approach used to capture the inferences in (48) over-generates dramatically. Consider that if the postulates in (49) are correct, then we would predict the following inferences should also hold when the subject pluralities overlap (as noted in Kuhn (2020)) But such is not the case and (50) attests:

(50) **Context:** *there are three types of books: green German green, green French books, red French books*
The green books weigh 10kg.

[4] Assuming that there is more than one element in the extension of *weigh*.

The French books weigh 10kg.

⇒ The books weigh 20kg.

The inferences in (48) are thus not adequately explained by the event-mereological assumptions in (50). The quantization principle can be maintained.

Sticking to the quantization principle, the inferences in (48) can be explained without appeal to mereology: we can simply assume that the existence of an event e_1 of weighing 5kg by the red books and an event e_2 of weighing 5 kg by the green books entail the existence of an event e_3 of weighing 10kg by the books but that e_3 is mereologically independent from e_1 and e_2.

This illustrates the case of *weigh 5 kg* but the same observations apply to other *numerous*-type predicates. They too fail to give rise to any summative inference, as attested for a number of predicates in the examples below. Because they do not yield any summative inferences, it is fair to assume that the extension of these predicates is quantized as well.

(51) The green books fit in the trunk.

The red books fit in the trunk.

$\not\Rightarrow$ The books fit in the trunk.

(52) The green books are 5 in number.

The red books are 5 in number.

$\not\Rightarrow$ The books are 5 in number.

Because, as said earlier, quantization implies lack of homogeneity in the system designed so far, Recall that quantization implies lack of homogeneity: if P is quantized, then $e \lhd P$ if and only if $P(e)$.

If the event predicates denoted by *numerous*-type predicates are quantized, then no event e can be part of ($\lhd$) such an event predicate without

All in all then, non-homogeneneity in *numerous*-type predicates is a consequence of their trivial part-whole structure. Another observable consequence of this trivial part-whole structure is the lack of summativity inference, in contrast to mixed predicates for instance.

Conclusion

This chapter has laid out an elaborate typology of patterns of homogeneity. This typology partially lines up with traditional typologies of collectivity. The existence of such partial correlations brings hope that homogeneity, rather than being stipulated, may in fact be deduced from other semantic properties of a predicate.

In the second part of the chapter, I provide a partial derivation of homogeneity properties from semantic properties. I show that summativity of an event predicate and certain forms of downward inferences (i.e. stratified reference) are predicted to give rise to downward homogeneity. Predicates which lack either downward inferences or summativity, such as *numerous*-type predicates, will also lack homogeneity.

This is an interesting but partial account. It remains a mystery why certain *gather*-type predicates but not others trigger homogeneity and how exactly sidewards homogeneity comes about precisely.

Chapter 7

Distributivity

This thesis's main focus is on cumulative readings. This chapter makes a small detour to discuss distributivity, another phenomenon of plural interpretation. This aside serves three purposes: …first, it explains how the present theory can be integrated within the broader galaxy of plural semantics ; second, it gives us more tools

7.1 Short introduction to distributivity.

Lexical vs. phrasal distributivity. For this work, distributive readings refer to readings of plural-referring expression where the plural-referring expression can be adequately paraphrased as a universal over the plural parts of the plural-referring expression. The examples in (1) are cases in point.

(1) a. The boys smiled.
$\leftrightsquigarrow$ *every boy smiled.*

b. The German players are wearing a blue jersey.
$\leftrightsquigarrow$ *every German player is wearing a blue jersey.*

While the two examples in (1) both fall in the "*distributive reading*" category, they do not have exactly the same status. In (1a), the observed universal-like meaning observed can reasonably be attributed to the meaning of "*smiled*": as part of its lexical semantics, X smiles if and only if all members of X smiled.

On the other hand, lexical stipulation could not possibly explain the universal meaning of (1b) (Roberts, 1987). Indeed, in (1b), the existential *a blue jersey* is in the scope of the universal. A universal meaning hard-coded in the lexical semantics of the verb would always take low-scope.

In previous works, these two classes of distributivity have been called lexical distributivity and phrasal distributivity. Phrasal distributivity is typically assumed to arise through the application of a covert DIST operator. (P- and Q-distributivity is another name for this distinction (Winter, 2001).)

Lexical distributivity, i.e. the universal-like meaning of some predicates in positive contexts, has been studied in detail in the rest of this work (in chapters 2 and 4 for instance). I will therefore focus my attention on phrasal distributivity. Examples of phrasal distributivity abound. The examples below are a sample (partly drawn from de Vries (2015)). In each case, the paraphrased universal meaning captures in its scope various scope-bearing elements: an indefinite in (1b), a modal *can* in (2) , a disjunction in (3), a comparative in (4). In some of these cases, the sentence also has a non-distributive reading (not paraphrasable as a universal over elements of the plurality), which I do not represent.

(2) The dromedary can carry these bags.
$\rightsquigarrow$ *for every bag x, the dromedary can carry x*

(3) The students here are enrolled in the linguistics program or the philosophy program.
$\rightsquigarrow$ *every student is either enrolled in the linguistics or the philosophy program.*

(4) The calves are lighter than the pig.
$\rightsquigarrow$ *every calf is lighter than the pig.*

Traditionally (Roberts, 1987; Winter, 2001), such examples are explained by a covert adverbial DIST, a covert counterpart of adverbial *each*.

(5) $[\![\text{DIST}]\!] = \lambda p_{et}.\lambda X_e.\ \forall x \prec X,\ p(x)$

The phrasal distributive readings can be created by applying DIST to the appropriate predicates. This can include predicates derived by movement of a DP, as in (6b).

(6) a. The German players DIST [are wearing a blue jersey]

b. these bags DIST λx. [the dromedary can carry x]

c. the students here DIST [are enrolled in the linguistics program or the philosophy program]

d. the calves DIST [are lighter than the pig]

Homogeneity of phrasal distributivity and how to account for it. The reason why phrasal distributivity is relevant to this thesis's concerns is that it gives rise to homogeneity. This is true of all of the examples discussed so far, repeated below. In each case, the a. sentences are universal positive in meaning, while the b. sentences are universal negative in meaning. The account of phrasal distributivity sketched out above is silent on why there should be such homogeneity effects.

(7) a. The German players are wearing a blue jersey.
$\rightsquigarrow$ *every German player is wearing a blue jersey*

b. The German players aren't wearing a blue jersey.
$\rightsquigarrow$ *no German player is wearing a blue jersey*

(8) a. The dromedary can carry these bags.
$\rightsquigarrow$ *every one of these bags can be carried by the dromedary*

b. The dromedary cannot carry these bags.
$\rightsquigarrow$ *none of these bags can be carried by the dromedary*

(9) a. The students are enrolled in the linguistics program or the philosophy program.
$\rightsquigarrow$ *every student is enrolled in either program*

b. The students aren't enrolled in the linguistics program or the philosophy program.
$\rightsquigarrow$ *no students are enrolled in either program*

(10) a. The calves are lighter than the pig.
$\rightsquigarrow$ *every calf is bigger than the pig.*

b. The calves aren't lighter than the pig.
$\rightsquigarrow$ *no calf is bigger than the pig.*

Can this form of homogeneity be captured by the theory of this work? Not as such. In fact, a problem arises even earlier: the universal meaning of positive sentences is not captured. (11a) would be represented as (11b). For simplicity, I assume that *wear* is not part-homogeneous in any of its arguments and that it is summative in both arguments. Following chapter 4, this means that the weak meaning $[\![\exists\text{-wear}]\!](y)(X)$ is true of events of wearing y by some of X. Following the computations of chapter 4, this means that the event described in (11) is one where some of the players wearing a single blue jersey which is not an event of some of X wearing a blue jersey where X is sub-plurality of players or plurality that overlap with the players. The events that meet this description are events where all the players are wearing a single blue jersey: a collective reading.

(11) a. The German players are wearing a blue jersey.

b. $\exists e$, EXH the German players ∃-wear a blue jersey.

What the account seems to be missing is a counterpart of the DIST operator of traditional theories. This counterpart should also trigger some form of homogeneity. A starting point, following this work's leitmotiv (based on Bar-Lev (2018a)), would be to assign DIST a weak existential meaning, e.g. (12a), adequate for negative sentences. This meaning would then be strengthened in positive contexts to a universal meaning in positive contexts via exhaustification.

(12) $[\![\exists\text{-}\textsc{Dist}]\!] = \lambda p_{et}.\lambda X_e.\, \exists x \prec X,\ p(x)$

To distinguish between ∃-DIST and the type of homogeneity discussed in the previous chapters, I will sometimes refer to the latter form as lexical homogeneity and represent it with the symbol ∃−*verb*.

At this stage, an intriguing possibility is raised. In the sketch proposed, there are two sources of weak existential meanings: the verb itself (e.g. ∃-*verb*) and the ∃-DIST operator. Wouldn't it be more parsimonious to have a single mechanism for weak meanings? Specifically, one could hope to reduce ∃-*smile* to a complex combination of ∃-DIST and *smile*.

The reductions sketched here would identify the homogeneity of phrasal distributivity to lexical homogeneity, the homogeneity investigated so far in this work. Interestingly, Bar-Lev (2018a)'s theory, which this work has much drawn on, implements such a reduction.

In the sequel, I will present an overview of how Bar-Lev's theory works. We will then compare Bar-Lev's redeuctive theory of homogeneity to an unparsimonious theory that maintains side-by-side ∃-DIST and ∃-*verb*. I will argue that while initially undesirable, the unparsimonious account is in fact more economical and more explanatory, all data considered.

7.2 Bar-Lev (2018a) on phrasal and lexical distributivity

Bar-Lev (2018a) assumes that all weak meanings arise from ∃-DIST, the existential distributivity operator presented earlier. Applied to (13a), ∃-DIST generates an underlying existential meaning: *some German player is wearing a blue jersey.* This meaning is adequate for the negative case: under negation, the truth-conditions assert that no Germain players is wearing a blue jersey.

(13) a. The German players ∃-DIST [are wearing a blue jersey.]

b. $\exists x \in \iota\text{German-players}, \exists y \in \text{blue-jersey}, x \text{ is wearing } y$

c. The German players are not ∃-DIST [wearing a blue jersey.]

d. $\neg\exists x \in \iota\text{German-players}, \exists y \in \text{blue-jersey}, x \text{ is wearing } y$

For positive sentences, Bar-Lev assumes an *innocent inclusion* exhaustification operator. For the purposes of comparing theories, it does not matter precisely how Bar-Lev's *innocent inclusion* EXH proceeds. Here and below, I will loosely assume the effect of EXH is to strengthen existentials to universals (Free Choice implicature).

(14) $\textsc{Exh}(\exists x \in P, \ldots, \{\exists x \in C \cap P, \mid C \subset D_e\}) = \forall x \in P, \ldots$

Applied to the original cases, this operator derives the attested phrasal distributive meaning that every German player wears a blue jersey.

(15) a. The German players ∃-DIST [are wearing a blue jersey.]

b. $\textsc{Exh}(\exists x \prec \iota\text{German-players}, \exists y \in \text{blue-jersey}, x \text{ is wearing } y,$
$\left\{\exists x \prec \iota\text{German-players}, C(x) \wedge \exists y \in \textbf{blue-jersey}, x \text{ is wearing } y \middle| C \subset D_e\right\})$
$= \forall x \prec \iota\text{German-players}, \exists y \in \text{blue-jersey}, x \text{ is wearing } y$

This is adequate to capture both phrasal distributivity and the truth-value gaps it gives rise to. But, unlike the unparsimonious account, the theory of Bar-Lev (2018b) aims to capture all cases of plural homogeneity through this mechanism. For this reason, he assumes that even sentences involving lexical distributivity like (16), whose truth-conditions could in principle be captured by lexical stipulations, require an ∃-DIST operator. This stipulation ensures that even these sentences give rise to homogeneity.

(16) a. The dancers smiled.

b. EXH The dancers ∃-DIST smiled
all dancers smiled.

(17) a. The dancers didn't smile.

b. ¬ The dancers ∃-DIST smiled
no dancers smiled.

The unparsimonious theory, on the other hand, assumes both ∃-DIST and ∃-verb. Therefore, the sentence in (16) could in principle generate two logical forms, (18a) and (18b), depending on whether an ∃-DIST operator is used or not. Both forms would yield a universal meaning that all dancers smiled.

(18) a. EXH The dancers ∃-smiled.

b. EXH The dancers ∃-DIST ∃-smiled.

At this stage, the greater simplicity of Bar-Lev (2018b)'s theory is undeniable: it models the reading of (18) with one LF, where the unparsimonious account generates 2. There is however a point of comparison already. Previous literature (Dotlačil and Brasoveanu, 2015, 2021; Frazier et al., 1999) has argued that phrasal distributivity comes at a greater cost. Because jerseys are worn by single individuals, (19a) is biased toward a distributive interpretation. Without this plausibility pressure, there is in fact an overwhelming preference for sentences to receive a non-distributive interpretation.

(19) a. The German players are wearing a blue jersey.

b. The German players carried a suitcase

In the unparsimonious theory, this preference could be attributed to the cost of inserting an ∃-DIST operator. In the Bar-Lev's theory, it is not immediately clear what could be said to explain this preference[1].

Collectivity and intermediate distributivity. The initial presentation of Bar-Lev (2018a)'s theory needs to be refined. Collective predication, which also gives rise to homogeneity, is challenging to the current formulation of ∃-DIST. As given earlier, the ∃-DIST operator is an existential quantifier over the atoms that compose a plurality. After strengthening, it becomes a universal over such atoms.

(20) $[\![\exists\text{-}\textsc{Dist}]\!] = \lambda p.\lambda X.\ \exists x \prec X,\ p(x)$

strengthened to $\forall x \prec X,\ p(x)$

This atom-only denotation render collective predication out of reach. With or without strengthening, (21) implies that a singularity gathered.

[1]M. Bar-Lev (p.c.), in recent unpublished work, proposes that the preference for collective readings stem from a uniqueness implicature triggered by the indefinite *a car*. This proposal would explain the preference for distributive readings in cases where the object in ∃-DIST's scope is an indefinite. This will not work for other cases of phrasal distributivity (e.g. bound pronouns *the German players talked to their manager*). Thankfully for this theory, the work which reports a dispreference for phrasal distributivity focus on the indefinite case, so it is not yet known whether it genuinely extends to all cases of phrasal distributivity.

(21) The children ∃-DIST gathered.

⇝ some child gathered (without strengthening)

⇝ each child gathered (with strengthening)

To address this challenge, Bar-Lev proposes an enrichment[2] of ∃-DIST. In the enriched version, ∃-DIST asserts that "*the children gather*" is true (without strengthening) if and only if some child is part of a group of children X' that gathered. X' is constrained to belong to COV, a free parameter of interpretation called the "*cover*" (Schwarzschild, 1996).

(22) $[\![\exists\text{-DIST}_{\text{COV}}]\!](p) = \exists x \prec X,\ \exists X',\ x \prec X' \prec X \wedge X' \in \text{COV} \wedge p(x)$

To understand this cover-based version of ∃-DIST, let us start with collective predicates like *gather*. For collective predicates like *gather*, Bar-Lev assumes COV to be the set of all individuals (hereafter *the maximal cover*). In that case, the restriction to COV is vacuous and ∃-DIST reduces to:

(23) $[\![\exists\text{-DIST}_{\text{MAX}}]\!](p) = \exists x \prec X,\ \exists X',\ x \prec X' \prec X \wedge p(x)$

In negative sentences, this version of ∃-DIST gives rise to truth-conditions that validate downward inferences (cf (24b)): no sub-group of children gathered.

(24) The children didn't ∃-DIST gathered.

a. $\neg\exists x \prec X, \exists X', x \prec X' \prec X \wedge \mathsf{gather}(x)$

$\leftrightarrow$ *no child is part of a group of children that gathered.*

$\leftrightarrow$ *no group of children gathered.*

In positive environment, ∃-DIST is strengthened to a universal meaning. The observed truth-conditions of the sentence in (25b) are met just in case every child is part of a group of children that gathered. This could be true if all the children congregated together or if multiple gangs of children congregated in different parts of the city. Note that contrary to the view spelled out in chapter 6, these truth-conditions mean that Bar-Lev takes *gather* to be a summative predicate: if X gathered and Y gathered, X and Y gathered[3].

[2] For simplicity, my presentation is closer to Bar-Lev (2020) than Bar-Lev (2018a).

[3] Kuhn (2020) reports that *gather* is not summative so this may be an incorrect prediction.

(25) a. EXH The children ∃-DIST gathered.

b. $\forall x \prec X, \exists X', x \prec X' \prec X \wedge \mathsf{gather}(x)$

every child is part of a group of children that gathered.

But Cov can receive different settings. If Cov is equal to AT, then the enriched ∃-DIST reduces to the earlier atomic version of ∃-DIST:

(26)
$$\llbracket \exists\text{-DIST}_{\text{AT}} \rrbracket (p) = \exists x \prec X,\ \exists X',\ x \prec X' \prec X \wedge X' \in \text{AT} \wedge p(x)$$
$$= \exists x \prec X,\ p(x)$$

This means that by setting COV to AT, we retrieve the explanation for the phrasally distributive sentences we looked at:

(27) a. EXH The German players $\exists$-DIST$_{\text{AT}}$ are wearing a blue jersey.

b. $\text{EXH}(\exists x \prec \iota\mathsf{German\text{-}players}, \exists y \in \mathsf{blue\text{-}jersey}, x \text{ is wearing } y)$

$= \forall x \prec \iota\mathsf{German\text{-}players}, \exists y \in \mathsf{blue\text{-}jersey}, x \text{ is wearing } y$

Finally, setting Cov to a singleton set (e.g. $\{\iota\mathsf{German\text{-}players}\}$) can be used to neutralize homogeneity. This trick can be used to explain the lack of homogeneity in a sentence like (28). Indeed, in this case, the meaning of ∃-DIST without strengthening (i.e. (28a)) is equivalent to its meaning after strengthening (i.e. (28b)).

(28) The German players $\exists$-DIST$_{\{\iota\mathsf{German\text{-}players}\}}$ are 10 in number.

a. $\exists x \prec X,\ \exists X',\ x \prec X' \prec \iota\mathsf{German\text{-}players} \wedge X' \in \{\iota\mathsf{German\text{-}players}\} \wedge \mathsf{ten\text{-}in\text{-}number}(X')$

$\leftrightarrow \mathsf{ten\text{-}in\text{-}number}(\iota\mathsf{German\text{-}players})$

b. $\forall x \prec X,\ \exists X',\ x \prec X' \prec \iota\mathsf{German\text{-}players} \wedge X' \in \{\iota\mathsf{German\text{-}players}\} \wedge \mathsf{ten\text{-}in\text{-}number}(X')$

$\leftrightarrow \mathsf{ten\text{-}in\text{-}number}(\iota\mathsf{German\text{-}players})$

To summarize, Bar-Lev proposes a single mechanism for creating weak meanings: ∃-DIST. This mechanism has a contextual setting COV. Setting COV to various values deliver different forms of homogeneity/collectivity: a maximal cover gives rise to downward homogeneity and summativity for *gather*-type predicates ; an atomic cover predicts atomic distributivity and "*distributive*" homogeneity ; a singleton cover predicts a pure collective reading and lack of homogeneity.

The unparsimonious theory could also adopt the cover-based ∃-DIST. But none of the data seen so far warrants that change. In chapters 4 and 6, we already saw a means to derive the homogeneity properties and truth-conditions of (29a) and (29b) through ∃-*verb*. (29c) does require application of ∃-DIST but the atomic version of ∃-DIST assumed initially is sufficient to derive the desired reading.

(29) a. The children ∃-gathered.

b. The children ∃-number 10.

c. The German players ∃-DISTAT ∃-wore a blue jersey.

However, more date shows that even the unparsimonious approach must assume a cover-based ∃-DIST. So far, we have focused on sentences like (29c) where distribution is down to atoms (i.e. *every atomic German player* ...). But Schwarzschild (1996) and Gillon (1992) have provided arguments that in certain cases distribution must be down to larger entities than atoms, i.e. *intermediate distributivity*. The most striking of such examples is (30). A salesperson may utter (30) and convey that each pair of shoes sells for $40.

(30) The shoes cost $40.

A naturally paired noun like *shoe* is not always required for such a reading to arise. With elaborate contexts, like (31), it becomes possible to obtain intermediately distributive reading[4] with other nouns as well. The use of *exquisite corpse poem*, which requires at least two people to write, ensures non-atomic distributivity ; the division in competing teams ensure that each team produces its own poem.

[4]There is some controversy whether such readings genuinely exist and how they should be represented (Buccola et al., 2021; Gillon, 1992; Grimau, 2021; Landman, 2000, a.o.). I follow Bar-Lev (2018a) in assuming that they exist and they can be accounted for by appeal to covers. If these assumptions are wrong, then the unparsimonious approach does not need to refine its definition of ∃-DIST, while Bar-Lev (2018b) needs to constrain covers so that they cannot fulfill the role of intermediate distributivity, while still assuming that they can be used to derive the different properties of homogeneity. This makes the unparsimonious approach preferable.

(31) a. **Context:** *in a TV game show, players are organized in teams of 3 and perform a series of physical and intellectual challenges. The host reports on what happened in the first round.*

In the first round, the players wrote an "*exquisite corpse*" poem in iambic pentameter.

b. **Observed truth-conditions:**

For every team of player, that team wrote an "*exquisite corpse*" poem in iambic pentameter.

In these readings, there is one poem per team. An important caveat at this stage is that apart from clear-cut cases (30), cases of intermediate distributivity are in general difficult for speakers to access. Some of the examples later suffer from the same degradation.

Regardless, the presence of this reading cannot be accommodated by the unparsimonious approach with an atomic ∃-DIST operator. As seen with the examples of phrasal distributivity studied earlier, using only ∃-*wrote* as a source for homogeneity, as in (32a), only delivers a collective reading. An atomic ∃-DIST_{AT}, on the other hand, would predict each player has written their own poem.

