Distributivity, collectivity, and cumulativity*

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Comments and suggestions welcome!

Abstract

This handbook article provides an overview of the major empirical phenomena discussed in connection with the theoretical concepts of distributivity, collectivity, and cumulativity. Topics include: an operational definition of distributivity; the difference between lexical and phrasal distributivity; atomic vs. nonatomic distributivity; collectivity and thematic entailments; two classes of collective predicates (*be numerous* vs. *gather*); how to distinguish between cumulative and collective readings; interactions of distributivity and collectivity; and a list of other relevant review papers and handbook articles.

1 Introduction

This article provides an overview of the major empirical phenomena discussed in connection with the theoretical concepts of distributivity, collectivity, and cumulativity.

Distributivity is dealt with in Section 2, which starts by reviewing recent empirical work on the conditions under which distributivity occurs in sentences where it is not obligatory (Section 2.1). Next up is an operational definition of the term (Section 2.2). This

*Some parts of this paper have previously appeared in modified form in my dissertation, Champollion (2010b), for which I am indebted to many people and institutions as indicated there.

is necessary because, perhaps surprisingly, there is no standard definition of distributivity in language, and a number of related concepts can be distinguished for which the word is used. Section 2.3 deals with the question whether the difference between distributive and nondistributive interpretations should be regarded as ambiguity or underspecification. I review relevant observations from the theoretical and psycholinguistic literature. Section 2.4 reviews the arguments for modeling distributivity as a property of arguments or of predicates. Taking the latter view as a starting point, Section 2.5 then distinguishes between lexical and phrasal predicates. While both can be distributive, the difference between them matters for theoretical purposes in that the latter have been used to argue for an operator-based approach to distributivity. This operator has been variously seen as distributing either only over singular, "atomic" individuals or also over plural entities; Section 2.6 reviews the debate between these two positions.

Collectivity is the subject of Section 3. I start by reviewing two similar but distinct conceptual views of collectivity (Section 3.1). On the first view, collectivity is defined positively in terms of the presence of certain entailments about a plural entity; on the second view, it is defined negatively in terms of the absence of distributivity. I then (Section 3.2) review the literature on how different collective predicates interact with certain plural distributive quantifiers like *all* and *most of the*. Based on this interaction one can distinguish two classes of collective predicates, of which *be numerous* and *gather* are prototypical examples. The literature contains scattered examples of predicates in these two classes; I have tried to collect all these examples in one place.

Cumulativity, the topic of Section 4, typically involves two plural entities and a relation that holds between their members in a cross-product-like way. Like distributivity, cumulativity can be seen as a property either of entire sentences or of predicates. The question of whether only lexical or also phrasal predicates can lead to cumulativity in discussed in Section 4.1. Sections 4.2 and 4.3 discuss the relations between cumulativity and collectivity, and between cumulativity and distributivity.

The paper concludes by listing a number of relevant review articles and similar sources that complement it, along with notes on how they differ in focus (Section 5).

Although this paper focuses on examples of high theoretical relevance, it does not introduce any formalism. Many of the papers mentioned in Section 5 provide relevant discussion. Several authors have developed theoretical frameworks in which many of the phenomena discussed in this paper appear as parts of a whole. To mention a few examples, Link (1998)(a collection of papers by the same author) provides mereological accounts of plurals, mass terms, distributivity and events. Winter (2001) presents a theory of plurality, morphological number, distributivity, coordination, copular verbs, the scope of indefinites, collectivity and the interaction between these phenomena. Champollion (2010b), from which parts of this paper are taken, builds on parallels between the collective-distributive

opposition, the telic-atelic opposition, and the intensive-extensive opposition to provide a unified account of distributivity, aspect and measurement. It is based on algebraic semantics and mereology in the tradition of Link (1983) and Krifka (1986).

2 Distributivity start here

The use of the word *distributivity* generally indicates the application of a predicate to the members or subsets of a set, or to the parts of an entity, as when the following sentences are understood as describing situations involving multiple rafts.

(1) a. John and Bill built a raft.
b. They built a raft.
c. The boys built a raft.
d. Three boys built a raft.

This contrasts with interpretations on which these sentences only entail the existence of a single raft. For now I will only refer to them indiscriminately as nondistributive interpretations. In later sections, I will differentiate between inverse-scope, collective, and cumulative interpretations.