(32) a. EXH The players ∃-wrote a poem

⇝ *one poem per player*

b. EXH The players ∃-DIST_{AT} ∃-wrote a poem

⇝ *one poem per player*

With covers and a cover-based ∃-DIST_C, these readings can be made sense of. To derive (31), one can assume that the cover parameter C is the set of all pluralities which form a team. With strengthening, (33a) becomes (33b). (I set aside the contribution of ∃-*wrote* in intermediately distributive sentences ; we will come back to it in the next section)

(33) a. EXH The players ∃-$\text{DIST}_{\text{TEAM}}$ (∃-)wrote a poem

where TEAM = $\{X \in D_e \mid$ there is a team t s.t. X are the members of $t\}$

b. $\forall x \prec X,\ \exists X',\ x \prec X' \prec \iota\text{German-players} \wedge X' \in \text{TEAM} \wedge [\![\text{wrote a poem}]\!](X')$

all players are part of team that wrote a poem.

The explanation of intermediate distributivity is of course immediately transposable to Bar-Lev (2018a)'s account, who assumes the cover-based ∃-DIST operator.

In summary, we have two theories of homogeneity and phrasal distributivity. One theory - Bar-Lev (2018a) - assumes that all sources of homogeneity come from a single ∃-DIST operator. By manipulating the choice of cover, this ∃-DIST operator can make a predicate distributive (atomic cover), intermediate distributive (pair cover, etc.) or collective (atomic or singleton) ; it can make it homogeneous (maximal cover) or non-homogeneous (singleton cover). Another theory - the unparsimonious account - assumes two sources of homogeneity: an ∃-DIST and the lexical ∃−*verb*. The ∃-*verb* determines, as seen in chapter 6, some of the homogeneity properties of the predicate on the basis of their event properties. The ∃-DIST operator is used to create phrasal distributivity. Its cover parameter modulates whether the reading obtained is atomically distributive or intermediate distributivity. It also introduces its own homogeneity, in addition to chat is already contributed by ∃-*verb*.

7.3 Intermediate distributivity and the nature of covers

At this stage of the comparison then, there would seem to be no good reason to cling to the unparsimonious approach: it assumes strictly more than Bar-Lev (2018a) for the same results (distributivity dispreference notwithstanding). I will now argue for the following fact: for Bar-Lev (2018a) theory to be empirically adequate, it must be assumed that one property of the cover is dependent on the nature of the predicate itself (e.g. *downward closure*) while another (e.g. *maximal elements*) is determined by how the predicate's argument is partitioned in context. In Bar-Lev (2018b)'s theory, this curious dual determination of covers must be some yet-to-be-understood component of the theory of implicit parameter selection. As I will show, this fact comes out, in the unparsimonious theory, as the result of a natural division of labour between ∃-DIST and ∃-*verb*.

Frozen covers. In presenting Bar-Lev (2018b), I have only presented those choice of cover settings which delivered the attested reading. I haven't touched a word on what other readings may be predicted for other choice of covers. Consider *numerous*-type predicates. To predict their lack of homogeneity, a singleton cover must be chosen. With a maximal cover, the cover used to predict the homogeneity properties of *gather*, *ten in number* would yield a surprising result in (34)[5]. (Recall the maximal cover is simply the domain D_e)

(34) **Maximal Cover with *numerous*-type predicates:**

a. **LF for positive and negative:**

The children ∃-DISTMAX are 10 in number.

not the children ∃-DISTMAX are 10 in number.

b. The children are 10 in number.

predicted:

$\forall x, \exists X',\ x \prec X' \prec \iota\text{children} \wedge X' \in D_e \wedge |X'| = 10$

every child is part of 10 children. (= there are at least 10 children)

c. The children are not 10 in number.

predicted:

$\neg\exists x, \exists X',\ x \prec X' \prec \iota\text{children} \wedge X' \in D_e \wedge |X'| = 10$

no child is part of 10 children. (= there are at most 9 children)

The cover parameter is assumed to be set by context and in principle, contextual implausibility can be a reason to rule out a cover setting. But the unattested meanings obtained here are sensible so they must be ruled out on other grounds.

Similarly, *gather*-type predicates can be made to behave non-homogeneneously by setting the cover to a singleton cover. (Note that this setting also gives rise to a one-

[5] It is often assumed that numerals have an underlying *at least* meaning which is then strengthened to an exact interpretation via scalar implicature. On that view, the *at least* reading predicted for (34) would not be so out of the ordinary. But more complex examples show that the *maximal cover* is a genuine problem. For instance, *the bags cost a multiple of 3 in dollars*, with the same ∃-DIST, would mean the same as *the bags cost $3 or more.*

gathering reading.)

(35) **Singleton Cover with *gather*-type predicates:**

a. The children gathered.

predicted: *there was a gathering of all the children.*

b. The children didn't gather.

predicted: *there wasn't a gathering of all the children.*

Here too, no plausibility considerations *a priori* rules out this cover setting. Bar-Lev (2018a) is aware of these predictions. He assumes, without going into details, that there is a strong connection between the choice of predicate and the choice of cover. Homogeneous predicates like *gather* receive, as a matter of rule, maximal covers. On the other hand, collective predicates receive singleton covers.

Yet, it cannot be that the cover is determined solely on the basis of the predicate. Extra-linguistic context must be allowed to play a role in cover setting. Recall the examples in (36). Here, a grouping of *the shoes* into pairs is rendered salient by world knowledge. It is presumably this world knowledge that determines the cover C be the set of shoe-pairs $\{x_1 + x_2 \in D_e \mid x_1 + x_2 \text{ is a pair of shoes}\}$.

(36) a. EXH The shoes $\exists$-DIST$_{\text{SHOE-PAIR}}$ cost \$10.

predicted: *each pair of shoes cost \$10*

b. The shoes don't $\exists$-DIST$_{\text{SHOE-PAIR}}$ cost \$10.

predicted: *no pair of shoes cost \$10*

To summarize the discussion so far, we see here a dual behavior. To correctly predict the homogeneity properties of different classes of lexical predicates, a strong connection must be posited between the choice of the cover and the nature of the predicate. On the other hand, in some cases of distributivity, the context - specifically the way that the subject of the predicate can be partitioned - seems to impact the choice of cover.

Combining lexical and contextual requirements I will now present examples where both effects seem to play a role. In these cases, the nature of the predicate decides some aspects of the cover (namely its downward closure properties), while the salient partitioning of the context decides another (namely the maximal elements).

As our running context for the examples below, imagine a game show where participants are separated in three teams (A, B, C and D). Each team must raise funds for the WWF ; the team that collects the most money wins. At the end of the game, we observe the following results:

(37)

Team A	Team B	Team C	Team D
$18,000	$17,000	$8,000	$9,000

This context is built to make partition of players into teams salient.

Our first example is sentence (38a). I restrict our attention to the players from the first two teams so as to create contrast with the last team. As already discussed, phrasal distributive readings and more specifically intermediate distributivity readings are difficult to access ; contrast, for unknown reasons, seems to facilitate them. (38a) can truthfully be uttered in the context of (37). By contrast, the negation of that sentence, (38b), could only be true if both teams collected less than $15,000. This would make it false in the scenario in (37).

(38) a. The players in team A and team B collected more than $15,000. (The players in team C and team D did not.)
$\rightsquigarrow$ *the players in team A collected more than $15,000.*
$\rightsquigarrow$ *the players in team B collected more than $15,000.*

b. The players in team A and team B didn't collect more than $15,000.
$\rightsquigarrow$ *the players in team A didn't collect more than $15,000.*
$\rightsquigarrow$ *the players in team B didn't collect more than $15,000.*

Within Bar-Lev (2018a), the truth-conditions of (38a) and (38b) can be derived by assuming the cover to be the set of words within a list $\textsc{Team} := \{\iota\text{players-in-team-A}, \iota\text{players-in-team-B}\}$. With this cover, the predicted truth-conditions for both sentences, written formally in (39), are equivalent to the attested truth-conditions.

(39) a. $\forall x \in \iota\text{players-from-teams-A-and-B}, \exists X',\ x \prec X' \prec \iota\text{players-from-teams-A-and-B} \wedge X' \in \text{TEAM} \wedge [\![\text{collected more than \$15,000}]\!](X')$

The players in team A collected more than $15,000, the players in team B collected more than $15,000

b. $\neg\exists x \in \iota\text{players-from-teams-A-and-B}, \exists X',\ x \prec X' \prec \iota\text{players-from-teams-A-and-B} \wedge X' \in \text{TEAM} \wedge [\![\text{collected more than \$15,000}]\!](X')$ The players in team A didn't collect more than $15,000, the players in team B didn't collect more than $15,000

As a context for our second sentence, suppose we now wonder why team A and team B have been so much more successful than team C and team D. By uttering the sentence (40a) as an answer to that question, speakers can, in this context, express that each team is composed of high school friends. Like the negation of the first sentence, the negation of the second sentence has homogeneity "*at the team level*": it conveys that neither team is composed of high school friends. But unlike the first sentence, it also has homogeneity down "*to the player*": it does not simply assert that the players in team A are not all high school friends, it asserts that none of them (or very few[6]) are.

(40) a. The players in team A and team B are high school friends. (The players in team C and team D are not.)

$\rightsquigarrow$ *every player in team A is a high school friend of a player in team A.*

$\rightsquigarrow$ *every player in team B is a high school friend of a player in team B.*

b. The players in team A and team B are not high school friends.

$\rightsquigarrow$ *no player in team A is a high school friend of any player in team A.*

$\rightsquigarrow$ *no player in team B is a high school friend of any player in team B.*

If the cover in this second example is the same cover TEAM used to derive the meaning of the first sentence, this extra layer of homogeneity is not predicted. The predicted meaning for the negative sentences, written formally in (41b), simply asserts that neither team contains *only* high school friends.

[6]This is the phenomenon of non-maximality mentioned in chapter 1.

(41) a. $\forall x \in \iota\textsf{players-from-teams-A-and-B}, \exists X', \; x \prec X' \prec \iota\textsf{players-from-teams-A-and-B} \wedge X' \in \textsc{Team} \wedge [\![\text{friends}]\!](X')$

The players in team A are all high school friends, the players in team B are high-school friends

b. $\neg\exists x \in \iota\textsf{players-from-teams-A-and-B}, \exists X', \; x \prec X' \prec \iota\textsf{players-from-teams-A-and-B} \wedge X' \in \textsc{Team} \wedge [\![\text{friends}]\!](X')$ The players in team A are not all high school friends, the players in team B are not all high school friends

To capture the homogeneity properties of this second sentence, a different cover must be used: $\textsc{Team}^{\cup} = \{X \in D_e \mid X \text{ are part of the same team}\}$. This cover contains any sub-plurality of teammates, whereas $\textsc{Team}$ only contain the team plurality themselves. With the inclusion of these smaller pluralities, the meaning in (42) now adequately represent the "*two-layered*" homogeneity effects observed in the second sentence:

(42) a. $\forall x \in \iota\textsf{players-from-teams-A-and-B}, \exists X', \; x \prec X' \prec \iota\textsf{players-from-teams-A-and-B} \wedge X' \in \textsc{Team}^{\cup} \wedge [\![\text{friends}]\!](X')$

The players in team A are all high school friends, the players in team B are high-school friends

b. $\neg\exists x \in \iota\textsf{players-from-teams-A-and-B}, \exists X', \; x \prec X' \prec \iota\textsf{players-from-teams-A-and-B} \wedge X' \in \textsc{Team}^{\cup} \wedge [\![\text{friends}]\!](X')$ No two players in team A are high school friends, no two players in team B are high school friends

The contrast between the homogeneity properties of the two examples is curious. Since the context for both sentences makes salient the same partition of players into teams, why do the two examples give rise to different covers? If not in the extra-linguistic context, the difference must lie in the predicates used: *collect more than $15,000* vs. *be high school friends*. In the typology of chapter 6, the former is an unhomogeneous *numerous*-type predicate and the latter is a homogeneous *gather*-type predicates.

What these examples illustrate is that the cover needed by Bar-Lev (2018a)'s account depends on both context and predicate choice. Both covers $\textsc{Team}$ and $\textsc{Team}^{\cup}$ make reference to the teams whose identity is established in context. $\textsc{Team}^{\cup}$ is downward-closed (if $X \oplus Y$ is in the cover, so is X), which creates "*homogeneity down to the player*" and this property seems to reflect the nature of the predicate itself (*be friends*). $\textsc{Team}$, on the other hand, is quantized (if $X \prec Y$ are both in the cover, then $X = Y$), which blocks "*homogeneity down to the player*" and this property is a reflection of the nature of the predicate. A general (rough[7]) principle could be stated in this way:

(43) **Cover setting principle**

In a sentence …$\exists$-DIST$_C$Pred, C is such that:

- the maximal elements of C are the partition salient in
- If Pred belongs to a certain semantic class H, then C is downward-closed
- If Pred belongs to a certain semantic class NH, then C is equal to the set of its maximal elements

This principle is extremely specific. It begs the question: why should covers be determined in this dual manner? In Bar-Lev (2018a)'s theory, any generalization about cover setting belongs to the theory of implicit parameters (since covers are an instance of such parameters). But little is known about the selection of implicit parameters so the mystery around why covers behave the way they do remains whole.

By contrast, the unparsimonious theory has a very natural way to understand these generalizations. The lexical semantics of the predicate $\exists$-*verb* determines a particular kind of homogeneity (e.g. *collect more than $15,000* vs. *be high school friends*). Added to that, an $\exists$-DIST cover-based homogeneity operator creates homogeneity with respect to the cells of a cover (e.g. team-based partition). The only generalization about covers needed is that the cover C is *literally* equal to the salient partition of the argument is salient in context ; downward-closed covers can be dispensed with entirely.

Let me start the illustration of this account with the second example, repeated in (44). (44a) illustrates a pseudo-derivation of the meaning of the first sentence. This derivation is not faithful to the implementation to be presented in section 7.4, but provides a good approximation. The passage from the first line to the second line corresponds to the homogeneity properties of homogeneous *gather*-type predicate seen in

[7] Refinements will be needed for cases where the context determines a cover, rather than a partition (i.e. where two pluralities overlap). Since my point is that the complexity of this pragmatic principle makes it an undesirable one to have, incorporating refinements would bolster the argument.

chapter 6. From the second to third, I assume an EXH operator strengthens both existential to universals. The derivation of the negative sentence in (44b) follows the same steps. The resulting meanings adequately predict a two-layered form of homogeneity: homogeneity "*down to the team*" and homogeneity "*down to the player*".

(44) EXH The players from team A and team B are ∃-$\text{DIST}_{\text{TEAM}}$ ∃-[high school friends]

a. Players := ιplayers-from-teams-A-and-B

$$\text{EXH}\left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge [\![\exists\text{-friends}]\!]\,(X')\right)$$

$$= \text{EXH}\left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge \exists X'' \prec X', [\![\text{friends}]\!]\,(X')\right)$$

$$= \forall x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge \forall X'' \prec X', [\![\text{friends}]\!]\,(X'')$$

All players from team A and B are part of a team such that all members of it are high-school friends

b. $$\neg\left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge [\![\exists\text{-friends}]\!]\,(X')\right)$$

$$= \neg\left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge \exists X'' \prec X', [\![\text{friends}]\!]\,(X')\right)$$

No players from team A and B are part of a team such that any members of it are high-school friends

The first example, repeated in (45), also uses Team as a cover. This is welcome as both sentences are uttered in contexts that make available the same partition of players into teams. The difference here is that ∃-*verb*, because it applies to a *numerous*-type predicate, is vacuous. This is a consequence of the analysis of chapter 6. As a consequence, only homogeneity "*down to the team*" is predicted.

(45) EXH The players from team A and team B ∃-$\text{DIST}_{\text{TEAM}}$ ∃-[collected] more than \$15,000

a. Players := ιplayers-from-teams-A-and-B

$$\text{EXH}\left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge [\![\exists\text{-collected}\ldots]\!]\,(X')\right)$$

$$= \text{EXH}\left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge \exists X'' \prec X', [\![\text{collected}\ldots]\!]\,(X')\right)$$

$$= \forall x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \wedge X' \in \text{TEAM} \wedge [\![\text{friends}]\!]\,(X')$$

All players from team A and B are part of a team such that the members of it collected more than \$15,000

b. $\neg \left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \land X' \in \text{TEAM} \land [\![\exists\text{-collected} \ldots]\!]\,(X') \right)$

$= \neg \left(\exists x \in \iota\text{Players}, \exists X',\ x \prec X' \prec \iota\text{Players} \land X' \in \text{TEAM} \land [\![\text{collected} \ldots]\!]\,(X') \right)$

No players from team A and B are part of a team such that the members of it collected more than $15,000

Summary. The goal of this section was to investigate the possibility of reducing the homogeneity observed in lexical predication to the homogeneity created by phrasal distributivity. A theory where both forms of homogeneity arise from different source seemed like an *unparsimonious* and therefore undesirable theory. Bar-Lev (2018a) served as our model of what a parsimonious and reductive theory would look like. In this theory, a cover parameter determines both the homogeneity properties of the sentence and the granularity of the distributivity it gives rise to (i.e. atomic or intermediate). Following arguments from previous literature, the cover was shown to be a component of the theory of phrasal distributivity, which an unparsimonious approach would independently need.

The problem of the reductive account is that the covers are made to play too many roles, encompassing both lexical homogeneity and the homogeneity of phrasal distributivity. To ensure that the observed readings are the only ones delivered, sophisticated pragmatic constraints need to be assumed. In the end, the initial simplicity of the theory is offset by the complexity of these constraints.

What is, in Bar-Lev (2018b), a single articulate homogeneity effects reveals itself to be the composition of two simple homogeneity effects in the unparsimonious approach: the homogeneity effects of ∃-verb and the homogeneity effects of ∃-DIST. The needed pragmatic principles are transparent. This account also gives a handle on why phrasal distributive readings are hard to obtained, if it is assumed that the insertion of ∃-DIST is a costly operation.

7.4 Formal analysis

Last section has argued for the necessity of *both* ∃-DIST operators and ∃-*verb*. In presenting the argument, I gave an event-less definition of ∃-DIST following Bar-Lev (2018b) and conducted the discussion on that basis. If we wish to incorporate ∃-DIST in the event framework of chapter 4 however, an adaptation of this operator will need to be made. This is what I set out to do now.

For simplicity, let us start with the case where ∃-DIST combines with an atomic cover. We want to capture the atomic phrasal distributivity reading of the two sentences in (46) by application of an event-based ∃-DIST operator.

(46) a. The German players aren't wearing a red jersey.
⇝ *no German players is wearing a red jersey*

b. The German players are wearing a red jersey.
⇝ *every German player is wearing a red jersey*

Translated to event talk, the truth-conditions of (46a) of (46a) could be expressed as "*there is no event of wearing a red jersey by a German player*", e.g. (47a), or as "*no event is a sum of wearing a red jersey by a German player*", cf (47b). These two formulations are truth-conditionally equivalent but (47b) will make the passage from (46a) to (46b) through .

(47) a. $\neg\exists e, \exists y \prec \iota\mathsf{German\text{-}player}, \exists x \in \mathsf{red\text{-}jersey},\ \mathsf{wear}^{\mathsf{ag+thm}}(e)(x)(y)$

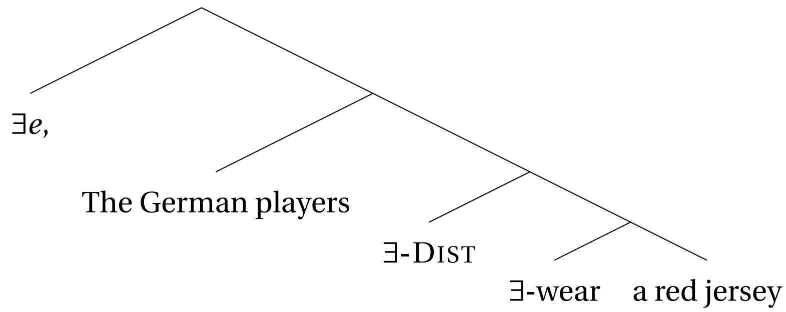
b. $\neg\exists e, e \in {}^*\big(\lambda e'.\exists y \prec \mathsf{German\text{-}player}, \exists x \in \mathsf{red\text{-}jersey},\ \mathsf{wear}^{\mathsf{ag+thm}}(e')(x)(y)\big)$

Abstracting away the particulars, we form the event definition of ∃-DIST from (47b).

(48) $[\![\exists\text{-}\textsc{Dist}]\!] = \lambda X.\ {}^*\big(\lambda e.\ \exists x \prec X,\ \mathsf{Atom}(x) \wedge p(x)(e)\big)$

With the LF in (49a) and without any form of exhaustification, the composition yields the truth-conditions in (49b). Assuming that *wear* is not part-homogeneous (i.e. there are no non-trivial part of *wear* events with singular thematic roles), we can ignore the contribution of ∃- in ∃-wear, since both arguments of ∃-*wear* are singulars. So (49b) can be simplified to (49c). (49c) is the desired result: its truth-conditions are exactly the complement of the truth-conditions we described in (47b).

(49) a.



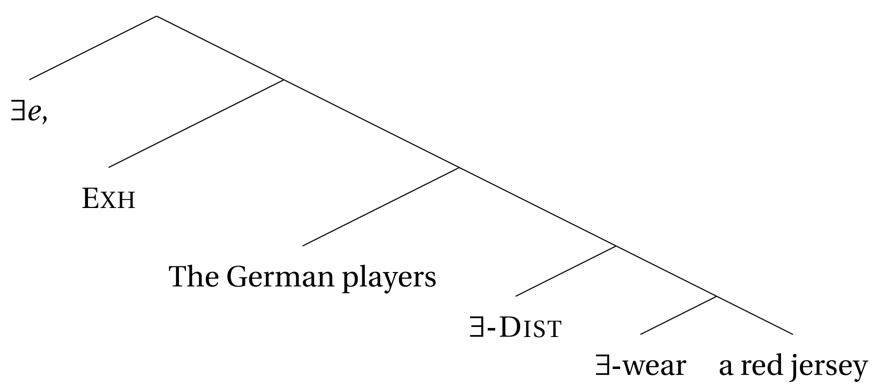
b. $\exists e,\ e \in {}^*\big(\lambda e'.\ \exists x \prec \iota\text{German-players}, \exists y \in \text{red-jersey},\ [\![\exists\text{-wear}]\!]\,(e')(x)(y)\big)$

$\exists e,\ e \in {}^*\big(\lambda e'.\ \exists x \prec \iota\text{German-players}, \exists y \in \text{red-jersey},\ e' \lhd \big(\lambda e''.\text{wear}^{\text{ag+thm}}(e'')(x)(y)\big)\big)$

c. $\exists e,\ e \in {}^*\big(\lambda e'.\ \exists x \prec \iota\text{German-players}, \exists y \in \text{red-jersey},\ \text{wear}^{\text{ag+thm}}(e')(x)(y)\big)$

Let us now turn to the truth-conditions of the positive sentence, a.k.a. the strong truth-conditions. To obtain these truth-conditions, we apply the recipe for exhaustification proposed in chapter 4. An exhaustification operator inside the scope of $\exists e$ strengthens the meaning of the event predicate, by negating alternatives obtained by replacing *the German players* with various other entities. As in chapter 4, we can separate the class of alternatives in three groups: the sub-plurality alternatives, the overlap alternatives and the super-plurality alternatives.

(50) a.



b. **Prejacent:** $\lambda e.\ e \in {}^*\big(\lambda e'.\ \exists x \prec \iota\text{German-players}, \exists y \in \text{red-jersey},\ \text{wear}^{\text{ag+thm}}(e')(x)(y)\big)$

c. **Alternatives:**

- $\lambda e.\, e \in {}^*\big(\lambda e'.\, \exists x \prec \iota\text{young-German-players}, \exists y \in \text{red-jersey},\ \text{wear}^{\text{ag+thm}}(e')(x)(y)\big)$ (sub-plurality alternatives)

- $\lambda e.\, e \in {}^*\big(\lambda e'.\, \exists x \prec \iota\text{young-players}, \exists y \in \text{red-jersey},\ \text{wear}^{\text{ag+thm}}(e')(x)(y)\big)$ (overlap alternatives)

- $\lambda e.\, e \in {}^*\big(\lambda e'.\, \exists x \prec \iota\text{players}, \exists y \in \text{red-jersey},\ \text{wear}^{\text{ag+thm}}(e')(x)(y)\big)$ (super-plurality alternatives)

The computation runs as follows: because an event which is a sum of events of German players wearing a red jersey is always a sum of events of players wearing a red jersey, the super-plurality alternatives cannot be negated without creating contradictions. On the other hand, all other alternatives can be negated without contradiction. After negating these alternatives, there only remains in the extension of the event predicate events where all the German players are wearing a red jersey are in the extension of the prejacent but not in the extension of any sub-plurality or overlap alternatives.

(51) $\exists e,\ e \in {}^*\big(\lambda e'.\, \exists x \prec \iota\text{German-players}, \exists y \in \text{red-jersey},\ \text{wear}^{\text{ag+thm}}(e')(x)(y)\big)$
$\wedge \forall x \prec \iota\text{German-players}, \exists y \in \text{red-jersey}, \exists e',\ \text{wear}^{\text{ag+thm}}(e')(x)(y) \wedge e' \prec e$

The truth-conditions are adequate. Note that the procedure did not rely on lexical homogeneity. So, in principle, that account of strengthening in terms of a simple exclusion-based exhaustification operator could also be adopted by Bar-Lev (2018b), instead of the mechanism of innocent inclusion.

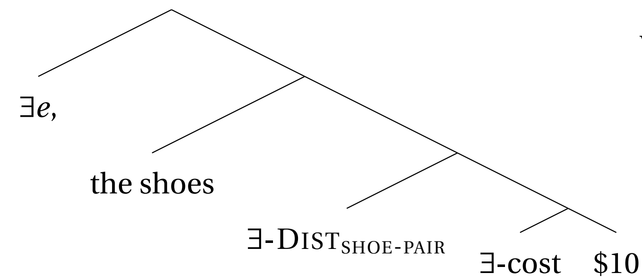
Covers but not lexical homogeneity. The definition of ∃-DIST given above is only tailored to atomic distributivity. Minimal revisions are needed for the intermediate distributivity case in e.g. (52).

(52) The shoes cost \$10.
⇝ *every pair of shoe cost \$10*

To cover these cases, one simply needs to replace the Atom requirement in the earlier definition of ∃-DIST to a cover requirement. Formally:

(53) $[\![\exists\text{-}\textsc{Dist}_C]\!] = \lambda X. {}^*\big(\lambda e.\ \exists X' \prec X,\ X' \in C \wedge p(X')(e)\big)$

The LF of (52) is (54a), which composes to the truth-conditions of (54b). As seen in chapter 6, since *cost* is numerous-type, the weak meaning of ∃-*cost* does not differ from *cost*, because there are no non-trivial part (◁) of a cost event. (54b) therefore simplifies to (54c).

(54) a. 

where

$\textsc{shoe-pair} = \big\{x_1 + x_2 \in D_e \,\big|\, x_1 + x_2 \text{ is a pair of shoes}\big\}$

b. $[\![(54a)]\!] = \exists e,\ e \in {}^*\big(\lambda e'.\ \exists X \prec \iota\text{shoes},\ X \in \textsc{shoe-pair} \wedge e' \lhd \big(\lambda e''.\ \text{cost}^{\text{holder}+\mu}(e'')(X)(\$20)\big)\big)$

c. $[\![(54a)]\!] = \exists e,\ e \in {}^*\big(\lambda e'.\ \exists X \prec \iota\text{shoes},\ X \in \textsc{shoe-pair} \wedge \text{cost}^{\text{holder}+\mu}(e)(X)(\$20)\big)$

The truth-conditions obtain read "*there is an event which is a sum of event where shoe pairs cost $20*" or, more simply, "*some shoe-pairs cost $10*". This weak meaning is exactly appropriate to capture the truth-conditions of (55):

(55) The shoes don't cost $10.

The same exhaustification procedure as above yields the attested reading of the positive counterpart of (56b). Both sub-plurality alternatives and overlap alternatives can be negated. The strengthened event predicate only picks out events which are sums, containing for all shoes, events of costing $20.

(56) a. **Prejacent:** $\lambda e.\ e \in {}^*\big(\lambda e'.\ \exists X \prec \iota\text{shoes},\ X \in \textsc{shoe-pair} \wedge \text{cost}^{\text{holder}+\mu}(e)(X)(\$20)\big)$

b. **Alternatives:**

- $\lambda e.\ e \in {}^*\big(\lambda e'.\ \exists X \prec \iota\text{red-shoes},\ X \in \textsc{shoe-pair} \wedge \text{cost}^{\text{holder}+\mu}(e)(X)(\$20)\big)$ (sub-plurality alternatives)

- $\lambda e.\ e \in {}^*\big(\lambda e'.\ \exists X \prec \iota\text{red-shoes-or-sandals},\ X \in \text{SHOE-PAIR} \wedge \text{cost}^{\text{holder}+\mu}(e)(X)(\$20)\big)$ (overlap alternatives)

- $\lambda e. e \in {}^*\big(\lambda e'. \exists X \prec \iota\text{shoes-or-sandals},\ X \in \text{SHOE-PAIR} \wedge \text{cost}^{\text{holder}+\mu}(e)(X)(\$20)\big)$ (super-plurality alternatives)

Covers and lexical homogeneity. In the case of atomic distributivity, lexical homogeneity cancelled out because the predicate only showed plural homogeneity and not part homogeneity. In the case of intermediate distributivity considered above, there was no lexical homogeneity. The last case to consider than is a case where lexical homogeneity and the homogeneity of phrasal distributivity interact. I will consider the examples in (38) and (40), repeated below with their intended reading.

(57) a. The players from Team A and Team B are high-school friends.
$\rightsquigarrow$ *both team A and team B are composed of high-school friends.*

b. The players from Team A and Team B are not high-school friends.
$\rightsquigarrow$ *neither team A nor team B are composed of high-school friends.*

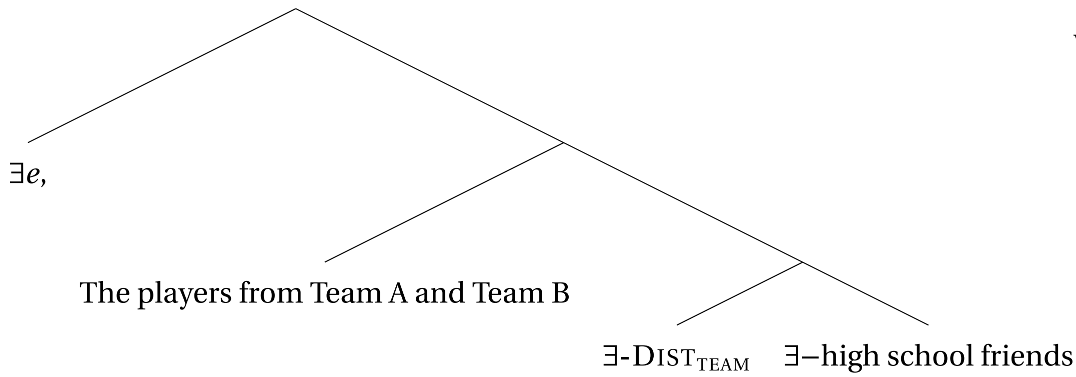
Here are some simplifying assumptions that I make: I treat *high school friends* as an indecomposable predicate of events, where event is conceived as encompassing states. I take *high-school friends* to be a *gather*-type predicate (e.g. ✓ *all of them are high-school friends*). By the theory of chapter 4, this means that (58a) reduces to (58b).

(58) a. $[\![\exists\text{-high school friends}]\!] = \lambda X.\lambda e.\ e \lhd \big(\lambda e'.\ \text{high-school-friend}(e')(X)\big)$

b. $[\![\exists\text{-high school friends}]\!] = \lambda X.\lambda e.\ \exists X' \prec X,\ \text{high-school-friend}(e')(X)$

With these assumptions, the weak truth-conditions derived for (59a), with correct cover and through the LF in (59b), is adequate: it asserts the existence of an event which is a sum of X' being high-school friends where X' is a sub-plurality of either the players in team A or the players in team B. The negation of these truth-conditions say that no sub-plurality of the players of teams A and B are high school friends.

(59) a. The players from Team A and Team B are high-school friends.

b. 

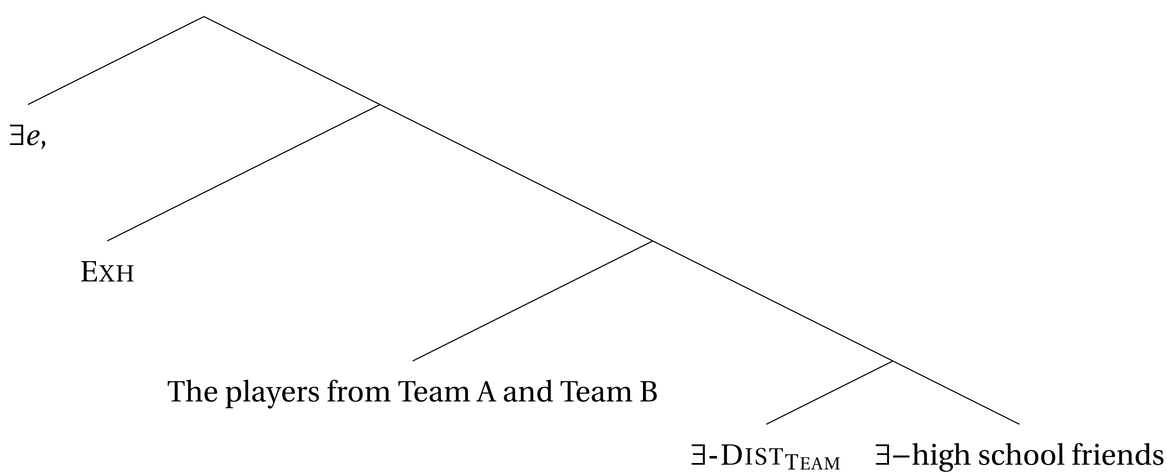
where

TEAM = $\{\iota$member-of-team-A, ιmember-of-team-B$\}$

c. $[\![(59a)]\!] = \exists e,\ e \in {}^{*}\big(\lambda e'.\ \exists X \prec \iota\text{players-from-A-and-B},\ X \in \text{TEAM} \wedge [\![\exists\text{-h. s. friends}]\!]\,(e')(X)\big)$

d. $[\![(59a)]\!] = \exists e,\ e \in {}^{*}\big(\lambda e'.\ \exists X \prec \iota\text{players-from-A-and-B},\ X \in \text{TEAM} \wedge \exists X' \prec X, \text{high-school-friend}(e')(X'$

We encounter a problem when trying to derive the strong truth-conditions of (60), via exhaustification. Consider the LF in (60). Consider the alternatives obtained from the prejacent by *the players from team A and B* with an expression that denotes Y.The very small of this example cover (a two-element set) makes these alternatives equivalent to one of the alternatives in (60b).

(60) a. 

b. $\exists e,\ e \in {}^{*}\big(\lambda e'.\ \exists X \prec Y,\ X \in \text{TEAM} \wedge \exists X' \prec X, \text{high-school-friend}(e')(X')\big)$ is equivalent to

- $\exists e,\ e \in {}^{*}\big(\lambda e'.\ \exists X \in \text{TEAM}, \exists X' \prec X,\ \text{high-school-friend}(e')(X')\big)$

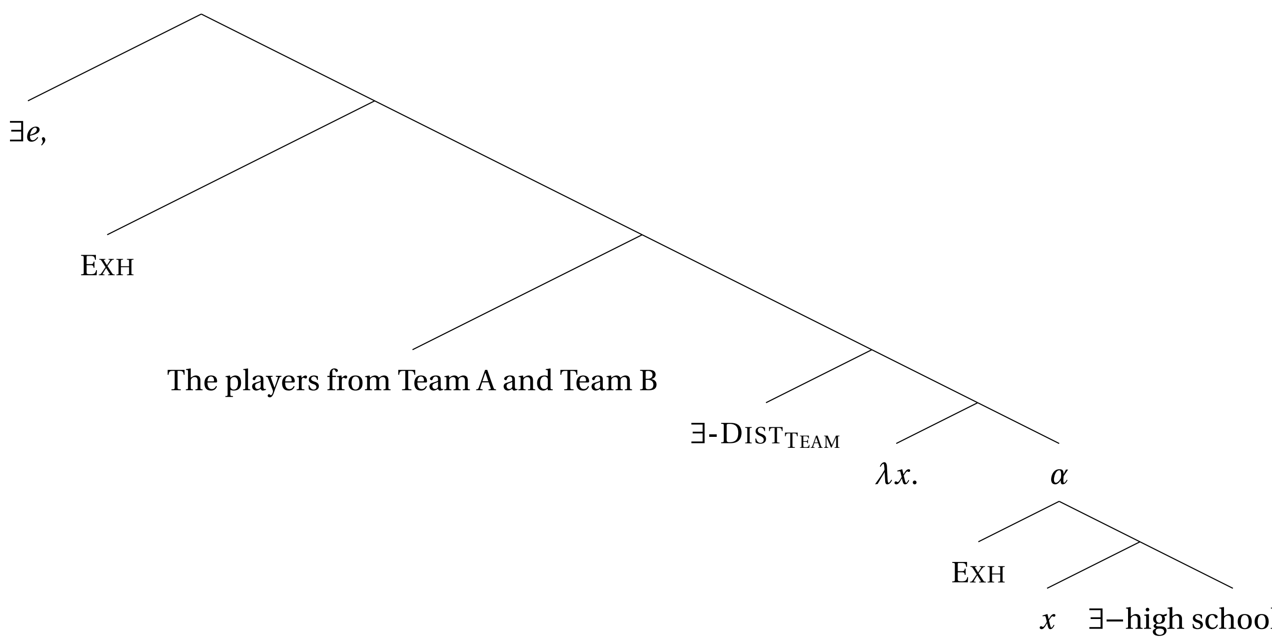
- $\exists e,\ e \in {}^{*}\big(\lambda e'.\ \exists X \prec \{\iota\text{players-of-team-A}\}, \exists X' \prec X, \text{high-school-friend}(e')(X')\big)$

- $\exists e,\ e \in {}^{*}\big(\lambda e'.\, \exists X \prec \{\iota\text{players-of-team-B}\}, \exists X' \prec X, \text{high-school-friend}(e')(X')\big)$

Of those alternatives, only the first two can non-contradictorily be negated. By negating them, we obtain the meaning in (61c), which in plain English reads: *there is an event which is a sum of sub-pluralities of either Team A or Team B being high school friends ; it is not a sum of sub-pluralities of Team A being high-school friends ; it is not a sum of sub-pluralities of Team B being high-school friends.* This is stronger than the prejacent but not as strong as needed. For instance, if two players from team A are high-school friends and two players from team B are as well, the sentence would be true. It does not imply that all players from Team A and Team B are high-school friends.

To solve this problem, I assume that distributivity operators must be scoped, as in (61a). With this new scope position, each weaknening operator (∃-DIST and ∃-*h.s. friends*) now comes associated with its form of strengthening. This assumption does not really follow from anything said so far. Note that it has a family resemblance to the assumption needed to obtain the strengthening of part homogeneity under quantifiers.

(61) a.



In this structure, each EXH operator serves to "*cancel*" the existential meaning of the verb or the ∃-DIST operator. Starting bottom up, constituent α has the same structure as "*X are high school friends*". From the theory of chapter 4, we expect this to strengthen the meaning of this constituent to (62).

(62) **Prejacent:** $\lambda e.\, \exists X' \prec X,\ \mathsf{high\text{-}school\text{-}friend}(e)(X')$

Strengthened meaning: $\lambda e.\ \mathsf{high\text{-}school\text{-}friend}(e)(X)$

From then on, the computation runs just as above, replacing the weak predicate ∃-*h.s. friends* with its strong version.

(63) $\exists e,\ e \in {}^*\big(\lambda e'.\, \exists X \prec Y,\ X \in \textsc{team} \wedge \exists X' \prec X, \mathsf{high\text{-}school\text{-}friend}(e')(X')\big)$ is equivalent to

- $\exists e,\ e \in {}^*\big(\lambda e'.\, \exists X \in \textsc{team}, \exists X' \prec X,\ \mathsf{high\text{-}school\text{-}friend}(e')(X')\big)$
- $\exists e,\ e \in {}^*\big(\lambda e'.\, \exists X \prec \{\iota\mathsf{players\text{-}of\text{-}team\text{-}A}\}, \exists X' \prec X, \mathsf{high\text{-}school\text{-}friend}(e')(X')\big)$
- $\exists e,\ e \in {}^*\big(\lambda e'.\, \exists X \prec \{\iota\mathsf{players\text{-}of\text{-}team\text{-}B}\}, \exists X' \prec X, \mathsf{high\text{-}school\text{-}friend}(e')(X')\big)$

Conclusion

This chapter served two purposes. The main goal was to provide a discussion of the phenomenon of phrasal distributivity. Phrasal distributivity gives rise to homogeneity ; it seems natural to wonder whether this form of homogeneity arise through the same combination of weak part-meanings and exhaustification as proposed in chapter 4. The second goal of this chapter is to present the theory of Bar-Lev (2018a), which attempts to subsume all cases of plural homogeneity to one operator, the ∃-Distoperator. The alternative to such a theory - the unparsimonious theory - is one where the weak meanings of phrasal distributivity and lexical distributivity arise from different sources but a common mechanism for strengthening captures both.

While the theory of chapters 2 and 4 borrows many insights from Bar-Lev (2018a), I presented arguments that the unparsimonious account is preferable. In cases where properties of the predicate and the extra-linguistic context (contextual grouping) both play a role in determining the overall pattern of homogeneity, the less parsimonious account offers a less stipulative division of labor between semantics and pragmatics.

Chapter 8

Comparison between the eventless analysis and the eventful analysis

In chapter 1, we informally presented the recipe for deriving cumulative readings and their homogeneity properties adopted in the rest of this work. The recipe is based on two ingredients. First, simple verbs like *crack* are given existential denotations, which conform to the meaning observed in negative sentences.

(1) a. The squirrels didn't crack the nuts.

b. **Existential meaning:**
"*X crack Y*" iff some of *X* cracked some of *Y*

Second, additional inferences - the exhaustive participation inferences - are derived as scalar implicatures in positive sentences. Representing scalar implicatures in gray, the truth-conditions of (2a) are given in (2b), as the conjunction of this underlying existential meaning and the exhaustive participation inferences.

(2) a. The squirrels cracked the nuts.

b. **Truth-conditions:**
Some squirrels cracked some nuts
Every squirrel cracked a nut.
Every nut was cracked by a squirrel.

This recipe was shown to be adequate for ordinary cumulative sentences as well as cumulative readings of quantifiers. It describes not only the truth-conditions of positive cumulative sentences but also the truth-conditions of negative cumulative sentences.

This recipe was formalized in two ways. In chapter 2, an event-less analysis was presented, which kept to standard assumptions about composition and quantifier meaning. I will refer to this analysis as the event-less analysis. To cope with the additional data presented in chapter 3, I presented in chapter 4 an alternative formalization of the recipe within an event semantics. I will refer to this analysis as the eventful analysis.

In this section, I summarize the key differences between the two systems and compare their upsides and downsides. The chart below gives an anticipated summary of comparison points ; in the sequel, I will present these comparison points more at length, trying to assess which features in the two system are desirable and which aren't.