Distributivity can be diagnosed by the presence of certain entailments that will be called *distributive entailments*. For example, the distributive interpretations of (1a) entails the conjunction below:

(2) John built a raft and Bill built a raft.

In fact, the entailment also goes in the other direction, from (2) to (1a). This direction can be called a *cumulative entailment*. It is analogous to the entailment triggered by plural predicates such as *pop stars*:

(3) If David and Chris are pop stars and Jerry and Tina are pop stars, then David and Chris and Jerry and Tina are pop stars. (Landman, 1989)

Following Link (1983), this behavior is generally modeled by assuming that pluralized predicates have the property of *cumulative reference*: whenever they apply to each of two entities, then they also apply to the two entities taken together. In the case of (3), the first of these two entities consists of David and Chris, and the second consists of Jerry and Tina. I will call them "plural entities". Depending on theoretical and conceptual choices, plural entities can be modeled either as sets, or as sums in the sense of mereology (Link, 1983; Landman, 1996; Lønning, 1997; Winter, 2001; Winter and Scha, 2014). Mereological sums are different from sets in that they are "flat" and have no structure. For example,

the sum of the two entities just mentioned is also the sum of the four individuals David, Chris, Jerry, Tina. See Champollion and Krifka (2014) for an introduction to mereology, its axiomatic definitions, and its applications in formal semantics. The relationship between plurality and distributivity is explored in Landman (1989), Landman (1996), and Winter (2001). For more on the semantics of the plural, see also the references in Section 5.

2.1 The empirical basis of distributivity

While distributive interpretations of sentences with nonquantificational subjects like those in (1) have been discussed very widely in the literature, these interpretations are also often judged marginal or even unavailable. Dotlačil (2010, ch. 2) lists an impressive array of mutually incompatible opinions about the theoretical literature about whether such distributive interpretations are available, and reviews a number of relevant findings that were obtained, sometimes via control conditions in acquisition experiments. For example:

- Brooks and Braine (1996) asked 60 adult speakers who had read sentences like (1d) to say which of two pictures that illustrated a distributive and a collective interpretation went best with the presented sentence. 97.5% of them chose the collective one.
- Kaup et al. (2002) showed 60 adult German speakers translations of sentences like (1b) that involved the plural pronoun *they* (German *sie*). Four out of five participants interpreted such sentences nondistributively, and they found these sentences more acceptable than those who interpreted them distributively.
- In a truth-value judgment task, Pagliarini et al. (2012) found that only 50% of 97 adult speakers of Italian accepted sentences with definite plurals like (1d) as true when given a picture that depicted the distributive interpretation, while 98% accepted them as true when given a picture that depicted a collective interpretation.

Despite this general preference, distributive interpretations of sentences like (1) are available, and in any case they can be enforced by adding overt distributivity markers such as *each*. See Gil (1982), Zimmermann (2002), and Champollion (2012, 2014c) for cross-linguistic surveys of such markers and relevant theoretical discussion.

(4) a. John and Bill each built a raft.
b. They each built a raft.

While the word *distributivity* and derived terms are widespread in the semantic literature, there are no standard definitions, and a number of related concepts can be distinguished for which the word is used. Distributivity can be seen as property of quantifiers, a relation between two constituents, a property of predicates, or as a property of constructions (Champollion, 2010b).

Distributivity can also be enforced by using quantificational noun phrases headed by determiners like *every* or *each* (e.g. Scha, 1981). The truth conditions of these noun phrases involve application of the verbal predicate to each member of their witness set.

(5) a. Each boy built a raft.
b. Every boy built a raft.

When two different constituents contribute to the content of a distributive entailment, they are said to stand in a distributive relation. The presence of a distributive relation will be referred to as *relational distributivity*. In examples like (4a), the constituents involved in a distributive relation are a subject and a verb phrase. A theory of distributivity that relies heavily on the concept of a distributive relation is developed in Choe (1987). More recent theories typically do not assume that distributive relations must be reified as syntactic or semantic links.

A distributive relation can be obligatory or optional. For example, sentence (1a) leaves it open whether one or two rafts were built. In (4a), the relation between the subject and the verb phrase is obligatorily distributive. In (1a), it is optionally distributive.

Distributivity understood as a property of predicates is generally set in opposition to collectivity. These notions are based on the behavior of predicates when they occur with plural definites, noun phrases headed by distributive quantifiers like *every*, and coordinated noun phrases. Predicates such as *smile* or *sing* lead to (near-)equivalent sentences when these different kinds of arguments are used (6) (though see the next subsection for some caveats). These predicates are classified as distributive. The class of collective predicates is formed by those predicates for which this pattern breaks down because the combination with *every* and with singular proper names leads to a category mistake (7).