Event-less analysis	Event analysis
Event-less semantics	Event semantics
Existential verb denotations (type $e^n t$)	Event part verb denotations (type $e^n v t$)
Strengthening via recursive exhaustification	Strengthening via single exhaustification in the event domain
Regular quantifier denotations	Event denotations for quantifiers

Table 1: Comparion of the theories' characteristics

Event-less analysis	Event analysis
No straightforward extension to collective readings	Extends to collective readings
No extension to group and part homogeneity/cumulativity	Extends to group and part homogeneity
Does not expect predicate variation and predicate typology	Expects predicate variation and partially predicts typology
Extends to cumulative reading of downward-entailing quantifiers	Does not explain downward-entailing quantifiers.

Table 2: Comparion of the theories' predictions

8.1 Succinct reminder of both analysis

Let me start by reminding the reader of both analysis, focusing on the case of cumulative readings of *every*.

The event-less analysis starts from an existential verb meaning as in (3a). With nothing but this verb meaning, cumulative sentences receive the meaning in (3c), which lacks the inference that every squirrel cracked a nut.

(3) a. $[\![\exists\text{-crack}]\!] = \lambda X.\lambda Y.\, \exists x \prec X, \exists Y \prec Y,\ \mathsf{crack}(x)(y)$

b. EXH EXH the squirrels ∃-cracked every nut

c. **Prejacent:**

Every nut was cracked by some squirrels.

In positive environments, this exhaustive participation inference is derived by recursive exhaustification. The prejacent in (3c) is strengthened by negating the alternatives in (4), along with their implicatures (represented in gray).

(4) **Exhaustified alternatives:**

Every nut was cracked by Scrat or Acorn and no other squirrels cracked any nut.

Every nut was cracked by Waggs or Acorn and no other squirrels cracked any nut.

Every nut was cracked by Scrat orWaggs and no other squirrels cracked any nut.

The eventful analysis is expressed in event semantics. Instead of formalizing weak verb meanings as existential meanings, the eventful analysis spells out the meaning of *crack* in terms of event parts: *crack* is true of events which are parts of crackings of Y by X.

(5) $[\![\lhd\text{-cracked}]\!] = \lambda X.\lambda Y.\lambda e.\ \mathsf{crack}(e) \wedge e \lhd \lambda e'.\mathsf{cracked}^{\mathsf{ag+th}}(X)(Y)(e')$

Reasoning about the nature of cracking events (cf section 4.2.1), we come to the conclusion that this predicate is true of events of some of X cracking some of Y.

The event analysis assumes that quantifiers like *every* have an event denotation, so that (6a), without strengthening, has the truth-conditions in (6b), which simply say that every nut was cracked by some squirrels.

(6) a. ∃ (EXH) the squirrels ◁-cracked every nut

b. **Truth-conditions (without EXH):**

There is an event which is a sum containing, for every nut x, an event of some squirrels cracking x

To derive the exhaustive participation inference that every squirrel cracked a nut (or participated in cracking one), the eventful analysis assumes a single EXH placed within the event domain. The prejacent is compared with alternatives that replace the 3 squirrels with alternative agents. When all negatable alternatives are negated, the meaning arise that the event being described could only have involved all the squirrels.

(7) a. **Prejacent:**

e is an sum of events containing, for every nut x, a cracking of x by some of the squirrels.

b. **Alternatives:**

- *e* is an sum of events containing, for every nut x, a cracking of x by Acorn or Waggs.
- *e* is an sum of events containing, for every nut x, a cracking of x by Acorn or Scrat.
- *e* is an sum of events containing, for every nut x, a cracking of x by Scrat or Waggs. ...

Both analyses obey the template specified in chapter 1. Yet, they do so in radically different ways. In the sequel, I will compare the two theories side-by-side. I will start by a technical comparison: I will review the use or lack of use for events and review the methods for strengthening. I will then move on to compare four empirical predictions: group/part homogeneity, collective readings, verb variation and downward-entailing quantifiers.

8.2 Events or no events?

The eventful analysis assumes events whereas the event-less analysis doesn't. This assumption implies various constraints on the eventful analysis, which the event-less theory does not have. Because its rule for strengthening is formulated for the event domain, it must assume that quantifiers take scope in the event domain. It must therefore assume that quantifiers have event denotations and these denotations can often be quite complex. Here is for instance, the denotation for *every*.

(8) $[\![\text{every nut}]\!] = \lambda p.\lambda e'.\ (\iota\mathsf{nuts}, e) \in {}^{*}\left(\lambda x_e.\lambda e_v.\ \mathsf{Atom}(x) \wedge p(x)(e')\right)$

By contrast, the event-less analysis is free to posit simpler and more standard denotations for *every*:

(9) $[\![\text{every nut}]\!] = \lambda q.\ \forall x \in \mathsf{nut},\ q(x)$

At first blush then, such considerations about the simplicity of denotations in each theory appear to favor the event-less analysis.

Yet, the comparison is not so straightforward as it first seems. Its supporters would argue that the cost of an event semantics is offset by the facts it captures. These facts include but are not limited to adverbs.

As an example of this, the event denotation given to *every* can explain why some adverbials appear to modify "*ensemble events*" in sentences that contain it. In the famous example by Taylor (1985) given in (10a), *unharmoniously* can only be understood as describing the event of all students strking a note. Similarly, in (10b), *in less than one minute* can be understood as describing the time it took me to eat every cookie.

(10) a. Unharmoniously, every student struck a note.

b. I ate every cookie in less than one minute.

As it turns out, these ensemble events are precisely the events which a denotation for *every* as in (8) can generate. It is unclear how an event-less denotation as in (9) could achieve the same.

In conclusion, I prefer to not base any comparison between the event-less and eventful analysis on the framework that each is couched in ; these comparisons between frameworks inevitably involves facts beyond cumulativity, which are difficult to assess.

8.3 Recursive exhaustification or single exhaustification in the event domain?

A second point of comparison is the method of strengthening. The event-less approach of chapter 2 makes use of recursive exhaustification, as in Fox (2007). This means that sentences with plurals are typically parsed with two or more layers of exhaustification as in (11)

(11) EXH EXH The dancers smiled

The eventful analysis performs a single exhaustification, but it performs it before event closure (i.e. in the event domain), mirroring a similar idea by Zweig (2008).

(12) $\exists e$ EXH the dancers smiled

Both strategies can be seen as spelling out different ways to capture distributive implicatures, our model for cumulative readings. Can we say anything about how these methods compare *in abstracto*?

Not really: an obvious point of comparison is that the predictions of recursive exhaustification are hard to track on complicated cases. So much so that I had to resort to computational methods in chapter 2. However, this is only a problem for the linguist, not for the speaker who, if this theory is correct, must routinely perform these computations[1].

More to the point, these approaches have different empirical consequences. As we'll review in section 8.4, the method of the eventful approach avoids difficult questions

[1] Mascarenhas (2014) makes an argument that it may be unreasonable to assume that the speaker does in fact perform these compuations but Mascarenhas (2014)'s point is also valid for single layer of exhaustification so his point does not immediately help for the comparison.

raised by group homogeneity and part homogeneity that the method of the event-less approach raises. As we'll then review in section 8.7, recursive exhaustification is more robust to downward-entailing quantification.

To more accurately compare the event-less and the eventful proposal, let me now move on to four empirical comparison points in the sequel: group/part homogeneity, collective readings, verb variation and downward-entailing quantifiers.

8.4 Group/part homogeneity and cumulativity

As seen in chapter 3, homogeneity and cumulativity are also attested in expressions that do not denote pluralities, such as nouns denoting groups or nouns denoting objects with multiple parts. (13) illustrates group homogeneity and (14) part homogeneity.

(13) a. The jury smiled.
≈ *all did*

b. The jury didn't smile.
≈ *none did*

(14) a. I ate the pizza.
≈ *I ate it all.*

b. I didn't eat the pizza.
≈ *I didn't eat any of it.*

In the event-less theory. In section 3.4 of 3, we reviewed some of the reasons why an extension of the theory of chapter 2 to the cases above would seem problematic.

To summarize the point made there, we found that in order to model group and part homogeneity as in the theory of 2, we would need to make two assumptions. First, we would need to assume that the verbs involved in (13) and (14) have existential meanings (I ate X was eaten iff I ate bits of X were eaten ; X smiled iff some member of X smiled). Second, we would need to assume that the alternatives to *the pizza* are the bits of pizza and the alternatives to *the jury* are any sub-group in the jury.

Unfortunately, these assumptions have to hold in tandem. As we saw, some sentences do not yield homogeneity down to the pizza part or the jury member. Examples of non-homogeneous sentences are given below.

(15) a. The jury was formed by André.
$\not\approx$ *all members of the jury were formed by André.*

b. The jury wasn't formed by André.
$\not\approx$ *no members of the jury were formed by André.*

(16) a. I touched the pie.
$\not\approx$ *I touched all parts of the pie.*

b. I didn't touch the pie.
$\approx$ *I didn't touch any part of the pie.*

For these cases, one would both need to assume that the meaning of the verb does not have an existential meaning (or not one that quantifies over parts or members) *and* that *the pie* does have bits of pie as its alternatives, likewise for *the jury*.

If this were so, it would be a case where the alternatives to one constituent (i.e. *the pie*) would depend on the nature of the predicate (i.e. *ate* vs. *touch*). This would make the mechanism for generating alternatives to a sentence non-compositional in a sense.

The problem is perhaps not so damning for the event-less theory. Nevertheless, one can appreciate the fact that the eventful theory evades it entirely.

In the eventful theory. How does the eventful evade the problem of chapter 2? Just as in the sketch above, the eventful theory assumes event meanings for *eat* and *smile*, which simplify to weak meanings that existentially quantify over bits of pie and jury members. The exact denotations are given below (cf chapter 4).

(17) a. $[\![\text{ate}]\!] = \lambda x.\lambda y.\lambda e.\ \exists x',\ x' \sqsubset x \wedge \mathsf{eat}^{\mathsf{ag+thm}}(e)(x')(y)$

b. $[\![\text{smiled}]\!] = \lambda X.\lambda e.\ \exists X' \sqsubset X \wedge \mathsf{smile}^{\mathsf{ag}}(e)(X')$

Unlike the event-less theory however, the eventful theory takes all entities to be alternatives to *the pie* and *the jury*. The strengthening works on that basis. This means that there is no need to adapt the alternatives for the different cases of homogeneity (plural, group and part). This in turn implies that the eventful theory does not need to assume that the alternatives are systematically connected to the nature of the verb.

Conclusion. To deal with other forms of homogeneity, the event-less analysis must make two related assumptions: 1) that verbs have a meaning that existentially quantifies over non-plural parts, 2) that the alternatives to these verbs' arguments are exactly those non-plural parts that the verb quantifies over. Explaining the necessary connection between 1 and 2 is not so straightforward. The eventful theory does not make assumption 2. As a result, it does not beg any questions as far as non-plural homogeneity is concerned.

8.5 Collective actions, collective predicates

A salient difference between the event-less analysis and the eventful one concerns collective action. To put it simply, the event-less analysis has great difficulties in expressing the correct truth-conditions of cumulativity once collective action is ruled out, whereas it comes very naturally in the eventful analysis. Let us first focus on the event-less analysis.

Collective action in the event-less analysis. Chapter 2, where the event-less analysis was introduced, explicitly assumed that no collective action was taking place in the sentence under consideration. This allowed me to write and derive the truth-conditions of (18a) as (18b).

(18) a. The squirrels cracked the nuts.

b. **Truth-conditions** (without collective action)
Every squirrel cracked a nut
Every nut was cracked by a squirrel

With collective action, the truth-conditions in (18b) are no longer accurate. If squirrels can crack nuts in groups (some squirrel holding the nut while another gnaws at it), the range of situations that can make (18a) true is wider than the range of situations described by (19b). Indeed, it is no longer necessary that every squirrel cracked a nut ; all that is required is that all squirrels were part of at least one team of nut-crackers.

The most general expression of the truth-conditions for the cumulative sentence in (18a) is given in (19):

(19) **Truth-conditions** (with collective action)
Every squirrel <u>was part of a group of squirrels that</u> cracked a nut
Every nut was cracked by some squirrels

But the event-less theory does not derive (19). First of all, it assumes a weak meaning that makes reference to atoms: "*X crack Y*" is true in its weak meaning if and only if some atomic squirrel cracked some atomic nut.

(20) $[\![\exists\text{-crack}]\!] = \lambda X.\lambda Y.\, \exists x \prec X, \exists y \prec Y, \mathsf{cracked}(x)(y)$

This is problematic, as it predicts that the negative cumulative sentence in (21a) should mean (21b). This is incorrect if collective action is allowed: (21b) could be true when all squirrels cracked nuts in teams, whereas (21a) cannot be true in that case.

(21) a. The squirrels cracked the nuts.

b. **Incorrect truth-conditions:**
It's not the case that some squirrel cracked some nut.

Related to this first problem of incorrect weak meanings is the problem of incorrect strengthening. In positive environments, the procedure of exhaustification (akin to Free Choice and distributive scalar implicatures) delivers exhaustive participation inferences (in gray), which are universal quantifiers over atoms.

(22) a. The squirrels cracked the nuts.

b. **Incorrect derived truth-conditions:**

Some atomic squirrel cracked some atomic nut.

Every atomic squirrel cracked some atomic nut.

Every atomic nut was cracked by some atomic squirrels.

But these exhaustive participation inferences don't adequately reflect the truth-conditions of cumulative sentences with collective action.

The event-less analysis could be amended. A first option that springs to mind is to replace the original weak meaning with a plural version thereof: "*X crack Y*" is true in its weak meaning if and only if some squirrel or squirrels cracked some nut or nuts.

(23) $[\![\exists\text{-crack}]\!] = \lambda X.\lambda Y.\ \exists X' \prec X, \exists Y' \prec Y, \mathsf{cracked}(X')(Y')$

This new weak meaning adequately captures the meaning of negative cumulative sentences.

(24) a. The squirrels didn't crack the nuts.

b. **Incorrect truth-conditions:**

It's not the case that some squirrels cracked some nuts.

However, the procedure of strengthening in terms of Free Choice and distributive implicatures does not deliver the right result on this weak meaning. To see this informally, recall that the process for strengthening "*converts*" each existential in the meaning of *crack* in turn into a universal. From this observation, we expect the truth-conditions in (25a) but these truth-conditions are too strong: they predict that every group that can be formed from the squirrels will have cracked some number of nuts together. This rules out situations like (25b) since in that case, Scrat and Waggs did not crack nuts together.

(25) a. **Truth-conditions:**

Every plurality of squirrels cracked a plurality of nuts.

Every plurality of nuts was cracked by a plurality of squirrels

b. Squirrels: Scrat, Acorn and Waggs

Nuts: nut 1 and nut 2

Scrat and Acorn cracked nut 1.

Waggs and Acorn cracked nut 2.

There is another option to solve the problem of collective action in the event-less analysis. This option is taken from Bar-Lev (2018b)'s definition of distributivity operators (which we discussed in chapter 7). We replace the weak meaning in (23) with the truth-conditionally equivalent one in (26): "*X crack Y*" is true in its weak meaning if and only if some squirrel is part of a group of squirrels that cracked some nut part of a group of nuts.

(26) $[\![\exists\text{-crack}]\!] = \lambda X.\lambda Y.\, \exists x \prec X, \exists X' \prec X, x \prec X' \wedge \exists y \prec Y, \exists Y' \prec Y, y \prec Y' \wedge \mathsf{cracked}(X')(Y')$

The interest of this denotation is that it has two existentials per argument: one existential over atomic squirrel or nut and one over groups. We could generate the correct exhaustive participation inference by strengthening the former existential to a universal (and keep the latter existential): *every nut is part of a group of nuts such that ...* ; *every squirrel is part of a group of squirrels such that ...*. The expected truth-conditions with that strengthening are as in (27) and they match the observed truth-conditions:

(27) Some squirrels cracked some nuts.

Every squirrel was part of a group of squirrels that cracked nuts.

Every nut was part of a group of nuts that was cracked by some squirrels.

The devil is in the details. How can we strengthen one existential and not the other? In the event-less analysis, the strengthening from existential to universel is obtained by comparing the existential to alternatives which are existentials over a smaller domain. In turn, these alternative domains are obtained by replacing the argument of the verb - *the squirrels, the nuts* - by smaller pluralities - *the red squirrels, the chestnuts* -. Problematically, in the denotation in (26), both the existential over atom and the existential over plurals range over the same domain ; it is impossible to construct an alternative in which one existential would have a smaller domain while the other would keep the same domain. This means that we cannot strengthen one existential to the exclusion of other[2].

Regardless of how we spell out the strengthening, a finer problem arises for this way of integrating collective action into the eventless analysis. The truth-conditions derived by this form of underlying doubly existential meaning and a choosy strengthening are automatically summative. In other words, the derived truth-conditions of (28a) and (28b) entail (28c).

(28) a. The squirrels cracked the chestnuts.

b. The hamsters cracked the cashew nuts.

c. The squirrels and the hamsters cracked the chestnuts and the cashew nuts.

This is as it should be for the sentences in (28). The problem is that summativity *may* not be automatic for collective predicates that nevertheless display homogeneity. To illustrate the problem, consider the case of *meet* in (29). One would not conclude (29c) from (29a) and (29b). This fact is not universally accepted in the literature[3] so the problem to be shown in the sequel should be taken with a grain of salt.

(29) a. The Northern Italians met.

b. The Southern Italians met.

c. The Italians met.

Because they display homogeneity, we want to treat these predicates as involving some underlying existential which is strengthened in positive environments. Because they

[2] In Bar-Lev (2018b), this problem is circumvented because he considers the alternatives to be formed by changing covert domain restrictions, rather than acting on actual arguments. However, the notion of coverts restrictions makes more sense in his setting than in ours, since in his setting, these existential meanings are part of the meaning of a certain quantifier, the distributivity operator.

[3] Different authors present different facts regarding the summativity of *gather*-type predicates. Schein (1993) considers that *twenty artists collaborated* can be true of multiple collaborations, which would make the predicate summative, while Bayer (2013) deems the multiple collaboration reading absent. Kuhn (2020) also notes in passing that *gather* is not summative. Part of the disagreement could be due to the fact that, independently of the "*inherent*" summativity of the predicate, there is always the possibility of reading the sentence with a cover-based distributivity operator, as seen in chapter 7. Summativity-like readings are therefore expected even if the predicate is not summative ; in that case though, the summative-like reading is expected to be dispreferred.

involve collectivity, we want to adopt the double existential meaning as the underlying meaning of *meet*.

(30) $[\![\text{meet}]\!] = \lambda X.\, \exists x < X, \exists X' < X,\ x < X \wedge \mathsf{meet}(X)$

However, by the assumptions laid out earlier, this weak meaning of *meet* in (31a) is bound to strengthen to deliver truth-conditions as in (31b).

(31) a. The Italians met.

b. **Derived truth-conditions:**
Some Italian is part of a group of Italians that met.
Every Italian is part of a group of Italians that met.

These truth-conditions will validate the summativity inferences in (29), which may be incorrect.

Let us recap this discussion of collective action in the event-less fragment. The event-less fragment explicitly sidestepped the issue of collective action. I have shown two attempts at incorporating this missing piece in the event-less analysis. The first naive option was entirely unsuccessful, as it delivered too strong a meaning for cumulative sentences. The second option successfully derives the correct truth-conditions but is hard to implement and forces us to assume summativity across the board for all homogeneous predicates.

Collective action in the eventful analysis. By contrast, the eventful analysis and its peculiar way of strengthening can account for collective action without adjustments.

Let us start with instransitive predicates like (32). After consideration of the structure of *meet*-ing events (cf 6.3.3 of chapter 6), the weak meaning of *meet* is a predicate true of events of some Italians meetings. After strengthening, this predicate is only true of events which cannot be described as meeting of some of X, where X is strictly included in the Italians.

(32) a. The Italians met.

b. There is an event e such that:

a) e is an event of some Italians meeting.

b) for all X strictly included in the Italians, e is not an event of some of X meeting.

The only events that meet this description are events of meetings of all Italians. Thus, the derived truth-conditions say no more and no less than "*there was a meeting of all Italians*".

Contrary to the event-less analysis, the truth-conditions in (32b) don't imply summativity for *meet* per se. Indeed, (33a) and (33b) do not entail (33c) by themselves. They would if the following auxiliary assumption also held: one can form a meeting of all Italians by adding together an event of Southern Italians meeting and an event of Northern Italians meeting. To the extent that this assumption is false, summativity does not hold for *meet*.

(33) a. There is an event of Southern Italians meeting.

b. There is an event of Northern Italians meeting.

c. There is an event of Italians meeting.

Cumulative sentences with collective action are also accounted for by the eventful theory. (34a), for instance, is, in its weak meaning, true of events which are cracking of some nuts by some squirrels (after factoring in the event structure of cracking). After strengthening, it is true of only those events which can't be described as either cracking by a strict subset of squirrels, or a cracking of a strict subset of nuts. These events are just events of the squirrels cracking the nuts.

(34) a. The squirrels cracked the nuts.

b. There is an event e such that:

a) e is an event of some squirrels cracking some nuts.

b) for all X strictly included in the squirrels, e is not an event of some of X

cracking some of the nuts.

c) for all Y strictly included in the nuts, e is not an event of some of the squirrels cracking some of Y.

Whether this means the same as the desired truth-conditions in (35) depends on what it means to be an event of the squirrels cracking the nuts. In particular, if *crackings* are summative, i.e. if an event of X cracking Y and an event of X' cracking Y' sum to an event of $X + X'$ cracking $Y + Y'$, then the truth-conditions in (35) will be equivalent to there being an event of the squirrels cracking the nuts.

(35) Some squirrels cracked some nuts.
Every squirrel was part of a group of squirrels that cracked nuts.
Every nut was part of a group of nuts that was cracked by some squirrels.

Summary. On the issue of collective action, the eventful analysis clearly outperforms the event-less analysis. The eventful analysis correctly predicts that collective action would be possible and it does not impose that predicates which can yield collective readings are necessarily summative. The event-less analysis, on the other hand, has more difficulties in deriving the collective readings. To the extent that it can, the readings predicted are necessarily summative.