(6) **Distributive predicates**
a. The girls smiled. $\Leftrightarrow$ Every girl smiled.
b. John and Mary sang. $\Leftrightarrow$ John sang.

(7) **Collective predicates**
a. The girls gathered. $\not\Leftrightarrow$ *Every girl gathered.
b. John and Mary gathered. $\not\Leftrightarrow$ *John gathered.

stop here and move on to p. 17

2.2 An operational definition of distributivity

The distinction between distributive and collective predicates just presented is criticized by Winter (2001, 2002) as not very useful and hard to justify. Winter notes that the patterns in (6) and (7) are only valid if one abstracts away from a number of factors: conventionalized coordinations, nonmaximality effects on definite plurals, and effects related to group nouns. Winter's concern about conventionalized coordinations like *Simon and Garfunkel* is that they do not always give rise to entailments like (6b), as shown in (8), which Winter bases on a similar example he attributes to Fred Landman (p.c.). The biconditional in (6a) is only valid to the extent that the referent of the definite plural includes every member of its complement noun, but this is not the case if the definite plural has a nonmaximal interpretation (9). Furthermore, the test in (7) is only reliable as long as its nouns are not replaced by group nouns like *committee* and noun phrases like *the Ways and Means Committee* (10).

(8) Simon and Garfunkel are performing in Central Park.
$\not\Rightarrow$ Simon is performing in Central Park. (Winter, 2001)

(9) At the end of the press conference, the reporters asked the president questions.
$\not\Rightarrow$ Every reporter asked the president a question. (Dowty, 1987)

(10) a. Every committee gathered. *vs.* *Every girl gathered.
b. The Ways and Means Committee met. *vs.* *John met.

Winter does not make any distinction between distributive and collective predicates because he does not consider this distinction well-motivated. However, it is useful to have an operational definition of a distributive predicate. To develop such a definition, it is necessary to address Winter's concerns about the reliability of the traditional tests. I propose to do that by slightly reformulating the tests in order to control for effects related to nonmaximal interpretations, conventionalized coordinations, and group noun effects. As Malamud (2006b) observes, indefinite numerals do not give rise to nonmaximal interpretations. Sentence (11a) is from Malamud and sentence (11b) is from Landman (2000, p. 435).

(11) a. The women in Bogoduhov gave birth to only seven girls.
b. *Fifteen women gave birth to only seven girls.

In reformulating the traditional test, we must take care not to rely on constructions involving coordinations (because they might be conventionalized) and definite plurals (because they might be nonmaximal). Based on this reasoning, we can adopt the following operational definition of a distributive predicate:

(12) **Operational definition: Distributive predicate**
A distributive predicate is a predicate for which (13a) and (13b) are acceptable and entail each other when it is substituted for PRED.

(13) a. Three people PRED.
b. Three people each PRED.

The noun *people* may be replaced by another noun if necessary to avoid selectional restrictions such as animacy requirements. To address Winter's concern about group nouns, we restrict the test by agreeing that this noun may not be replaced by a group noun. An operational definition of group nouns is in turn proposed by Barker (1992): they are count nouns that can take an *of* phrase containing a plural complement but not a singular complement (*the group of armchairs/*armchair, a committee of woman/*women, an army of girls/*girl* etc.). Barker's test works well in most cases, but it incorrectly classifies container words like *box* as group nouns (*a box of cookies/*cookie*). This problem may mitigated by controlling for whether the container word is used in an existence-entailing sense (an actual box) or in a measuring sense (boxful of cookies). See Champollion (2010b, p. 47).

To mention a few examples, the predicates *sleep*, *run*, *sneeze*, *get up*, *wear a dress*, and *take a breath* are all distributive predicates according to the definition in (12) because the entailment from (13a) to (13b) is obligatory with them. Predicates like *eat a pizza*, *build a raft* and *ask a question* are not distributive because the entailment from (13a) to (13b) is not obligatory with them, and is in fact dispreferred as we have seen above. Such predicates are generally called *mixed predicates*. As for collective predicates like *meet* and *be numerous*, they are also correctly classified as not distributive because at least (13b) is not acceptable except when we replace the word *people* by a group noun such as *committee*, which by convention is not allowed for the purpose of this test.