8.6 Verb variation

A second point of comparison between the event-less analysis and the eventful analysis concerns predicate variation. As discussed at length in chapter 6, predicates vary in whether they give rise to homogeneity or not. There is a truth-value gap between (36a) and (36b); by contrast, (37a) and (37b) have complementary truth-conditions (in their collective use, cf chapter 6).

(36) a. The dancers smiled.

b. The dancers didn't smile

(37) a. The bottles weigh 50kg.

b. The bottles don't weigh 50kg.

To be successful, a theory must therefore be able to derive different homogeneity behaviors for different verbs. This is the first fact to explain. There is a second fact to explain: which predicates trigger homogeneity does not appear to be entirely random. For instance, we observed in chapter 6 that distributive predicates, like *smile* above, are always homogeneous. While there does not seem a hard and fast rule for determining homogeneity type, a theory must expect such regularities.

The eventful analysis The eventful analysis sets out to explain these facts. It proposes that the weak meaning of a verb makes reference to event parts. "*X smile*" is true of an event in its weak meaning if and only if it is a smiling event which is part of a smiling of X

(38) $[\![\lhd\text{-smile}]\!] = \lambda X.\lambda e.\, \mathsf{smiled}(e) \wedge e \lhd \lambda e'.\, \mathsf{smiled}^{\mathsf{ag}}(X)(e')$

In the case of *smile*, non-trivial parts can be found: any event where some of X smiles will be part of an event of X smiling. This, as we saw in chapter 4, is a consequence of *smile* being distributive: any event of X smiling will be a sum of events of atomic elements smiling.

In other cases however, the only parts an event predicate has are the events in its extension. This is the case of *weigh*. To explain the lack of summative inferences with these predicates, we proposed in chapter 6 that weighing events are quantized ; no event of weighing is part of another. This meant that (39a) reduced to (39b).

(39) a. $[\![\text{weigh}]\!] = \lambda m.\lambda X.\lambda e.\, \mathsf{weigh}(e) \wedge e \lhd \left(\lambda e'.\, \mathsf{weigh}(e') \wedge \mu(e') = m \wedge \mathsf{agent}(e) = X\right)$

b. $[\![\text{weigh}]\!] = \lambda m.\lambda X.\lambda e.\, \mathsf{weigh}(e) \wedge \mu(e) = m \wedge \mathsf{agent}(e) = X$

In other words, the weak meaning of *weigh* is equivalent to its strong meaning. We can check that the step of strengthening has no effect on the denotation in (39b). The strengthening would deliver the meaning in (40). However, thanks to quantization, the gray inference is in fact redundant.

(40) There is an event e such that:

a) e is an event of the bottles weighing 5 kg.

b) for all X different from the bottle, e is not an event of X weighing 5 kg.

This means that no truth-value gap is expected between the positive (41a) and (41b); no homogeneity is predicted.

(41) a. The bottles weigh 50kg.

b. The bottles don't weigh 50kg.

This recap illustrates that the eventful analysis capture both explananda. Because event parts are dependent on the event structure of a particular predicate, it is expected that there would be variation: some predicates have no mereological structure (quantization), some predicates have it.

Because this theory correlates event structure with homogeneity, the variation among predicates is not arbitrary. What event structure a predicate of events has will influence what kind of inferences it validates (summativity, distributivity, downward inferences, etc). This means that theory also gives a handle on the second explanandum.

The event-less analysis In chapter 2, I presented the event-less analysis without mention of predicate variation. Just as before with collectivity, we must therefore wonder how the event-less analysis could capture variation in homogeneity, focusing on the difference between *weigh* and *smile*.

Our starting point is negative sentences. Under negation, *smile* reveals a weak meaning. This weak meaning invites us to assign *smile* a weak meaning, as in (42b). As discussed, this weak meaning is then strengthened in positive contexts to a universal meaning.

(42) a. The dancers didn't smile

b. $[\![\exists\text{-smile}]\!] = \lambda X.\, \exists x \prec X,\ \mathsf{smile}(X)$

Because it lacks homogeneity, there is no need to assign a weak meanigns to *weigh 5kg* (treated for ease of exposition as not decomposable). We may simply take the underlying meaning of *weigh 5kg* to be as it appears in positive sentences: namely, "*X weighs 5kg*" is true if and only if *X*'s weight is 5 kg.

(43) a. The bottles weigh 5kg.

b. $[\![\text{weigh 5kg}]\!] = \lambda X.\, \mathsf{weigh\text{-}5kg}(X)$

One would hope that this difference in the underlying lexical entry of both verbs would amount to a difference in homogeneity. However, this is not so. As it turns out, recursive exhaustification, when applied to (43a), yields implicatures and therefore truth-value gaps.

To see this, consider the alternatives to (44a) in the first round of exhaustification. These alternatives are all negatable. This means that the sentence is predicted to implicate that no sub-plurality of bottles weigh 5kg. This implicature will persist in the second round of exhaustification, as exhaustification can only strengthen meanings.

(44) a. **Exhaustified alternatives:**
The red bottles weigh 5 kg.
The blues bottles weigh 5 kg.
...

b. **Predicted truth-conditions:**
The weight of the bottles is 5kg.
The weight of any sub-plurality of bottles is not 5 kg

Such an implicature may be reasonable for *weigh 5kg*: since no bottles are weightless, it can reasonably be assumed all sub-plurality of bottles weigh less than 5kg. However, such an implicature is stranger for other measure phrases like *cost €16*, which also lack homogeneity. With discounts, it may well be that the price of a plurality is the same as the price of one of its parts: in the Paris subway, 9 tickets are about as expensive as 10 tickets, because of a discount on 10 tickets. In that context, it is entirely possible to assert:

(45) These 10 tickets cost me about €16.

In short, lack of weak meanings in the event-less analysis is not sufficient to guarantee lack of a truth-value gap. Short of an explanation for lack of homogeneity, the event-less analysis cannot begin to tackle why predicates fall in the homogeneity types that they do.

Summary. There are two phenomena to explain: first, the fact that verbs vary with respect to homogeneity and, second, factors that condition this variation. The eventful analysis is able to predict lack of homogeneity. It correlates this property with inferential properties of this predicate. On the other hand, it is not obvious that the event-less analysis can explain either facts. With collective predicates, this constitutes a second point in favor of the eventful analysis. Let us now turn to the point that favors the event-less analysis.

8.7 Downward-entailing quantifiers

We already discussed the case of downward-entailing quantifiers in section 2.6.1 for the event-less analysis and in section 5.4 for the eventful analysis. Let me recap here the puzzle and the predictions.

Downward-entailing quantifiers give rise to cumulative readings, like other quantifiers. They however don't seem to give rise to exhaustive participation inferences: (46a) doesn't imply that all squirrels were involved in cracking some nuts.

(46) a. The squirrels cracked less than 3 nuts.

b. **Truth-conditions:**
Less than 3 nuts were cracked by any squirrels.

In short, the cumulative readings of downward-entailing quantifiers seem entirely described by a weak existential meaning for *crack*. No strengthening is necessary.

The challenge for the event-less and the eventful theory is to make sure that the procedure for strengthening does not over-apply and remains vacuous in the case of downward-entailing quantifiers.

As discussed in section 2.6.1, the event-less theory meets the challenge. In this theory, one key ingredient for deriving the exhaustive participation inferences in cumulative sentences is that quantifiers have existential alternatives. However, downward-entailing quantifiers do not have existential alternatives ; if they did, I argued, spurrious implicatures would be derived.

(47) a. Scrat and Acorn cracked every nut.

Alternatives:

Scrat cracked every nut. (sub-plurality)

Scrat and Acorn cracked some nut. (some/every)

Scrat cracked some nut. (sub-plurality & some/every)

...

b. Scrat and Acorn cracked less than 3 nuts.

Alternatives:

Scrat cracked less than 3 nuts. (sub-plurality)

~~Scrat and Acorn cracked some nut. (some/less than 3 nuts)~~

~~Scrat cracked some nut. (sub-plurality & some/less than 3 nuts)~~

...

As discussed in section 5.4, the eventful does not meet the challenge of downward-entailing quantifiers. Unlike the event-less theory, the alternatives of the quantifiers are irrelevant to strengthening. Strengthening thus has no reasons not to apply. We derive the spurious inferences in (48).

(48) The squirrels cracked less than 3 nuts.

$\rightsquigarrow$ *every beaver cracked more than 2 nuts*

The comparisons clearly favors the event-less account here. It is the only analysis that can derive the lack of exhaustive participation inferences with downward-entailing quantifiers.

8.8 Summary

This concludes our comparison of the event-less and the eventful approach. We can summarize the discussion as follows. On most counts, the eventful approach outperforms its event-less competitor. Only the case of downward-entailing quantifiers seems to favor the eventful approach. Nevertheless, the relative sobriety of assumptions of the event-less approach seems desirable. Plausibly, future research could remedy some of the deficiencies of the event-less approach.

Event-less analysis	Event analysis
Event-less semantics	Event semantics
Existential verb denotations (type $e^n t$)	Event part verb denotations (type $e^n v t$)
Strengthening via recursive exhaustification	Strengthening via single exhaustification in the event domain
Regular quantifier denotations	Event denotations for quantifiers
No straightforward extension to collective readings	Extends to collective readings
No extension to group and part homogeneity/cumulativity	Extends to group and part homogeneity
Does not expect predicate variation and predicate typology	Expects predicate variation and partially predicts typology
Extends to cumulative reading of downward-entailing quantifiers	Does not explain downward-entailing quantifiers.

Chapter 9

Loose ends: non-local cumulativity and non-maximality

9.1 Beck and Sauerland (2000) on the double star

Beck and Sauerland (2000) is an extremely influential work arguing for the existence of operators for cumulativity, the ** operator. In this section, I want to critically evaluate how the examples that motivate their operators can be rendered (or not) in this thesis's work. I will argue that it is not obvious that their examples require something more than what has been independently motivated in this thesis.

9.1.1 Background: lexical and dependent plural analysis

Beck and Sauerland make their argument for cumulativity operators in a specific theoretical context. Specifically, they argue that their operators are needed to cover cases not derived from two mechanisms for cumulativity available at the time of their writing. The first mechanism for deriving cumulative readings is simply lexical stipulation. As seen in chapter 1, the truth-conditions of simple sentences like (1a) don't require any compositional assumptions to derive ; they could simply be treated as arising from the lexical meaning of *caught*. This approach to cumulativity is championed by Scha (1984).

(1) a. The bears caught the salmons.

b. ⟦caught⟧ $(X)(Y)$ iff

every one of Y caught some of X

and every one of X was caught by some of Y

The second mechanism for deriving cumulative readings is dependent plurals. Winter (2001) argues that some definites contain covert bound variables. Thus, in a sufficiently rich context, (2a) can be understood as if the struck-out phrase was actually pronounced.

(2) **Context:** *Each soldier was assigned some set of targets to shoot.*

The soldiers will get promoted if they hit the targets ~~that were assigned to them~~

Winter (2001) defends the idea that dependent plurals can yield a cumulative reading in simpler sentences such as (3).

(3) The soldiers hit the targets ~~that were assigned to them~~.

9.1.2 Cumulativity across constituents: a problem for lexical approaches

Beck and Sauerland argue that these two mechanisms alone cannot explain all attested cumulative readings. Note that they do not deny that these mechanisms exist and explain some of the attested cumulative readings. Also note that in chapter 1, I constructed a similar argument against a purely lexical approach for cumulative readings of *every*. Beck and Sauerland's argument is based on very different set of data.

Beck and Sauerland's argument is based on sentences where the two plurals which form the cumulative reading are separated by a constituent. In (4), the constituent is "*a bad mark*" ; in (5), it is the embedding verb *want*.

(4) a. These five teachers gave a bad mark to those 20 protesting students.

b. **Truth-conditions:**

Every one of the teachers gave a bad mark to one of the protesting students.

Every one of the protesting students was given a bad mark by one of the five teachers.

(5) a. Jim and Frank want to marry the two dentists.

b. **Truth-conditions:**
Both of Jim and Frank want to marry one of the two dentists.
Both dentists are such that one of Jim and Frank wants to marry them.

In the sequel, I will call examples like (4) examples *non-local monoclausal cumulativity* and examples like (5) *non-local biclausal cumulativity*.

The lexical account and the plural dependent account do not give a handle on either of these examples. For the lexical account, the reported reading of (5) is impossible to obtain: here, there is simply no single verb in which to encode the cumulativity assumption that this account rests on. (4) has a verb which can encode cumulativity - *give* - but encoding cumulativity as in (6a) results in a reading where the same bad mark was given to all students (cf the truth-conditions after simplification in (6b)).

(6) a. $[\![\text{give}]\!](X)(Y)(Z)$ iff
every one of Z gave some of Y to some of X
and every one of Y was given some of X by some of Z
and every one of X was given by some of Z to some of Y

b. **Truth-conditions:**
There is a bad mark x such that
Every one of the teachers gave x to one of the protesting students.
Every one of the protesting students was given x by one of the five teachers.

The dependent plural analysis is also challenged by these examples. The problem is not so much that cumulativity happens across constituents, rather the fact that the putative dependent plural contains a numeral. Including the covert phrase struck out in (7a) yields a reading according to which there are 20 students per teacher, or that Jim wants to marry two dentists.

(7) a. These five teachers gave a bad mark to those 20 protesting students ~~they had in their class~~.

b. Jim and Frank want to marry the two dentists ~~they are in love with~~.

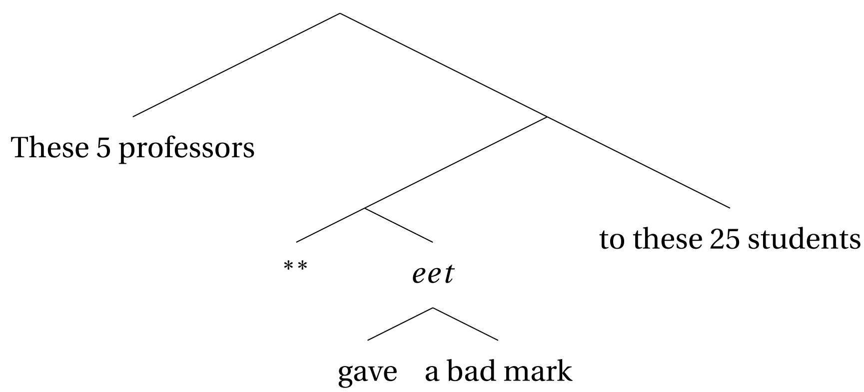
9.1.3 The double star solution

The plural dependent analysis and the lexical analysis are insufficient ; an alternative mechanism for cumulativity is needed. Beck and Sauerland (2000) propose a covert ** operator (crediting Krifka (1986)) which encodes cumulativity. This operator is freely insertable on any node of the appropriate *eet* type.

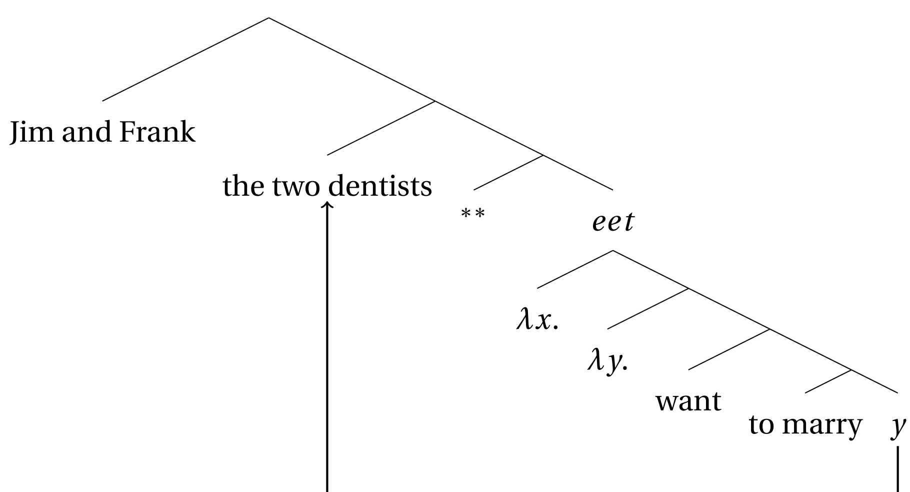
(8) $$[\![^{**}]\!](p) = \lambda X.\lambda Y.\ \forall x \prec X, \exists y \prec Y, p(x)(y) \\ \wedge \forall y \prec Y, \exists x \prec X, p(x)(y)$$

In particular, they propose that ** may apply to non-lexical predicates as in (9a) and to predicates derived by movement as in (9b).

(9) a.



b.



9.1.4 From the perspective of the present work

Beck and Sauerland (2000)'s examples appear problematic to the theory developed in this work as well. At its core, the theory developed here is a lexical one, relying on weak existential meanings placed in the meaning of the verb. In the sequel, I will show what problems Beck and Sauerland (2000) raises for this work's theory and how they might be solved. I will start with the mono-clausal example in (10a) before discussing the bi-clausal example in (10b).

(10) a. These five teachers gave a bad mark to those 20 protesting students.

b. Jim and Frank want to marry the two dentists.

The mono-clausal case What does the theory of chapter 4 predict for (11)? Following the account of chapter 4, *gave* is affixed with ∃ which weakens its meaning. Focusing on the case where the direct object is singular, I assume that "X ∃-*gave* y *to* Z" is true of an event e if and only if some of X gave y to some of Z in e (for the exact mechanism, refer to chapter 4). Armed with this weak meaning, we derive a weak meaning for the event predicate in (11a) as in (11b).

(11) a. These five professors ∃-gave a bad mark to these 25 students

b. $[\![\text{gave a bad mark}]\!](X)(Y)$
$= \lambda e. \exists X' \prec \iota\text{professors}, \exists Z' \prec \iota\text{students}, \exists m \in \text{bad-mark}, \text{gave}^{\text{ag+thm+goal}}(X')(m)(Z')(e)$
e is event where some of X gave some of Z a bad mark

In positive sentences, both of the plural-referring expressions are associated with an EXH operator. Glossing over technical details (see chapter 4), the EXH asserts that all and only the members associated to its argument participated in the event described. This makes two exhaustive participation inferences: an inference that in the event described, the professors are all the agents of the event described and an inferences that the students are all the goals of the event described. This, in combination with the weak meaning of (11b), gives the truth-conditions in (12).

(12) **Predicted truth-conditions:**

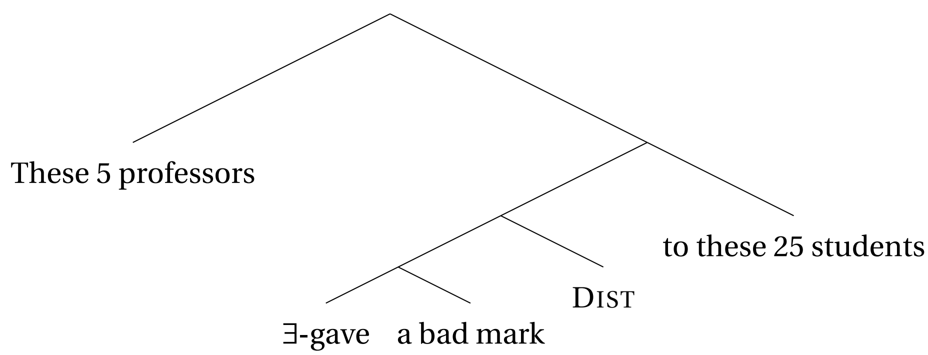
$$\exists e, \exists m \in \textsf{bad-mark}, \textsf{gave}^{\textsf{ag+thm+goal}}(\iota\textsf{professors})(m)(\iota\textsf{students})(e)$$

There is a bad mark the professors gave the students.

The truth-conditions are not the desired ones: they implies that the bad grade is the same for all students. This is precisely the truth-conditions derived by the lexical account. But this is not the reading pointed out by Beck and Sauerland. All in all, the account does not seem to fare any better than the lexical account.

However, a minimal fix is possible. To obtain co-variation between students and grade, it is sufficient to interpret "*these 25 students*" distributively as in (13). Distributivity operators, as we saw in chapter 7, are independently needed in the theory.

(13)



With distributivity, the predicted meaning is more satisfactory. Adding together the homogeneity effect of ∃-DIST and ∃-*gave*, the weak meaning of this sentence asserts that in the event *e*, some of the professors gave a student a bad mark. Added to that underlying meaning, there are two exhaustive participation inferences. The exhaustive participation inference associated to "*these 25 students*" asserts that in *e*, the students were each given a bad mark by some professors. The exhaustive participation inference associated to "*these 5 professors*" asserts that in *e*, every professor was involved in giving bad marks. This derivation of non-local monoclausal cumulativity through distributivity was first offered in Kratzer (2003) to my knowledge. It seems to deliver the right truth-conditions: every professor was involved in giving bad marks, and every student received a bad mark.

These truth-conditions appear, at first blush, to be equivalent to the prediction of a ** account. However, the truth-conditions are in fact subtly different. The reading derived by my account in (13) is atomically distributive in the students ; there is one bad mark per student. This is due to the fact, discussed in chapter 7, that the distributivity operator, in the absence of supporting context, is typically atomic. With covers, other non-atomic readings may arise but the out-of-the-blue context does not support any salient division of the students. At the same time, the predicted reading is not atomically distributive in the professors: it allows that some professors collectively graded some of the students.

Beck and Sauerland (2000)'s definition of the ** operator - repeated below in (14)- is also "*atomically distributive*" in the students. It is in fact atomically distributive in both arguments. Not only is it predicted that each student received one bad mark (object atomic distributivity), but it is also predicted that each professor gave a student one bad mark (subject atomic distributivity).

(14) $$[\![^{**}]\!](p) = \lambda X.\lambda Y.\ \forall x \prec X, \exists y \prec Y, p(x)(y) \wedge \forall y \prec Y, \exists x \prec X, p(x)(y)$$

for every atom x part of X, there is an atom y part of Y, ...