I have described predicative distributivity as a property of intransitive predicates. The notion can be generalized to describe transitive predicates, but in this case it needs to be relativized to an argument position or thematic role. For example, *kill* is distributive on its theme role but not on its agent role, since a plurality of people can only be killed if each of its members is killed, but a plurality of people can kill a person without each of them killing that person (Lasersohn, 1988; Landman, 2000). This is illustrated in the following scenario. The two outlaws Bonnie and Clyde were killed by a posse of six police officers, which included Sheriff Jordan. Given this background knowledge, (14a) entails (14b) but not (14c).

(14) a. The police officers killed Bonnie and Clyde.
b. ⇒ The police officers killed Bonnie.

c. $\not\Rightarrow$ Sheriff Jordan killed Bonnie and Clyde.

2.3 Ambiguity or underspecification?

As we have seen, sentences like *The boys built a raft* can be construed distributively, though with some difficulty, or nondistributively. But is this a true ambiguity, that is, a difference between readings, or is the sentence merely underspecified in the sense that it has just one reading that leaves it open how many rafts were built? An implicit assumption in a lot of the theoretical literature is that the sentence is truly ambiguous, but this is not a self-evident question. A number of points bear on it.

First, the distributive reading of sentences like (15a) is true in scenarios where (15b) is false but is not incompatible with it (Winter, 2000). The distributive reading does not entail the existence of more than one box, it is merely compatible with their existence; but it is also true in a scenario where the same box is lifted repeatedly and each time a different boy is lifting it.

(15) a. The boys lifted a box.
b. There is a box that the boys lifted.

This has to be kept in mind when testing for the presence of distributive readings. For example, it is advisable to use predicates such as *build a raft*, *bring a gift*, *eat an apple* etc. where world knowledge makes it unlikely that the same object is involved in different events of the relevant kind.

Second, according to many theories of scope, the indefinite object could be read as taking inverse scope over the rest of the sentence even when the sentence is interpreted distributively. On the resulting inverse-scope reading, there is only one box, but there are as many lifting events as there are boys. This differs from a situation where there is only one lifting event and the boys all take part in it together. These two readings are conceptually easy to distinguish, because only the former one requires the box to repeatedly be lifted and put down again. But the relevant distinction is not easy to model unless one uses a framework that combines distributivity and event semantics, such as Landman (2000) or Champollion (2014a).

A general method for distinguishing ambiguity from underspecification in cases where one putative reading entails the other is to embed the relevant predicate into a downward-entailing context such as negation (Schlenker, 2006). In line with this method, Schwarzschild (1993) and Kratzer (2007) present the following type of command as a problem for the ambiguity view:

(16) *The head mobster to one of his flunkies about an upcoming lottery:*

Beasly, better make sure those guys don't win a car this week!

Schwarzschild and Kratzer observe that this command requires Beasly to prevent the guys from winning a car, no matter if they win it together or separately. On the assumption that in order to comply with an ambiguous command (even one by a mobster), it is sufficient to comply with just one of its readings, this is problematic for the ambiguity view and favors the underspecification view.

Based on an eye-tracking study, Frazier et al. (1999) come to the opposite conclusion. In their investigation of the processing of conjoined noun phrases that are equally natural on a distributive or on a nondistributive interpretation, such as *Sam and Maria* in sentences like (17), they find that readers who encounter the distributive marker *each* a few words later, as in (17a), tend to slow down and look back to a greater extent (adjusting for word length) than when they encounter the collectivity marker *together* instead (17b). It is not the presence of *each* by itself that makes the sentence harder to read, but only its late appearance. When the two words are moved next to the noun phrase, as in (18), the effect that distinguishes them disappears.

(17) a. Sam and Maria carried one suitcase *each* at the airport.
b. Sam and Maria carried one suitcase *together* at the airport.

(18) a. Sam and Maria *each* carried one suitcase at the airport.
b. Sam and Maria *together* carried one suitcase at the airport.

On the assumption that readers resolve ambiguities early on but that they leave vagueness unresolved as long as possible, Frazier et al. (1999) conclude that this is a case of ambiguity rather than vagueness. Readers who see a noun phrase like the ones lin (17) initially assume lack of distributivity and revise their decision only when they encounter a distributive adverb a few words later, as in (17a) – a typical garden-path effect. The preference for nondistributive interpretations that is used here to explain the slowdown in (17a) is also consistent with the marginality of distributive interpretations more generally that was discussed in Section 2.3.

2.4 Distributive subjects or distributive predicates?

It is not always clear whether a given instance of distributivity, for example the distributive reading of a sentence like (19), should be classified as quantificational, as predicative, or as something else. The two options can be represented schematically as follows:

(19) Three boys built a raft.

(20) a. [(Each of) three boys] [built a raft].

b. [Three boys] [(each) built a raft.]

The question, simply put, is whether the ambiguity of sentence (19) derives from an ambiguity in the way the subject is interpreted, or from an ambiguity in the verb phrase.

The first view is that it is the subject of (19) is ambiguous between a distributive and a nondistributive (typically a collective) interpretation, as in (20a). Essentially, the subject either introduces a number of singular entities or one plural entity. This view is found in Bennett (1974), Hausser (1974), and Heim et al. (1991). It is tempting to adopt it given how plural noun phrases like *three boys* have been traditionally analyzed in generalized quantifier theory. For example, Barwise and Cooper (1981) represent the meaning of *three boys* as the set of all those sets S such that at least three of the elements of S are boys. A verb phrase like *build a raft* can then be represented as the set of all those entities x such that x built a raft. It will be a member of *three boys* just in case at least three boys each built a raft. The nondistributive reading can be obtained by interpreting *three boys* as the set of all those sets containing a plural entity that consists of at least three boys.

The second view is that the ambiguity is located in the verb phrase. Dowty (1987), Lasersohn (1995) and Winter (2000) all argue for this view, where the distributive reading of (19) comes from interpreting the verb phrase as a property of plural entities. On its distributive interpretation, as in (20b), the verb phrase is true of a given plural entity if each of the singular entities that make it up built a raft. The noun phrase *three boys* can then be taken to introduce such an entity into the discourse, for example by existentially quantifying over it. When *built a raft* is interpreted nondistributively, it may be taken to denote the set of all singular or plural entities X that built a raft – jointly, if X is in fact plural.

One challenge for the first view involves coordination of a collective and a distributive verb phrase (Dowty, 1987; Roberts, 1987; Lasersohn, 1995), as in the following example:

(21) Three students met in the bar and had a beer. (Winter, 2001)

Since noun phrases cannot be both distributive and collective at the same time, and conjunction reduction analyses are out of the question for well-known reasons, such sentences cannot be modeled by the first view. The second view has no problem, since it can rely on whatever property or process distinguishes distributive from collective interpretations of *build a raft* and distinguish the two verb phrases in (21) from each other in the same way.

This leaves open yet another possibility: the ambiguity is introduced neither in the subject nor in the verb phrase, but in the compositional process. This is the position defended in Landman (1989), based on a variation of the "temperature paradox", which was first discussed by Montague (1973) and attributed there to Barbara Partee. The temperature

paradox arises because a simple-minded analysis of the meaning of functional nouns like *temperature* and of the copula *be* validates the following argument:

(22) a. The temperature is ninety.
b. The temperature is rising.
c. Therefore, ninety is rising.

Loosely following Montague's own account, one might block this inference by stipulating that *temperature* has different meanings in both cases: in (22a), it denotes the temperature in the here and now, while in (22b), it denotes something more abstract, an individual concept (essentially a function that maps time points to temperatures). Landman points out that this will not work in cases like the following, where the subject seemingly has both denotations at once:

(23) The temperature is ninety and rising.

Landman argues for a system on which the first conjunct is type-shifted before it is conjoined with the second, so that the entire conjunction denotes a property of individual concepts. Analogous type shifters are also available on the side of the noun phrase. Landman suggests that a similar system of type shifters also applies in cases like (21). Presumably the ambiguity in (19) is to be modeled by as an optional application of type-shifting. The most prevalent view nowadays, however, is the second view mentioned above: the verb phrase is where the ambiguity originates. I come back to this point below.