This is not a necessary component of their account. In footnote 2, they propose alternative definitions for ** which do not have this feature. For instance, citing Krifka (1986) (cf also Sternefeld (1998)), they propose to see ** as an operator which makes predicates summative (a.k.a. closure under sum). This operator is described in (15b), and represented as $^{\oplus\oplus}$. (15b) may be equivalently rewritten as (15c), which is closer to the format of cumulative paraphrases (cf Champollion (2014b); Vaillette (2001) for similar reductions of existential cover-based operators to star operators).

(15) a. $(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2, y_1 + y_2)$

b. $[\![^{\oplus\oplus}]\!](p) = \lambda x.\lambda y.\langle x, y\rangle \in \min\{q \supseteq p \mid \forall x, y \in q,\ x \oplus y \in q\}$

The smallest summative predicate which includes the extension of p

c. $$[\![^{\oplus\oplus}]\!](p) = \lambda X.\lambda Y.\ \forall x \prec X, \exists X' \prec X, \exists Y' \prec Y,\ x \prec X' \wedge p(X')(Y')$$
$$\forall y \prec Y, \exists Y' \prec Y, \exists X' \prec X,\ y \prec Y' \wedge p(X')(Y')$$

This new cumulativity operator $^{\oplus\oplus}$ is built so as to not yield atomic reading in either argument. Applied to Beck and Sauerland (2000)'s example, it would yield a reading paraphrasable as (16):

(16) a. The professors gave a bad mark to the students

b. **Predicted paraphrase under $^{\oplus\oplus}$:**
Every professor is part of a group of professors who gave some students a bad mark.
Every student is part of a group of students who was given a bad mark by some professors.

In summary, the account of this work and the two cumulativity operator accounts predict subtly different truth-conditions for the non-local monoclausal reading, given in (17). Which of these truth-conditions represent the actual reading of the sentence?

(17)

	the professors	the students
this thesis	under-specified	atomic
**	atomic	atomic
$\oplus\oplus$	under-specified	under-specified

Under-specified in x = any group of x

Atomic in x = any atom of x

To test this accurately, two factors of potential confusion must be eliminated. First, the predicate *give a bad mark* must be changed, as it is biased towards atomic distributivity. Indeed, students typically get individual grades[1]. I will use "*gave $25*" ; money can be given to an individual or shared among a group.

Second, we have seen that in certain cases, the distributivity operator may yield non-atomic cover readings. Since these readings are hard to distinguish from under-specified readings, this may obscure the difference between the current account and the $^{\oplus\oplus}$ account. One way to avoid this confound is to use phrases which typically do not yield

[1] In the case of group projects, a grade may be given to a group as a whole ; yet, this grade is still considered in some sense individual. Hence, when I ask my friend what grades she received this semester, she would probably list even those grades which she received as part of a group project.

cover readings. Numerals are one such case. Despite world knowledge pressures for that reading (shoes are bought in pairs), (18a) cannot be read as saying two pairs of shoes cost $5. The sentence receives either an atomically distributive reading (four of the shoes cost $5 each) or a collective reading (four of the shoes cost $5 together.)

(18) Four of the shoes cost $5.

The sentence in (19) takes into account these points. In place of *a bad mark*, I use *$25,000*. In place of *these 25 students*, I use *16 of the innovators*, which can receive phrasally distributive interpretations but not covered interpretations.

(19) **Context:** *This is the next-gen innovation conference. Innovators are invited to present IT projects to investors.*
The 10 investors gave $25,000 to 16 of the innovators.

a. *...after it has been distributed among these 16 innovators, $25,000 is going to amount to very little.*
object-collective reading: $25,000 to a group of 16 innovators, donations by individual investors or groups of investors.

b. *...in total, 160 innovators received money.*
subject-distributive readings:

c. *...not true! $15,000, that is what each of these 16 innovators received.*
underspecified/distributive reading: $25,000 per person, individual or collective donations

d. *...not true! One of these 16 innovators received only one donation of $25,000 from a group of investors. She did not receive any money from individual investors.*
***distributive/distributive reading:**$25,000 per person, individual donations

e. *...adding up everything, these 16 investors together received a total of $50,000 from the investors.*
***underspecified reading:** groups of innovators receiving $25,000 from groups

of investors. Every investors was part of a group that gave money ; every innovator was among the recipients of a donation.

The resulting sentence has many construals - as many as Beck and Sauerland (2000)'s original sentence. In sub-examples a. to e., I highlight each reading by providing continuations that are most sensible with it. The continuation is either a follow-up by the same speaker or an objection from another speaker, assuming in each case a particular interpretation of the sentence.

Some of these readings are irrelevant for our purposes. For instance, there is a purely collective reading where $25,000 does not vary with investors (cf (20a)) : this is the reading obtained without ** or $^{\oplus\oplus}$ in Beck and Sauerland (2000) and without distributivity operators in my proposal. Another class of irrelevant readings are subject-distributive readings. In these readings, a different set of *16 innovators* is picked for different investors (cf (20b)). Under both theories, this reading would come about as the result of applying a distributivity operator to the subject.

Let us then focus on the target readings where *$25,000* co-varies and *16 innovators* does not. There are 3 types of predicted readings. The reading predicted by the ∃-DISTapproach is one where each innovator receives $25,000 and the sentence does not specify whether the investments were done by individual investors or group of investors. The reading predicted by Beck and Sauerland (2000) with ** is one where each innovator receives $25,000 and furthermore, the sentence specifies that each investment came from single investors. With the $^{\oplus\oplus}$ operator, the reading predicted is maximally under-specific: the $25,000 investments were either to single innovators or groups of innovators received $25,000 and they were performed by either single investors or groups of investors. (20c-e) provides continuations that latch on the special features of each of these readings.

Only the continuation provided for (20c) seems sensible. What this shows is that the truth-conditions of the relevant reading of (19) track the properties of the distributivity operator, as discussed in chapter 7, rather than the properties of either the ** or the $^{\oplus\oplus}$ operator. In particular, the theory in this thesis does not need to be amended to account for such examples as (19).

Bi-clausal cases and more than 2 arguments. This is one of the two types of non-local cumulativity cases presented by Beck and Sauerland (2000). The other example involves cumulative readings of bi-clausal constructions such as (20a).

(20) Jim and Frank want to marry the two dentists.

In principle, this example may be treated using the same distributive strategy as above. In that case, the lower plural would take scope in the main clause and receive a distributive interpretation there.

(21) [Jim and Frank] [the two dentists] Dist λx. want to marry x

However, there is evidence that suggests that this is not the correct analysis of Beck and Sauerland (2000)'s examples. Examples like (21b) with more than two arguments are a case in point:

(22) The two retirees wanted to donate 6 of their horses to 3 of our stables

Here, a cumulative reading seems possible in which adding up the retirees' wished contribution amounts to a six horses-three stables donation. To get either argument to enter a cumulative relationship, the distributive approach must assume that they take distributive scope in the main clause as in (23). But the structure in (23), with one distributivity operator in the scope of another, yields a doubly-distributive reading: the retirees must have the contradictory desire to give their 6 horses to every one of the stables at the same time. This is not the target reading of the sentence.

(23) The two retirees [6 of their horses] DIST λx. [3 of our stables] DIST λy. wanted to donate x to y

In Beck and Sauerland (2000)'s approach, an explanation of these cases is possible: one simply needs to assume a *** operator, a natural generalization of the ** operator to 3 arguments. This seems to comfort the position that ** and variants thereof are a needed ingredient of cumulativity.

(24) $$[\![{}^{***}]\!](p) = \lambda X.\lambda Y.\lambda Z.\ \forall x \prec X, \exists y \prec Y, \exists z \prec Z, p(x)(y)(z) \\ \wedge \forall y \prec Y, \exists x \prec X, \exists z \prec Z, p(x)(y)(z) \\ \wedge \forall z \prec Z, \exists x \prec X, \exists y \prec Y, p(x)(y)(z)$$

Yet, the bi-clausal cases have a peculiarity which may independently explain why cumulative-like readings are possible. Note that it is in fact not clear that a lexical account makes the wrong predictions for cases like (25). Without assuming any form of movement or distributivity, (22) naturally gives rise to a reading paraphrasable as (25):

(25) The two retirees want the following thing: they donate 6 of their horses to 3 of our stables.

Beck and Sauerland (2000) deny that such a reading can express the intended truth-conditions without clearly stating their reason. One argument for the incorrectness of (25) might be that this reading implies that both retirees want the same thing. This reflects a tacit assumption that *want* is distributive: $x + y$ wants p entails that x wants p and y wants p.

Pasternak (2018) argues that *think* and other attitudes are not in fact distributive. We can construct examples similar to his for *want*. Consider a survey made by the town council regarding a new community center to be built. Asked about what they would want, one survey respondent replies that they would like a Victorian manor to be built ; one survey respondent insists on an indoor swimming pool in the community center ; another survey respondent insists on the use of natural materials. The results of survey can be summarized as in (26).

(26) The survey respondents want us to build a Victorian manor with an inside pool using only natural materials.

If desires may be aggregated in this way, then (27)'s truth-conditions may simply be an instance of it: the two retiree's wished donation is the simply the sum of their individual wished donations.

(27) The two retirees wanted to donate 6 of their horses to 3 of our stables

To tell whether collective desire is indeed the reason for (27)'s reading, we need a diagnostic for collective wishing. In some cases, as Pasternak (2018) notes, collective attitudes cannot be formed and attitudes ascriptions become purely distributive. This happens when the attitudes contradict one another in some way. If, in the survey, one respondent desires the community center to have a Victorian architecture with an indoor pool and the other wants the building to have a brutalist design and no indoor pool, (28) is not possible to utter:

(28) The survey respondents want us to build a brutalist building with an inside pool using only natural materials.

A prediction of treating these cases of cumulativity as collective attitudes is that the presence of a cumulative-like reading would be sensitive to contradictions among the wishes of the holder. And indeed, we do seem to find such a connection.

Imagine that two retail managers, Joana and João, are in constant disagreement on how to dress the 4 mannequins on display in the store's window. For today, Joana wants mannequin 1 & 2 & 3 to wear the green hat, the blue hat and the red hat respectively and mannequin 4 to go bare-headed. João, on the other hand, wants mannequin 4 to have the purple hat and mannequin 3 to have the brown hat and the rest to be bare-headed. It is clear here that the wish of both managers' cannot be met at the same time, if all mannequins can only wear one hat. In that context, the sentence in (28) seems contradictory or odd.

(29) # Today, Joana and João want the 4 mannequins on display to wear 5 hats.

With cumulativity operators like ***, there is no reason why this should be: the predicted reading would simply assert that Joana and João each want some number of hats to be placed on some mannequins, that these numbers add up to 5, and that for all mannequins, at least one person desire it to have a hat. This meanings is given formally below in (30).

(30) $\exists X \in \text{hats}, |X| = 5$

$\forall p \in \text{Joana} + \text{João}, \exists m \prec \iota\text{mannequins}, \exists x \prec X$, p wants m to wear x

$\forall m \prec \iota\text{mannequins}, \exists p \in \text{Joana} + \text{João}, \exists x \prec X$, p wants m to wear x

$\forall x \prec X, \exists p \in \text{Joana} + \text{João}, \exists m \prec \iota\text{mannequins}$, p wants m to wear x

So it seems that the cumulative readings of bi-clausal constructions are sensitive to contradictory wishes. An approach that makes use of ** does not seem to predict that it would be so. But this does not constitute the final word on bi-clausal cumulative readings ; we will come back to these readings when discussing the plural projection framework.

Conclusion

Beck and Sauerland (2000) have given examples of non-local cumulativity. Just like the cumulative reading of singular quantifiers introduced in chapter 1, these examples show that cumulativity cannot be accounted for with a naive lexical account. But they are also challenging to this theory of cumulativity presented in this work. On the basis of these examples, Beck and Sauerland motivate the introduction of cumulativity operators, like **, which implement cumulativity in the grammar. In this section, I have argued that in fact, the examples of Beck and Sauerland lend themselves to different interpretations.

First, while the mono-clausal examples of Beck and Sauerland (2000) do motivate an operator, I found these cases to be adequately handled by a distributivity operator, rather than a cumulativity operator. After carefully examining the truth-conditions and "*granularity*" of such examples, I found that these examples undermine rather than motivate an approach in terms of ** (or $^{\oplus\oplus}$). Instead, they seem to support an approach in terms of distributivity.

The bi-clausal examples of Beck and Sauerland (2000) however do not lend themselves to a distributivity analysis. But here too, the cumulative readings seem to display properties, which are not adequately captured by a ** operator. One such property is a certain form of dependence on contradictory wishes. This points to these readings being an instance of collective attitudes.

This concludes my discussion of Beck and Sauerland (2000). There are some components of their proposal which I have not commented on. For instance, they observe that their **-based approach leads them to predict that non-local cumulativity would obey scope islands. They provide evidence that this is the case. While this is not expected by the alternatives that I have proposed, the data that supports it has been criticized in the plural projection framework. This line of research, which I now turn to, present examples of cumulative readings across very long distances, including finite clause boundaries and scope island boundaries.

9.2 Plural projection framework

In a series of works, Haslinger and Schmitt (Haslinger and Schmitt, 2018; Schmitt, 2013, 2017) advance a wealth of examples in support of the idea that cumulative relations can be established across long distances. Their examples go beyond Beck and Sauerland (2000), because they suggest that cumulative relations can be established non-syntactically. On the basis of this data, they argue for a *plural projection framework*, a semantic framework where all categories (individuals, propositions, etc.) can be plural and they introduce new rules of composition tailored to these new plural objects.

The analysis developed in this thesis cannot account for the cases of non-local cumulativity that the plural projection framework is based on. Because the account fails to accommodate this data, it *prima facie* seems that the alternative offered by the *plural projection framework* is required.

I will give speculative reasons to resist this conclusion. Multiple strands of evidence suggest that non-local cumulativity, in contrast to local cumulativity, is limited in its availability. The plural projection framework does not readily explain this. As an alternative, I will outline an alternative compositional pathway, based on distributivity operators, which could explain non-local cumulativity and make sense of the different restrictions on its availability.

9.2.1 Generalized cumulativity

A first example of cumulative readings across clauses is offered by Schmitt (2020) and reproduced below in (31)[2].

(31) a. **Scenario:** Ada believes in zombies, Bea in griffins. Neither exist. Last week, Ada and Bea spent the night at Roy's castle. Around midnight, Ada thought she heard a zombie walking around in her room. A little later, Bea believed she saw a griffin sitting on her bed. They didn't discuss it with each other, but each took Roy aside and told him what she believed was going on. Roy tells me: Well, I had invited Ada and Bea to the castle. Bad idea... I know it can be a little spooky here, but...

b. *Diese Idioten haben echt geglaubt, dass da zwei Monster im Schloss unterwegs waren!*
these idiots have actually believed that there two monsters in-the castle roaming were

These idiots actually believed that two monsters were roaming the castle!

From the context, it is clear that the truth-conditions of the sentence do not entail that both Ada and Bea believe that two monsters were roaming the castle. Rather, the truth-conditions seem to entail both Anna and Bea believed some monster was roaming the castle and that the number of monsters any of them believe was roaming the castle is two. The paraphrase just sketched mirrors the paraphrase obtained for ordinary cumulative readings, as in (32).

(32) a. These idiots saw two monsters.

b. **Possible truth-conditions:**
Both of these idiots saw a monster.
The number of monsters seen by any of them is two.

[2] I give Schmitt (2020)'s examples in German. It is as of yet unclear whether there is cross-linguistic variation on this data (cf later discussion of Haslinger et al. (2020)).

Because of the similarity between the two paraphrases, it seems legitimate to call the reading of (31) a *cumulative reading across an attitude verb*. It is important to note that the existence of such examples directly run counter to some of Beck and Sauerland (2000)'s claims. Beck and Sauerland (2000) take non-local cumulativity to be limited by scope: two pluralities may enter a cumulative relation if and only if they can scope at the same position.

9.2.2 Non-cumulative analyses of cumulation across attitudes

Cumulative truth-conditions don't immediately call for cumulative composition. There may be alternative analyses which derive the desired reading using fairly standard assumptions. Schmitt (2020) dismisses two such analyses:

- Collective belief.
- Scope of embedded DPs.

Collective belief. The first analysis to rule out is a lexicalist treatment. Much semantic work has tried to delineate the correct truth-conditions for attitude sentences with singular attitude holders. But it isn't clear what it takes for a plurality of attitude holders to believe something. One possibility is that attitude verbs like *believe* are distributive: "$x + y$ *believe* p" entails that x believes p and y believes p.

But Pasternak (2018) provides examples like (33) in support for the idea that *believe* can be a collective predicate. In (33), neither cousins individually believes that Paul married a New Yorker who is rich, but it seems that the plurality they form does.

(33) a. **Context:** *Paul just got married and his cousins Arnie and Beatrice, who have never met, just caught wind of it. Arnie suspects that Paul's husband is rich, and has no other relevant opinions. Beatrice thinks he's a New Yorker, and has no other relevant opinions.*

b. Paul's cousins think he married a rich New Yorker.

It is not always possible to ascribe to a plurality the conjunction of the individuals' beliefs. In the context of (34) for instance, where Arnie and Beatrice have opposite opinions, the collective interpretation of (33) does not seem possible.

(34) **Context:** *Paul just got married and his cousins Arnie and Beatrice, who have never met, just caught wind of it. Arnie suspects that Paul's husband is rich and from Maryland. Beatrice thinks he's a poor New Yorker.*

More generally and simplifying somewhat, Pasternak (2018) claims that a group $x + y$ will believe $p \wedge q$, so long as one member of the group believes p, some other member believes q and both entertain $p \wedge q$ as possible. In other words, when beliefs of individuals don't contradict, the belief of a plurality is the conjunction of the beliefs of the individuals.

If this generalization is correct, then it could well be that cumulative readings across attitudes, such as (35), are an instance of collective attitudes: the plurality of Ada and Bea believes that two monsters are roaming the castle even though neither of them holds this belief.

(35) These idiots actually believed that two monsters were roaming the castle!

If this is so, then cumulative readings do not require a special mechanism for cumulative interpretation and follows from the lexical semantics of a verb like *believe*.

Against this possibility, Schmitt first observes that plurals and conjunctions notwithstanding, collective beliefs are in fact much more restricted than Pasternak's generalization would allow for. While (35) is possible, (36b) is not true in context (36a), even though the beliefs reported are not contradictory and in conjunction would entail the belief reported in (36b).

(36) a. **Context:** *Ada is looking forward to Sue's party ; she is certain that every man at the party will fall in love with her. Bea is also looking forward to the party ; she hates men and is certain that only one man will attend - Roy. Sue tells me: Ada and Bea are really looking forward to the party:...*

b. *Sie glauben, dass Roy sich in Ada verlieben wird! Die spinnen!*
they believe that Roy refl in Ada fall.in.love will. they are.crazy

"*# They believe that Roy will fall in love with Ada! They're crazy!*"

This example, I believe, shows that Pasternak's generalization is not fully adequate. Yet, they do not immediately dismiss the idea that cumulative readings across attitudes, like (31), are due to the lexical semantics of *believe*. Although we may not understand the conditions under which collective beliefs are possible, they could still explain cumulative readings across attitudes.

Schmitt thus gives a second strong argument that at least some cumulative examples cannot follow from collective attitudes. The general mechanism for cumulativity that Schmitt (2020) proposes is limited to certain types of expression: only certain elements - plurals, conjunctions, etc. - are liable to cumulative interpretations. On the other hand, a lexical analysis *à la* Pasternak (2018) would predict that readings similar to cumulative-like interpretations - which are a form of collective belief - would not need conjunctions to arise.

The contrast is illustrated by (37) (credited by Schmitt (2020) to N. Haslinger). In the scenario described in (37a), Arnie and Beatrice have contradictory beliefs. Only (37b), which reports the beliefs of Arnie and Beatrice by means of a conjunction (*from NY and from Maryland*), yields the predicted reading. When the belief is expressed via modification (*a NYer from Maryland*), the sentence reads as a contradiction. If cumulativity across attitudes is a result of the lexical semantics of *believe*, minor syntactic variations of this sort which do not alter the meaning of the complement clause should not affect the availability of a cumulative-like reading in both cases.

(37) a. **Context:** *Paul just got married and his cousins Arnie, Beatrice and Carl, who have never met, caught wind of it. Arnie supsects that Paul's husband is from New York. Beatrice thinks he is from Maryland. Carl thinks he is from France. Paul tells me...*

b. *Arnie und Beatrice glauben, dass mein Mann ein New Yorker und*
Arnie and Beatrice believe that my husband a New Yorker and
aus Maryland ist, und der irre Carl denkt, ich hätte einen
from Maryland is and the crazy Carl thinks I would.have a
Franzosen geheiratet!
French.person married

'Arnie and Beatrice believe that my husband is from New York and from Maryland, and crazy Carl thinks I married someone from France!'

c. *Arnie und Beatrice glauben, dass mein Mann ein New Yorker*
Arnie and Beatrice believe that my husband a New Yorker
aus Maryland ist, und der irre Carl denkt, ich hätte einen
from Maryland is and the crazy Carl thinks I would.have a
Franzosen geheiratet!
French.person married

'Arnie and Beatrice believe that my husband is a New Yorker from Maryland, and crazy Carl thinks I married someone from France!'

The possibility of contradictory belief examples seems to run counter to the example provided in section 9.1.4. There, we saw that contradictory beliefs do seem to affect the availability of a cumulative reading. I will leave this discrepancy aside for the moment and continue to follow Schmitt (2020)'s argumentation. The contrast in (37) establishes that indeed, not all cumulative readings across attitudes are derived from the lexical semantics of *believe*. Another ingredient must be added to the theory. Schmitt proposes that this other ingredient is the general cumulativity procedure offered by the plural projection framework.

Scope Schmitt also rules out an analysis of cumulation across attitudes following Beck and Sauerland (2000). With Beck and Sauerland (2000)'s **operators, the readings of Schmitt (2020) could be derived by giving both pluralities scope in the matrix clause and cumulating the relation obtained in this way, as in (38).