2.5 Lexical and phrasal distributivity

Whenever several people smile, or wear a dress, this entails that each of them smiles, or wears a dress. As the following examples show, we find distributive and collective interpretations among lexical predicates (denotations of just one word) as well as phrasal predicates (denotations of multiple words):

(24) **Lexical distributivity/collectivity**
a. The girls smiled. *distributive*
b. The girls met. *collective*

(25) **Phrasal distributivity/collectivity**
a. The girls are wearing a dress. *distributive*
b. The girls are sharing a pizza. *collective*

The distinction between lexical and phrasal distributivity is related to the distinction between P(redicate)-distributivity and Q(uantificational)-distributivity introduced

in Winter (1997, 2001). Winter uses the term P-distributivity to refer to those cases of distributivity which can, in principle, be derived from some property of the lexical item involved. It is possible to ascribe the difference between (24a) and (24b) to the meaning of *smile* and *meet*. Early attempts to model distributivity took lexical distributivity as a paradigm case. For example, without distinguishing between lexical and phrasal predicates, Hoeksema (1983) suggests that the difference between distributive and collective predicates in general is that while both can apply to singular as well as plural entities, when the former do so they always also apply to their singular parts. On this lexical approach to distributivity, a sentence like *The girls smiled* can be treated as ascribing the property *smile* to the referent of *the girls*, just like *The girls met* can be treated as ascribing the property *met* to that referent. The only difference is that a lexical property of the predicate *smile* entails that whenever a plurality smiles, so do their members, while there is no such property for *meet*.

In the case of phrasal distributivity, this approach is not possible because the distributive predicate may contain an indefinite or numeral quantifier, as in (25a). In order for (25a) to entail that each girl wears a different dress, the entire verb phrase *wear a dress* and not just the verb *wear*, must be regarded as distributive. On traditional views of verbal denotations, only phrasal constituents can contain quantifiers, so Q-distributivity is by necessity always phrasal (but see Champollion (2010c, 2014b) for an argument that all verbs denote generalized quantifiers over events).

The distributive interpretation in (25a), and more generally Q-distributivity in general, involves a scopal dependency between the definite plural subject and the indefinite object. When a plural definite takes scope over something else, it behaves in several respects like a distributive quantifier. Not only can it cause indefinites to covary, as in (25a), it can also bind pronouns in ways that are similar to quantifiers (Winter, 2000):

(26) a. The boys will be glad if their mothers arrive.
b. Every boy will be glad if his mother arrives.

As Winter (2000) argues, the lexical approach to distributivity is unable to account for this behavior. The way out of this problem is to introduce a covert distributive operator in the logical representation that can induce covariation of indefinites and binding of pronouns. This is the purpose of the D operator postulated by Link (1987, 1991) and Roberts (1987). This operator shifts a verb phrase to a distributive interpretation, more specifically, one that holds of any entity X each of whose singular individuals satisfy the unshifted verb phrase.

(27) a. $[\![\text{build a raft}]\!] = \{ \text{x} - \text{there is a raft that x built} \}$
b. $[\![\text{D[build a raft]}]\!] = \{ \text{X} - \text{for all singular individuals y in X, there is a raft}$

that y built }

This D operator operator goes back to Link (1991), originally written in 1984. See Roberts (1987, p. 157) for discussion. Just like *every*, this operator introduces a universal quantifier, and it is the scopal interaction of this quantifier with the indefinite inside a Q-distributive predicate (e.g. *a raft* in *build a raft*) that accounts for the covariation effects in Q-distributivity. It corresponds to the optional adverbial *each* in (20b).

The D operator is able to apply to entire verb phrases and not just to lexical predicates. It is this property that allows the D operator to account for phrasal distributivity (Dowty, 1987; Roberts, 1987; Lasersohn, 1995). Moreover, at least Roberts (1987) allows the D operator to apply to any predicate, whether it is a verb phrase or not. For example, it may apply to a predicate that has been derived in order to derive an interpretation of (28) where each of two girls received a pumpkin pie:

(28) John gave a pumpkin pie to two girls.
D[John gave a pumpkin pie to] [two girls] (Roberts, 1987)

This approach involves an otherwise unmotivated structure or perhaps an application of quantifier raising, and is criticized for this reason by Lasersohn (1998), who provides a generalization of the operator that can apply not only to verb phrases but to arbitrary constituents. The need for the D operator to be able to target noun phrases other than the subject is stressed in Champollion (2010b, 2014a), who postulates a variant of the operator that ranges over temporal intervals. Both authors just mentioned also provide a reformulation of the D operator for an event semantic framework.