(38) a. [they] [two monsters] ** $\lambda x.\ \lambda y.\ y$ believe that x are roaming the castle.

b.

It is controversial whether this type of non-clause-bounded QR is possible to begin with(Syrett, 2015; Syrett and Lidz, 2011; Wurmbrand, 2016). Added to this, the required structure seems to predict that "*two monsters*" should be interpreted De Re, and yield an inference that monsters do exist. Regardless of how these worries may be assuaged, Schmitt shows additional cases of cumulative readings that no amount of LF movement would be able to capture. These are given below in (39).

(39) The two girls made Gene feed the two cats and brush Harry.

a. **Verifying Scenario:** *Girl 1 made Gene feed one cat and brush Harry, girl 2 made Gene feed another cat.*

b. **Verifying Scenario:** *Girl 1 made Gene feed the two cats, girl 2 made brush Harry.*

These examples show two "*layers*" of cumulativity: first, *the two girls* enters a cumulative relation with the VP conjunction *feed . . . and brush Harry* ; second, the two plurals enter a cumulative relation with *the two cats.*

Schmitt shows that this form of two-layered cumulativity cannot be captured, even allowing for the VP conjunction to be treated as some form of VP plurality and even allowing for as many island-violating movements as necessary. Some sample LFs are given in (40); none give rise to the correct reading[3].

(40) a. **LF 1:**

The two girls [feed the two cats and brush Harry] $^{**}\lambda X.\ \lambda P.\ X$ made Gene P

Predicted meaning:

every girl either made Gene feed the two cats or made Gene brush Harry.

one girl made Gene feed the two cats.

one girl made Gene brush Harry.

(false in (39a))

b. **LF 2:**

The two girls the two cats $^{**}\lambda y$. made Gene feed x and brush Harry

Predicted meaning:

every girl made Gene feed one of the two cats or made Gene brush Harry.

one girl made Gene feed cat 1 and brush Harry.

one girl made Gene feed cat 2 and brush Harry.

(false in (39a))

Summary In summary, neither a lexical approach (based on collective attitudes) nor an approach *à la* Beck and Sauerland (2000) can capture all readings which the plural projection framework can capture. This goes to show that something else is required.

9.2.3 The plural projection framework

In this subsection, I want to give a broad overview of the plural projection approach the phenomenon of cumulativity. I will step away from technical details[4] and focus my presentation on the core ideas.

The first idea is that every domain (e.g. the domain of individuals D_e, the domain of predicates D_{et}, etc.) has a corresponding plural domain. Just as there are plural individuals, there are plural predicates, plural propositions, etc.

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[3] The example is however subject to a response equivalent to the collective belief response seen earlier. In principle, sentences "*The two girls made Gene VP*" could be true if no girl individually brought about Gene performing VP. Examples similar to Pasternak (2018) may be constructed as in (41).

(41) **Context:** *Ada ordered Joe to clean the bathroom. When Joe went to get some supplies, Bea, who is in charge of cleaning supplies, would not give Joe to use the mop, the broom. She would only allow him a toothbrush.*
The two girls made Joe clean the bathroom with a toothbrush.

The factivity of *make* renders it difficult to construct the same examples that Schmitt (2020) gave for *believe*.

[4] In particular, I ignore the important fact that the framework embeds an alternative semantics.

(42) a. $\mathsf{Joana} + \mathsf{Marius}$

b. $(\lambda x.\ x \text{ slept}) + (\lambda x.\ x \text{ smiled})$

c. $\mathsf{sleep}(\mathsf{Joana}) + \mathsf{smiled}(\mathsf{Marius})$

The second idea is that pluralities "*project*". A plurality of individuals combines with a transitive predicate to form a plurality of intransitive predicates. The plurality of intransitive predicates may combine with a subject to form a plurality of propositions, so on and so forth.

(43) $[\![\text{Joana and Marius}]\!] = \mathsf{Joana} + \mathsf{Marius}$

$[\![\text{praise Joana and Marius}]\!] = \mathsf{praise}(\mathsf{Joana}) + \mathsf{praise}(\mathsf{Marius})$

The third idea is that cumulative readings arise in the course of the composition when two plural elements combine with each other. For instance, when the plural subject *Billie and Sue* combines with the plural VP *praised Joana and Marius*, a cumulative reading is created which is true if and only if both Billie and Sue praised either Joana or Marius and both Joana and Marius were praised by either Billie or Sue. Because writing the full cumulative reading is cumbersome, I abbreviate it using a CUMUL meta-language operator.

(44) a. $[\![\text{praise Joana and Marius}]\!] = \mathsf{praise}(\mathsf{Joana}) + \mathsf{praise}(\mathsf{Marius})$

$[\![\text{Billie and Sue}]\!] = \mathsf{Billie} + \mathsf{Sue}$

b. $[\![\text{Billie and Sue praised Joana and Marius}]\!] =$

$(\mathsf{praise}(\mathsf{Joana})(\mathsf{Billie}) \wedge \mathsf{praise}(\mathsf{Marius})(\mathsf{Sue})) \vee$

$(\mathsf{praise}(\mathsf{Joana})(\mathsf{Sue}) \wedge \mathsf{praise}(\mathsf{Marius})(\mathsf{Billie}))$

$= \textsc{Cumul}(\mathsf{Billie} + \mathsf{Sue})(\mathsf{praise}(\mathsf{Joana}) + \mathsf{praise}(\mathsf{Marius}))$

Cumulativity across attitudes. These three ideas together predict that cumulative readings occur over unbounded distances. In this system, a plural element like *two monsters* can "*project*" freely up the tree, forming pluralities of predicates, propositions, etc along the way.

(45) These idiots actually believed that two monsters were roaming the castle!

(46) illustrates this projection behavior. For simplicity, I take *two monsters* to denote a plurality, effectively ignoring *two monsters* is an indefinite. By the projection rule presented above, a plural belief predicate is formed by the composition.

(46) $[\![\text{two monsters}]\!] = \mathsf{Griffin} + \mathsf{Zombie}$
$[\![\text{two monsters were roaming the castle}]\!] = \mathsf{roaming}(\mathsf{Griffin}) + \mathsf{roaming}(\mathsf{Zombie})$
$[\![\text{believed two monsters were roaming the castle}]\!]$
$= \mathsf{thought}(\mathsf{roaming}(\mathsf{Griffin})) + \mathsf{thought}(\mathsf{roaming}(\mathsf{Zombie}))$

This plural belief predicate can combine with the subject plurality to form a cumulative reading.

(47) $[\![\text{These two idiots believed two monsters were roaming the castle}]\!]$
$= \textsc{Cumul}(\iota\mathsf{idiots}, \mathsf{thought}(\mathsf{roaming}(\mathsf{Griffin})) + \mathsf{thought}(\mathsf{roaming}(\mathsf{Zombie})))$

This, in spirit, is the analysis proposed for all cases of cumulativity.

9.2.4 Another look at the missing ingredient

The analysis of the plural projection framework is very broad and captures many examples. One fact that remains unexplained is the relative difficulty that there is in obtaining the relevant readings. Without the context they were presented with, the (English) sentences like (47) naturally give rise to distributive readings.

(48) These idiots actually believed that two monsters were roaming the castle!
$\rightsquigarrow$ Idiot 1 believed that two monsters were roaming the castle.
$\rightsquigarrow$ Idiot 2 believed that two monsters were roaming the castle.
$\rightsquigarrow$ ...

Another piece of evidence for the markedness of cumulation across attitudes comes from the preliminary survey results reported by Haslinger et al. (2020). The survey investigated the acceptability of a sentence like (49b) in the contexts in (49a) from various languages.

(49) a. **Context:** *Ada believes criminal 1 is threatening Gene. Bea believes that criminal 2 is threatening Gene.*

b. Ada and Bea believe that two criminals are threatening Gene.

On these cumulative examples, the authors report: "*the cumulative reading was available in German, Punjabi and SerBo-Croatian but not in Polish and Hungarian, and the judgements for Dutch and Japanese were unclear*". However, the numbers of speakers consulted for each language is small ; it may well be that these languages behave uniformly but the intended reading is simply dispreferred. The mixed judgements thus reveals either speaker's variable tolerance for cumulative readings across attitudes, a language's dispreference for such construals or a combination of these two factors.

Adding to the suspicion that speaker variation is at fault, rather than language variation, Schmitt (2017) reports that German speakers find the sentences more or less acceptable. She reports that that difference only partially correlate with dialectal lines. In my own cursory investigation on 3 non-linguist speakers of French (of the same dialect), I found the following result: two accepted the reading and one rejected it. .

It is worth mentioning that all languages in the sample surveyed by Haslinger et al. (2020) got cumulative readings in bi-clausal cases like (50a) and (50b).

(50) a. **Scenario:** *Ada tried to arrest criminal 1, Bea tried to arrest criminal 2.* Ada and Bea tried to arrest two criminals.

b. **Scenario:** *Ada saw woman 1 sell drugs. Bea saw woman 2 sell drugs.* Ada and Bea saw two women sell drugs.

However, the lexical analysis of these cases, contrary to *believe*, is harder to rule out. For instance, *try* more naturally lends itself to collective interpretations than *believe*, as the contrast between (51a) and (51b) attests As for *see*, event analysis of perception report already predict the possibility of collective interpretation.

(51) (An *exquisite cadaver* is a type of literary piece composed by alternating authors.)

a. Jeremiah and Rebecca tried to write an exquisite cadaver.

$\not\rightsquigarrow$ *Jeremiah tried to write an exquisite cadaver.*

b. Jeremiah and Rebecca believe they wrote an exquisite cadaver

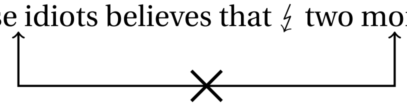
$\rightsquigarrow$ *Jeremiah believe they wrote an exquisite cadaver*

I draw two provisional conclusions from this discussion: 1) cumulative readings across attitudes are real and widespread across languages (mostly European so far), 2) they are dispreferred. This stands in contrast with monoclausal cumulative readings which are widespread and possibly universal (Ferch, 2013; Gil, 1982; Kratzer, 2003; Müller and Negrão, 2012) and unmarked (Gil, 1982; Ussery, 2007).

Ideally, a semantic theory should do justice to observations 1 and 2. The plural projection framework predicts observation 1 by assuming that plural projection is a natural mode of composition. In doing so, it also makes 2 hard to explain. In fact, so far as the framework presented in section 9.2.3 goes, there is no way to predict anything but a cumulative reading across clause boundaries. With minimal modifications however, the unmarked reading can be derived. For instance, it is possible to design operators which "*collapse*" plural propositions, predicates, etc. into singular ones (Haslinger and Schmitt, 2018). For instance, the ↯ operator in (52a) makes plural propositions into a singular conjunctive proposition. Cumulative readings will not be established across such "*collapsing*" operators.

(52) a. $[\![↯]\!] = \lambda P.\ \bigwedge_{p<P} p$

b. These idiots believes that ↯ two monsters are roaming the castle.



With this operator, the plural projection framework now predicts two parses:

(53) a. **Distributive belief parse:**

Ada and Bea believe two monsters are roaming the castle

b. **Cumulative belief parse:**

Ada and Bea believe ↯ two monsters are roaming the castle

This strategy for explaining observations 1 and 2 is certainly feasible but one wonders whether the opposite strategy might not be more fruitful. Rather than a compositional system that naturally yields cumulative readings but ruled out by the addition of an operator, could one have a compositional system where the cumulative attitude reading is derived by addition of an operator? The reading's difficulty would then be tied to the licensing conditions of such an operator. In the sequel, I provide a speculation about what such a system might look like. I will try to show how this alternative can capture the reading and its licensing conditions, as well as explain properties of this reading that differ from those cumulative readings discussed in the thesis.

9.2.5 Pairings and context distributivity operator

I want to propose that some of the cases of cumulativity across attitudes follow from a generalized notion of phrasal distributivity. There is some evidence that the predicate-based view of phrasal distributivity, as presented in chapter 7, needs to be generalized. A first example of this is given in Schwarzschild (1996). He notes that (54a) seems paraphrasable as a universal-like reading (54b).

(54) a. The books of the first column complement to the books of the second column.

b. **Paraphrase:**
for every row, the books in that row in the first column complements the book in that row on the second column.

c.

Fiction	**Non-fiction**
Alice in Wonderland	Aspects i ; Language (Bloomfield)
Fantastic Voyage	Gray's Anatomy
David Copperfield, Hard Times	Das Kapital, The Wealth of Nations
Oedipus Rex, Agamemnon	Freud's Intro. to Psychology
Richard III	Machiavelli's The Prince

The reading described looks like distributivity ; it is paraphrasable as a universal. But this one universal is, in some sense, associated with two elements, *the books in the first* *column* and *the books in the second column.*

To make sense of this observation, Schwarzschild (1996) proposes a generalization of the cover-based DIST operator that we discussed in chapter 7, which I will write DDIST. DDIST applies to eet predicate, rather than et predicates. Instead of covers, DDIST is parametrized by pair covers, a sets of pairs of individuals salient in context.

(55) $[\![\text{DDIST}_C]\!] = \lambda p_{eet}.\lambda x.\lambda y.\ \forall \langle x', y'\rangle \in C, x' < x \wedge y' < y \wedge p(x')(y')$

In the book example of (54a), the paired-cover is presumably the set of pairs of book-pluralities on the same row of the chart. With this cover, we can derive the meaning of (54a) with the LF in (56b).

(56) a. $C = \{\langle \mathsf{alice}, \mathsf{aspects} + \mathsf{language}\rangle, \ldots\}$

b. The books of the first column [DDIST complement] to the books of the second column.
$\forall \langle x', y'\rangle \in C, x' < x \wedge y' < y \wedge \mathsf{complement}(x')(y')$

At first blush, DDIST is reminiscent to Beck and Sauerland (2000)'s **operator. They are both eet-level operators. But the parallel stops here. The readings generated are very different. **operator generates cumulative readings readings: every book on the first column is such that some book on the second column .... DDIST generates universal-like meaning: for every pair $\langle x', y'\rangle$ in the cover, ... An additional difference between the two operators is that DDIST requires a contextually provided paired-cover ; **does not require this form of contextual support.

Tying it to cumulative interpretation across attitudes. This latter difference has its importance. Because DDIST is dependent, for its interpretation, on a contextually provided pairing, it is reasonable to assume that DDIST cannot be applied if the context does not provide a value for such a parameter. This gives us a natural licensing condition on the use of this operator. This licensing condition, in turn, remind one of the type of contexts used to elicit cumulative attitudes in Schmitt (2017, 2020). These contexts typically provide an explicit pairing between the two pluralities which are to enter the cumulative reading (repeated in (57)).

(57) a. **Context:** *Ada believes in zombies, Bea in griffins. Neither exist. Last week, Ada and Bea spent the night at Roy's castle. Around midnight, Ada thought she heard a zombie walking around in her room. A little later, Bea believed she saw a griffin sitting on her bed. They didn't discuss it with each other, but each took Roy aside and told him what she believed was going on. Roy tells me: Well, I had invited Ada and Bea to the castle. Bad idea... I know it can be a little spooky here, but...*

b. These idiots actually believe that two monsters are roaming the castle.

(58) a. **Context:** *Paul just got married and his cousins Arnie, Beatrice and Carl, who have never met, caught wind of it. Arnie suspects that Paul's husband is from New York. Beatrice thinks he is from Maryland. Carl thinks he is from France. Paul tells me ...*

b. Arnie and Beatrice believe that my husband is from New York and Maryland.

This provides a hope that the readings of these sentences arise by application of a DDIST operator. For instance, the LF's in (59) spells out how DDIST might be used to that effect:

(59) [these idiots] [two monsters] $\text{DD}{\small\text{IST}}_{\text{C}}$ λx. actually believe that x are roaming the castle.

Problematically, this LF seems to require island-violating movement to be derived. Unless we give up some assumptions about the locality of scope operations, it seems the desired LF can't be predicted. But there is evidence that a second generalization of distributivity is required.

Need for a second generalization of DIST. There are other observations which motivate a generalization of DIST along a different line. Chatain (2019b) observes that in some cases, the universal force associated with that DP can have scope in the matrix even when the DP itself is not in the matrix (similar examples are also reported in Charlow (2010); Kamp and Reyle (2013)). I refer to these cases as cases of *exceptional scope distributivity*.

(60) When these employees enter the facility, Marius smiles. (But he doesn't when those ones do.)
$\rightsquigarrow \forall x \in [\![\text{these employees}]\!]$ when x enter the facility, Marius smiles.

With DIST, these readings can only be obtained by forming a predicate like (61). But forming this predicate requires an island-violating movement operation.

(61) these employees ∃-DIST when ~~these employees~~ enter the facility, Marius smiles.

Chatain (2019b) proposed to derive these readings by treating the distributivity operator as an operator over contexts (i.e. assignment functions) rather than predicates. The notion can be formalized within a plural dynamic semantics but I will not present these details here.

(62) D_i when *these employees*$_{\text{i}}$ enter the facility, Marius smiles.

The important fact for our purpose is that the analysis of D_i requires its associate (e.g. *these employees* in (62)) to be sufficiently referential. The exceptional scope distributive reading does not seem available for plural quantifiers of various stripes:

(63) a. When all employees enter the facility, Marius smiles.

b. When most employees enter the facility, Marius smiles.

In sum, we have seen that two generalizations of the DIST operator are need. First, we need to extend the DIST operator to multiple arguments. Second, we need a context-based DIST operator to deal with cases of exceptional scope distributivity. But there is evidence that these two innovations must be compounded: a context-based DDIST operator may also be needed[5]. The same exceptional scope distributive behavior is attested when the two pluralities in question are sufficient paired.

(64) a. After you read the books on the second column, you start to understand better the books in the first column

b. **Context:** *At the G20, each French minister meets with its Japanese counterpart in a separate room.*
When the French ministers entered the conference room, the Japanese ministers greeted them in French.

Similar examples are given in Schmitt (2019), although her description is in terms of cumulative readings.

(65) a. **Context:** *An experiment on human-cat interaction: In room 1, Abe is watching a video of Carl, in room 2, Bert is watching a video of Dido. Whenever Carl moves, Abe must press a button. Whenever Dido moves, Bert has to press a button.*

b. If the two cats / Carl and Dido move, the two boys have to press a button.

To tackle such readings, the context-based operator of 62 must be generalized to two positions and relativized to paired covers. If this can be done, we have an operator apt to derive cumulative-like readings across attitudes

(66) $\text{DD}\textsc{ist}_{C,3,7}$ [These idiots]$_3$ actually believe that [two monsters]$_7$ are roaming the castle. $C = \left\{\langle \mathsf{Ada}, \mathsf{Griffin}\rangle, \langle \mathsf{Bea}, \mathsf{Zombie}\rangle\right\}$

Much needs to be spelled out. But we can already foreshadow that this operator has at least two licensing conditions. First, as discussed earlier, it requires a context where the two pluralities are matched in some way (so that a paired cover is salient). As mentioned earlier, this seems mostly borne out: Schmitt (2017)'s examples do require explicit pairing. Second, the operator would only associate with sufficiently referential expressions.

[5] Generalization to more than 2 positions, it seems that distributivity would require an unselective context-based operator. If this is correct, this operator looks furiously like a generic operator. This parallel between genericity and distributivity is explored in Kamp and Reyle (2013).

What is predicted is that cumulative readings of quantifiers across attitudes would not be possible. As the next section discusses, this also seems to be borne out.

Cumulative readings of quantifiers One critical difference then between the approach of the last section and the plural projection approach is which elements would give rise to cumulative readings. A prediction is made that quantifiers, even thought they give rise to cumulative readings would not give rise to cumulative-like readings across attitudes. Focusing on modified numerals like *exactly 6* as a quantifier, Schmitt warns that "*it is difficult to contextually motivate the use of the modified numeral in the embedded clause*" (Schmitt, 2020, p. 11). So contexts must be carefully constructed when assessing the availability of these readings. This is what (67) intends to do. If the target answer in (67) truly had a cumulative reading, then the sentence should, on the model of cumulative readings, mean that there are more than 10 different women for whom we can find at least one expert who believes that she was married to Pharaoh Djoser (and all experts have an opinion). This piece of information is assuredly very relevant in explaining how little agreement there is among the different experts ; yet, it cannot be conveyed by (67). (67) rather conveys that Djoser was polygamous, something that is totally incongruent with the presuppositions of the context.

(67) _ Would you say that the experts agree on the identity of Pharaoh Djoser's wife?
_ Far from it! # The experts believe that Pharaoh Djoser was married to more than 10 women.

Similarly, none of the other quantifiers studied in this thesis are amenable to the cumulative reading. Yet, in all cases, the cumulative readings is quite sensible and called for in context.

(68) _ Would you say that the experts agree on the identity of Pharaoh Djoser's wife?
_ Far from it! # The experts believe Pharaoh Djoser was married to every woman mentioned in the inscriptions.

(69) _ Would you say that the experts agree on the identity of Pharaoh Djoser's wife?

_ Far from it! # The experts believe Pharaoh Djoser was married to most women mentioned in the inscriptions.

My conclusion then is that at least in English, there are no cumulative readings of modified numerals across finite clause boundaries. Schmitt (cf Schmitt (2013, 2017, 2020)) draws a different conclusion for German. On the basis of examples like (70), she suggests that modified numerals like *genau 13 Geister* (exactly 13 ghosts) do yield cumulative readings, illustrated in (70).

(70) a. **Context:** *There is a myth concerning the castle: One day, exactly 13 ghosts will appear and then everyone will die within 24 hours. Ada and Bea are unaware of this myth, and Roy, who is aware of it, doesn't believe in it. His father does. Ada thinks she saw 7 different female ghosts in her room and that no other ghosts are in the castle. Bea thinks she saw 6 different male ghosts in her room and that no other ghosts are in the castle. They don't discuss it, but each tells Roy about her beliefs. Roy tells his father:*

b. *diese Idioten glauben, dass da genau 13 Geister im Schloss*
these idiots believe that there exactly 13 ghosts in-the castle
unterwegs waren!
roaming were

'These idiots believe that exactly 13 ghosts were roaming the castle.'