Schwarzschild (1996, p. 62) and Winter (2001, Sections 3.3.2 and 6.3) provide additional motivation for the D operator. Schwarzschild discusses an example from Angelika Kratzer (p.c.) in which the operator interacts scopally with a raising predicate. Winter argues for the D operator on the basis of the observation, due to Ruys (1992), that noun phrases can take existential and distributive scope at different places in the syntax. In sentences like (29), the existential component and the distributivity component of the numeral indefinite can have two distinct scopes. Sentence (29) has a reading that does not involve three specific workers and a reading that does. These readings are paraphrased in (29a) and in (29b) respectively.

(29) If three workers in our staff have a baby soon, we will have to face some hard organizational problems.
   a. If any three workers each have a baby, there will be problems. if $> 3 > D > 1$
   b. There are three workers such that if each of them has a baby, there will be

problems. $3 > \text{if} > D > 1$

In the latter reading, the existential component of *three workers* takes scope outside of the antecedent of *if*, but the distributive component takes scope inside of it. Since antecedents of *if*-clauses are islands for quantifiers, this illustrates that the existential component of *three workers* is not island-bound, which is a familiar fact about indefinites. Unlike the existential component, however, the distributive component cannot take scope outside of the *if*-island. If it could, sentence (29) should have a reading that can be paraphrased as in (30), contrary to fact. As Winter points out, these observations can be modeled by the assumption that the distributive interpretation of *three workers* comes from a verb phrase modifier like the D operator together with the assumption that this modifier is island-bound. For an overview of the difference between existential and distributive scope of indefinites, see also Szabolcsi (2010, ch. 7).

(30) There are three workers such that for each x of them, if x has a baby, there will be problems. $*3 > D > \text{if} > 1$

2.6 Atomic or nonatomic?

In the previous section, I have presented what can be called the atomic view on distributivity. This view assumes that phrasal distributivity involves universal quantification over singular individuals, so that in the distributive reading of a sentence like *The girls are wearing a dress*, the indefinite *a dress* covaries with respect to a covert universal quantifier that ranges over individual girls. This view is defended in Lasersohn (1998, 1995), Link (1997), and Winter (2001), among others.

There is also a nonatomic view, which holds that phrasal distributivity merely involves universal quantification over certain parts of the plural individual, and that these parts can be nonatomic. Variants of this view are defended in Gillon (1987, 1990), van der Does and Verkuyl (1995), Verkuyl and van der Does (1996), Schwarzschild (1996, ch. 5), Brisson (1998, 2003), and Malamud (2006a,b), among others. The nonatomic view originated from a discussion of sentences like the following example, adapted from Gillon (1987):

(31) Rodgers, Hammerstein, and Hart wrote musicals.

This sentence plays on a particular fact of American culture: neither did the three composers it mentions ever write any musical together, nor did any of them ever write one all by himself. However, Rodgers and Hammerstein wrote the musical *Oklahoma* together, and Rodgers and Hart wrote the musical *On your toes* together. On the basis of these facts, the sentence is judged as true in the actual world, although it is neither true on the collective interpretation nor on an "atomic distributive" interpretation. Gillon (1987, 1990)

argues that in order to generate the reading on which (31) is true, the predicate *wrote musicals* must be interpreted as applying to nonatomic parts of the sum entity to which the subject refers. Note that this predicate is phrasal.

Nonatomic distributive readings are not always freely available. For example, in a situation where John, Mary, and Bill are the teaching assistants and each of them was paid exactly $7,000 last year, sentences (32a) and (32b) are both true Lasersohn (1989). Sentence (32a) is true on its distributive reading, and Sentence (32b) is true on its collective or cumulative reading. But sentence (32c) is false, which means that it does not have a nonatomic distributive reading.

(32) a. The TAs were paid exactly $7,000 last year. *atomic distributive*
b. The TAs were paid exactly $21,000 last year. *collective*
c. The TAs were paid exactly $14,000 last year. **nonatomic distributive*

The difference between the predicate *write musicals* in (31) and the predicate *be paid exactly $n* corresponds to the difference between P- and Q-distributivity Winter (2000). The nonatomic distributive reading of (31) does not involve covariation of an indefinite. As Lasersohn (1989) points out, it can be modeled by assuming that *write* is cumulative: whenever a writes x and b writes y then the plural entity consisting of a and b writes the plural entity consisting of x and y. I come back to cumulativity in Section 4.