The construction of this data point is surprising. The context makes relevant the proposition "*exactly 13 ghosts are roaming the castle*", as a prophecy. At first blush, the fact that Ada's 6 ghosts and Bea's 7 ghosts add up to the 13 ghosts of the dreaded prophecy seems like these pieces of information are intended to confirm the prophecy. Deceiving these expectations, the context asserts that both Ada and Bea think that less than 13 ghosts are roaming the castle. The intended cumulative readings of (70b) entails that, as far as the beliefs of Ada and Bea are concerned, the prophecy is not fulfilled.

By contrast, I take the context induced by the Pharaoh Djoser examples to be more straightforward and a more accurate view into what happens when the use of the modified numerals is contextually motivated. I cannot explain the acceptability of (70b) in the given scenario. I can only guess that speakers have glossed over *genau* (exactly) in their parse of the sentence, something which the complexity of the context makes plausible. Without *genau*, the sentence is similar to one of the unmodified numeral example studied already.

Cumulative readings across negation Another element of difference concerns cumulativity across negation. The following sentence is true

(71) **Context:** *The professor assigned each student different books to read for the class next week. One week later, the students haven't completed none of their assigned readings. Instead, they got the assigned list mixed up and read each other's assigned readings. She exclaims:*

The students didn't read the books!

Chapter 10

Conclusion

10.0.1 The problem and the solution

Cumulativity from homogeneity: the paradox This thesis's goal is to provide a new theory of cumulativity. In particular, I have tried to solve the following paradox of cumulativity: the same meaning for *crack* which accounts for the truth-conditions of (1a) delivers too strong a meaning for (1b). Specifically, the cumulative truth-conditions of (1a) lead us to posit a cumulative denotation for *crack*, as in (2) but this denotation, along with reasonable assumptions about the meaning of *every*, predicts (1b) to mean "*every squirrel cracked every nut*"

(1) a. The squirrels cracked the nuts.

b. The squirrels cracked every nut.

(2) $$[\![\text{cracked}]\!] = \lambda X.\lambda Y.\ \begin{array}{ll} & \forall x \prec X, \exists y \prec Y, \mathsf{crack}(y)(x) \\ \wedge & \forall y \prec Y, \exists x \prec X, \mathsf{crack}(y)(x) \end{array}$$

As seen in chapter 1, the problem also arose with other quantifiers than *every*, including non-partitive *most* and Lebanese Arabic SAT numerals.

Cumulativity from homogeneity: the recipe This thesis's main contribution is a recipe to solve the paradox. The recipe's first ingredient is that verbs like *crack* are not as strong as they appear in e.g. (2). In truth, all that is required for X to crack Y is one of X cracking one of Y. This is the weak denotation for *crack*. The recipe's second ingredient is that the additional inferences not captured by this weak denotation, the exhaustive participation inferences, are taken to be the result of implicature strengthening.

This ingredients of this recipe were conceived by investigating in depth the homogeneity properties of cumulative sentences. More specifically, following Bar-Lev (2018b), we showed that the truth-conditions of the negative sentences in (3) could be taken as revealing the weak meaning postulated by the recipe.

(3) a. The squirrels didn't crack the nuts.

b. The squirrels didn't crack every nut.

Two theories of cumulativity. The recipe itself is a general schema. In this work, the schema was spelled out in two radically different ways. Chapter 2 proposed a theory of weak meanings and strengthening based on a traditional non-event-based composition and recursive exhaustification (as in e.g. Heim and Kratzer (1998)). Chapter 4 proposed a theory of weak meanings and strengthening based on event composition and single exhaustification.

Both theories had their merits, which were compared in chapter 8. The event-less theory of chapter 2 is more sober in its assumptions and explains the cumulative readings of downward-entailing quantifiers. The eventful theory of chapter 4 critically relies on event semantics and helps answer more fundamental questions about the origin of verb variation and more diverse forms of homogeneity/cumulativity.

10.0.2 This thesis's contributions

The two theories of cumulativity based on weak meanings and strengthening are this thesis's main contribution. In the process of developing this theory, this work has tried to make a number of other contributions which I review here.

Extending the range of cumulativity and homogeneous sentences considered. One contribution of this thesis is to putting together a broader set of facts regarding homogeneity (following the lead of (Löbner, 2000)) and cumulativity than has previously been considered.

Specifically, chapter 3 has shown how non-plurals also display homogeneity and cumulativity. I gave two examples: the case of objects with parts and the case of group nouns. For each type of noun phrases, we showed examples of homogeneity and cumulativity.

Developing an understanding of verb variation in both homogeneity and cumulativity. Verbs, as we saw, vary in whether they display homogeneity or not and how much of it they display (cf group and part homogeneity, in chapter 3). A contribution of this thesis is to develop an understanding of what explains this variation.

An answer was provided in chapter 4 of this work. I proposed that whether weak meanings arise is a function of what parts event of a certain type have. For instance, events of *eating the apple* have eating parts that correspond to the events of eating bits of the apple. Because of this, sentences involving this predicate will display homogeneity down to the parts. As we saw in chapter 6, this connection helps explain certain correlations between homogeneity/cumulativity and inferential properties such as summativity.

A distinction between lexical and phrasal homogeneity. A more minor contribution of this thesis is the distinction between lexical homogeneity (originating from the predicate) and phrasal homogeneity (originating from an operator). In chapter 7, I showed that this distinction yields a clear picture of the homogeneity properties of sentences displaying phrasal distributivity, compared to an approach that tries to generate all homogeneity effects from one same source.

(Partial) reanalysis of long-distance cumulativity. In chapter 9, I offered a partial reinterpretation of cases described as cases of non-local cumulativity in terms of distributivity. The case was clearer for Beck and Sauerland (2000). There, it was shown that a analysis in terms of non-local cumulativity made subtly incorrect predictions about the truth-conditions of such sentences.

The examples of Haslinger and Schmitt (2020) were more challenging to explain away. Nevertheless, converging evidence seem to show that these examples of non-local cumulativity are not as accessible as the cumulativity discussed in the rest of the thesis. This motivates considering them as stemming from a different source.

10.0.3 Extensions

This thesis has not exhausted all the problems afferent to homogeneity and cumulativity. In this section, I want to mention some questions which could not be addressed in this thesis, although they directly concern homogeneity and cumulativity.

Cumulative readings of modified numerals Among quantifier, modified numerals offer the most intricate cases of cumulative readings. Specifically, the cumulative readings of such sentences as (4) are difficult to explain under standard assumptions.

(4) a. More than 3 children ate less than 5 cookies.

b. **Truth-conditions:**
More than 3 children ate cookies.
Less than 5 cookies were eaten by children.

Landman (2000) and Brasoveanu (2013) offer interesting and intricate proposals on how such readings may be derived. While both proposals are couched in very different frameworks (event semantics and dynamic semantics), they exploit similar ideas: they consider that (4a) has a core existential meaning as in (5), onto which cardinality tests (as in (5b)) are grafted at a later stage (either through post-suppositions or event closures).

(5) a. Some children ate some cakes.

b. The children were more than 3.
The cookies were less than 5.

Given this thesis' focus on weak existential meanings for verbs, there is a hope that one may reinterpret the core existential meaning in (5a) of Landman (2000) and Brasoveanu

(2013) as a consequence of existential verb denotations. This is a potential consequence of this work which could not be taken up in this thesis.

Homogeneity removal. An important topic left aside concerns the homogeneity removal properties of quantifiers. Quantifiers which range over pluralities do not yield homogeneity effects (Kriz, 2015). Starting from existential verb denotation for *see*, one might expect (6) to mean (6a). Here, no strengthening would take place, as the plural quantifier is in the scope of negation. Frustrating these expectations, the attested reading in (6b) behave as if strengthening from existential to universal had taken place under the scope of negation.

(6) I didn't see four firefighters

a. **Expected:**

It's not the case that that there are four firefighters such that I saw **any** of them.

$\rightsquigarrow$ *I saw no firefighters*

b. **Attested:**

It's not the case that that there are four firefighters such that I saw **all** of them.

$\rightsquigarrow$ *I saw less than 4 firefighters*

This fact is unexpected. As Bar-Lev (2018b) proposed for *all*, we could adapt the semantics of plural quantifiers to contain a form of exhaustification and strengthening. This works but begs the question as to why all plural quantifiers incorporate exhaustification in their semantics. I leave the question open here ; hopefully, future research can provide answers to that question.

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Glossary

m-**part** This represents the expression "*is a part of*" as it applies to properties, in sentences like *this is part of a Pigeot car*. Wholes are not required to exist for this relation to apply (e.g. no Pigeot car needs to exist or have ever existed in the actual world for something to be part of one). 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 175, 178, 179, 180, 183, 184, 189, 193, 194, 201, 213, 230, 246, 248, 250, 252, 254, 255, 257, 280, 282, 283, 289, 290, 303, 368

ι This meta-language symbol picks out from a meta-language predicate the maximal element (in terms of plural parthood) if it exists. ιsquirrels is thus the sum of all squirrels (since this sum is the maximal element in the extension of squirrels. This use goes against the common use of ι, as a uniqueness operator but it allows me to keep to Link's insight that there is no conceptual distinction between singular and plural definites. 19, 24, 25, 26, 32, 38, 39, 40, 41, 43, 44, 45, 46, 48, 50, 51, 52, 54, 55, 56, 57, 62, 68, 82, 83, 86, 87, 89, 92, 93, 94, 110, 114, 149, 150, 153, 154, 155, 156, 157, 158, 159, 160, 163, 164, 166, 168, 169, 170, 171, 172, 177, 179, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 198, 199, 205, 210, 211, 212, 213, 215, 216, 217, 227, 228, 230, 231, 232, 234, 247, 248, 249, 252, 254, 263, 264, 267, 269, 271, 273, 274, 275, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 291, 313, 314, 322, 332, 363

$\prec$ This meta-language symbol translates "*is a plural part of*". This relation does not exclude singularities nor does it preclude non-proper parts. So all the following statements are true: $X \prec X, x \prec x+y, x+y \prec x+y+z$ 14, 17, 19, 22, 23, 24, 25, 26, 38, 39, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 54, 55, 56, 57, 62, 68, 69, 72, 75, 79, 80, 82, 83, 84, 86, 87, 88, 90, 92, 93, 94, 110, 141, 157, 178, 179, 181, 182, 183, 184, 185, 186, 189, 190, 191, 193, 194, 210, 211, 212, 213, 215, 216, 221, 224, 230, 231, 232, 233, 234, 251, 252, 260, 262, 264, 265, 266, 267, 269, 271, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 289, 296, 297, 298, 300, 304, 312, 313, 315, 320, 322, 334, 336, 343, 364, 365

EXH^2 This symbol is used to represent two successive exhaustification mechanisms in the object language. Thus, (7a) must be read as (7b).

(7) a. EXH^2 [the dancers smiled]

b. EXH [EXH [the dancers smiled]]

87, 88, 89, 90, 91, 92, 93, 141

** This is the double star operator of Beck and Sauerland (2000). The operator applies to a two-place predicate and two arguments and delivers a cumulative reading.

(8) $$[\![^{**}]\!](p) = \lambda X.\lambda Y.\quad \forall x \prec X, \exists y \prec Y, p(x)(y) \\ \wedge \forall y \prec Y, \exists x \prec X, p(x)(y)$$

309, 312, 314, 315, 316, 318, 319, 322, 323, 328, 329, 330, 336, 364

admissible partition From Löbner (2000). An *admissible* partition of *a* is defined as a set of parts of *a*, mutually disjoint and whose sum is *a*, which all meet the selectional restriction of the predicate. 104, 105

all-or-nothing inference Refers to any situations where a positive sentence has a meaning paraphrasable as "*All of X did Y*" and its negative counterpart as "*None of X did Y*". All-or-nothing inferences includes the plural homogeneity with which this work is mostly concerned with, part/group homogeneity, bare conditionals, etc. 97, 98, 99, 101, 102, 103, 111, 114, 116, 118, 123, 144, 366, 368

anti-symmetric A relation R_{eet} is anti-symmetric if and only if for every x, y, $R(x)(y)$ and $R(y)(x)$ entails $x = y$. 149, 368

assignment function A *partial* function mapping integers to entities. 198

cover A cover of plurality X is a set of pluralities that add to X. Formally, C is a cover of X if and only if $X = \sum_{x \in C} x$. 253, 336, 339

cumulative reading The most salient reading of a sentence with at least two verbal arguments. The truth-conditions of these readings is typically paraphrased (although not always) by "*for all members of Y, there is a member of X such that ... and for all members of X, there is a member of Y, such that ...*" 31, 32, 33, 34, 36, 38, 45, 61, 74, 75, 88, 93, 176, 179, 213, 229, 259, 289, 309, 310, 319, 322, 323, 324, 326, 327, 328, 329, 331, 334, 336, 339, 340, 341

dataset This refers to the set of the cumulative sentences in (9). These are the sentences which this chapter wants to give an account of. 35, 36, 39, 42, 50, 51, 76, 83, 84, 94

doubly-distributive reading A reading of the form $\forall x, \forall y, R(x, y)$, where both arguments of a transitive verb are interpreted universally 84, 88, 89, 90, 91, 319

event domain In an event semantics, this refers to the constituent that forms the scope of the existential over events $\exists e$. 28, 177, 180, 185, 189, 194, 196, 199, 200, 201, 228, 230, 231, 288, 290, 291, 292, 308

exhaustive participation inference An inference of the form $\forall x \prec$ some-plurality, $\exists y \in p, \exists z \in q, \ldots$ witnessing the fact that all members of a plurality participated in the action described in the verb. The shape of these inferences in cumulative sentences is given by the *exhaustive participation* generalization 22, 23, 25, 26, 41, 42, 44, 47, 54, 55, 57, 58, 59, 63, 64, 68, 69, 70, 74, 75, 76, 79, 81, 110, 118, 140, 146, 147, 170, 171, 179, 180, 181, 186, 187, 190, 191, 194, 195, 196, 198, 200, 213, 214, 215, 216, 232, 234, 287, 289, 290, 296, 297, 298, 306, 307, 313, 314, 344

group homogeneity Refers to any situations where a positive sentence has a meaning paraphrasable as "*All members of X did Y*" and its negative counterpart as "*No members of X did Y*". This phenomenon belongs to the broader class of all-or-nothing inferences inferences. 99, 131, 141, 142, 144, 145, 146, 159, 166, 173, 175, 293, 366

homogeneity In this thesis, *homogeneity* refers narrowly to the truth-value gap exhibited by definite plurals. It is characterized by a strong universal meanings of both positive and negative sentences containing definite plurals and by the feeling of queasiness experienced by speakers when asked to choose between the positive sentence and its negation in intermediate situation where only half of the relevant members of the plurality satisfy the description.

(9) a. The children are hungry.
$\rightsquigarrow$ *(almost) all children are hungry*

b. The children aren't hungry.
$\rightsquigarrow$ *(almost) no child is hungry*

Similar phenomena that do not involve definite plurals *per se* are given different names or compound names, e.g. all-or-nothing inference, group homogeneity and part homogeneity. 97, 109, 111

intermediate distributivity This is a sub-class of phrasal distributivity. In most cases of phrasal distributivity, the universal quantification associated with the reading of particular DP is a universal quantifier over atoms. In cases of intermediate distributivity, the universal quantification is over larger quantities than atoms, such as *pairs*, as in (10b).

(10) a. The books cost \$10. (atomic distributivity)
$\rightsquigarrow$ *every book cost \$10*

b. The shoes cost $10. (intermediate distributivity)

⇝ *every pair of shoe cost $10*

Intermediate distributivity are licensed by context where the plural arguments is divided in some salient manner (as with shoes). 268, 269, 270, 273, 281, 283, 366

lexical homogeneity This refers to the type of homogeneity considered in the bulk of this work, obtained through existential meanings in the meaning of the verb (e.g. ∃-crack). It is distinguished from phrasal homogeneity, which refers to the type of homogeneity that arises from phrasal distributivity. Chapter 7 explore the question of whether these two flavours of homogeneity arise from a common source. 262, 263, 281, 283

logical paraphrase The meta-language formula used to express the truth-conditions of an utterance. The latter is also called *logical form* Schein (1993) or *logico-philosophical form* Kratzer (2003). I choose this term to avoid interference with the term *logical form* or LF, which refers to the syntactic structure posited by and to emphasize that I use a *direct semantics*, in which formulas are mere *paraphrases* of the truth-conditions. 154, 169, 205, 209, 210, 211, 212, 214, 221

L-summativity From Löbner (2000). Defined in (**??**). 104, 105, 108, 109, 111, 144

non-maximality Refers to the fact that definite plurals can yield near-universal, or even existential meanings in some contexts:

(11) The windows are open.

101, 122

ordinary cumulative sentence A sentence which contains nothing but plural-referring expressions 32, 33, 35, 91, 107, 176, 288

part This refers exclusively to the classical extensional notion of material part, as in the sentence "*this wheel is part of that bike*", as opposed to the notion of *m*-part. This meta-language symbol translates "*is a material part of*". This relation is assumed to be transitive ($x \sqsubset y$ and $y \sqsubset z$ entail $x \sqsubset z$), reflexive ($x \sqsubset x$). It is not assumed to be anti-symmetric, i.e. $x \sqsubset y$ and $y \sqsubset x$ is not assumed to entail $x = y$. Natural language does indeed seem to make a difference between things which one would judge to be composed of the same material parts (e.g. *the ring* and *the gold that makes the ring*, Link (1983)) 141, 149, 150, 151, 152, 153, 154, 155, 156, 157, 159, 160, 161, 163, 164, 165, 178, 183, 184, 185, 186, 187, 188, 247, 249, 252, 254, 255, 294

part homogeneity Refers to any situations where a positive sentence has a meaning paraphrasable as "*All parts of X did Y*" and its negative counterpart as "*No parts of X did Y*". This phenomenon belongs to the broader class of all-or-nothing inferences inferences. 99, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 113, 114, 115, 118, 123, 141, 142, 144, 145, 166, 173, 174, 175, 230, 262, 279, 283, 285, 293, 366

phrasal distributivity Theoretically, this refers to a universal reading of plural expressions obtained by application of a distributivity operator. It contrasts with lexical distributivity which refers to any universal-like meaning of plural expressions that arises from assumptions about lexical semantics. 259, 260, 261, 263, 264, 265, 269, 270, 278, 279, 283, 366

plural-referring expression Any type *e* element which refers to a plural object, e.g. a definite plural, a conjunction of proper names, a conjunction of plural definites, etc 31, 32, 37, 38, 39, 40, 41, 42, 45, 47, 48, 49, 50, 51, 54, 73, 81, 83, 84, 86, 88, 90, 91, 93, 94, 95, 145, 172, 236, 237, 238, 239, 251, 259, 313, 367

positive/negative environments In this chapter, an alias for upward and downward-entailing environments. In the future however, we will turn to conditionals, which despite being downward-entailing, license strong readings of plural expressions. When we get to this, it will be handy to have used a different term for the environments in which we find strong readings of plurals. 38, 39, 42, 45, 47, 50, 54, 55, 67, 83, 84, 87, 89, 90, 93, 94, 266

predicate sharability A predicate VP is sharable between a group noun NP and plural noun NP' if "*NP VP*" is equivalent in all its senses to "*NP' VP*". 119, 121, 122, 123, 124, 125, 126, 131, 138, 144, 158, 159, 160, 162

prejacent When an operator like EXH applies to a constituent α, i.e. EXHα, I call α the prejacent of EXH. The term is used both for the object language (the linguistic constituent) and the meta-language (the formula to which meta-language EXH applies). 70, 72, 76, 77, 78, 81, 180, 190, 195, 199, 233, 281, 284, 285

reflexive A relation R_{eet} is reflexive if and only if for every x, $R(x)(x)$. 149, 368

separated analyses Describes analyses of cumulativity which exploit Neo-Davidsonian event semantics and argument separation. In these analyses, the agent is introduced by a thematic role head ; a cumulative reading with a quantifier like *every* is achieved (in object position) when *every* takes scope below the agent thematic role head. 213, 214, 218, 219, 220, 226, 229, 234

separated event-free semantics This is the name by which I refer to the semantics in which events are replaced by assignment functions. 204

summativity A verbal predicate VP is summative iff for all X, Y, Z, if Z refers to the (material, plural, etc.) sum of X and Y, and VP holds of X and Y, the VP holds of Z 165, 166, 167, 177, 178, 230, 235, 247, 248, 249, 250, 255, 256, 257, 258, 262, 266, 267, 299, 300, 301, 302, 303, 304, 315, 345

transitive A relation R_{eet} is transitive if and only if for every x, y, z, $R(x)(y)$ and $R(y)(z)$ entails $R(x)(z)$. 149, 368

truth-value gap Truth-value gap refers to any case where a sentence and its negation do not exhaust the space of alll possibilities ; some situations are not adequately described by either utterances. Presupposition, scalar implicatures and homogeneity are all types of truth-value gaps. 20, 21, 37, 38, 42, 46, 55, 142, 162, 164, 165, 166, 235, 240, 242, 243, 244, 245, 254, 264, 302, 304, 305, 306

underlying meaning The underlying meaning of an utterance or lexical item is the meaning of this element prior to strengthening. In this chapter, this meaning is diagnosed by looking at the negative version of a sentence. 38, 54, 55, 57, 79, 86, 87, 88

video-game example This refers to any of the variations on Schein (1993)'s example below:

(12) The ten video-games taught every quarterback { four new plays / less than four new plays / between four and six new plays }

This example exhibits both a cumulative reading of *every* and a bare or modified numeral in its distributive scope. This example demonstrates that when it enters a cumulative reading, *every* still acts as a universal distributive quantifier for elements within its scope. 35, 36, 42, 44, 45, 58, 59, 82, 208, 210, 212, 215, 217