The search for clear cases of nonatomic distributivity has been going on since at least Link (1987). It is useful to distinguish between lexical and phrasal distributivity in this connection. Lexical nonatomic distributivity clearly occurs in examples like (31) and in the following ones:

(33) a. All competing companies have common interests. (Link, 1987)
b. Five thousand people gathered near Amsterdam. (van der Does, 1993)

In example (33a), the predicate *have common interests* can be applied distributively (that is, it describes several instances of having common interests) to nonatomic entities, because it does not make sense to say of a single company that it has common interests with itself. In example (33b), the predicate *gather near Amsterdam* can be applied distributively (that is, it describes several gatherings) to nonatomic entities, because a single person cannot gather.

Further support comes from the difference between *write musicals* and *write a musical*. The contrast between the two predicates can be seen as involving phrasal vs. lexical distributivity given an appropriate way to model the contribution of the plural on *musicals* (Sauerland et al., 2005; Spector, 2007; Zweig, 2009). For more details, see Champollion (2010b). The following sentence is false in the actual world, that is, it does not have the

nonatomic distributive construal that (31) has (Link, 1997).

(34) Rodgers, Hammerstein and Hart wrote a musical.

Lasersohn and others conclude from this and similar examples that phrasal distributivity, as opposed to lexical distributivity, is always atomic (e.g. Winter, 2001). However, cases of arguably nonatomic phrasal distributivity have been observed in contexts where discourse pragmatics makes a specific way of distributing over nonatomic entities salient. Here is an example. Shoes typically come in pairs, so a sentence like (35) can be interpreted as saying that each pair of shoes costs fifty dollars, as opposed to each shoe or all the shoes together.

(35) *Context: 3 pairs of shoes are on display, each with a $50 tag:*
The shoes cost fifty dollars. (Lasersohn, 1998)

The relevant reading is a nonatomic distributive reading: it does not assert that each individual shoe costs fifty dollars, nor that all the shoes taken together cost that much, but that each pair of shoes does. And it is phrasal because it is the denotation of the entire phrase *cost fifty dollars* that is applied to each pair of shoes. By contrast, no such reading is available for example (36), which can only mean that each suitcase weighs fifty pounds or all of them together do so.

(36) *Out of the blue:*
The suitcases weigh fifty pounds.

Schwarzschild (1996) suggests that the difference between (35), where a nonatomic distributive reading is available, and (36), where it is not, is due to the lack of a contextually salient partition or cover in the latter case. He argues that the distributivity operator should be modified to allow for "nonatomic distributive" interpretations only in a limited set of circumstances, essentially whenever there is a particularly salient way to divide a plural individual into parts other than its atoms. A similar phenomenon can be observed in the temporal domain, where there are arguably no atoms or in any case they are not accessible to universal quantification (Zucchi and White, 2001; Deo and Piñango, 2011; Champollion, 2010b, 2013):

(37) a. ??John found a flea on his dog for a month.
b. The patient took two pills for a month and then went back to one pill.

Example (37a) is from Zucchi and White (2001), and example (37b) is based on observations in Moltmann (1991). Out of the blue, examples like (37b) are odd just like (37a) because they suggest that the same flea is found repeatedly, the same pills are taken repeatedly,

and so on. But context can improve such examples by making covariation of the indefinite or numeral possible. Thus example (37b) is acceptable in a context where the patient's daily intake is salient (in a hospital, for example). It does not require any pill to be taken more than once, so we have covariation.

Summing up, it seems that nonatomic distributivity is readily available at the level of the verb (lexical level), but at the level of the verb phrase (phrasal level) it it much more restricted: if it exists at all, its availability is dependent on context. Atomic distributivity, by contrast, is uncontroversially available both at the lexical level and at the phrasal level. So one of the lessons from the debate on nonatomic distributivity, whatever its outcome, is that it is important to keep lexical and phrasal distributivity apart when studying their empirical properties.

3 Collectivity start here

Collectivity is often understood in opposition to distributivity, as a property of predicates. Collectivity generally involves the notion of a predicate that applies to a plural entity as a whole, as opposed to applying to the individuals that form this entity, as shown by examples (7a), (24b) and (25b), repeated here:

(38) a. The girls gathered.
b. The girls met.
c. The girls are sharing a pizza.

Beyond this general idea, the criteria for what exactly constitutes collective predication are usually not clearly spelled out. Two similar but distinct conceptual views on what constitutes collectivity can be distinguished in the literature, though they are almost never explicitly set in opposition to one another, with the exception of Verkuyl (1994). On the first view, collectivity is defined positively, in terms of the presence of certain entailments about a plural entity; on the second view, it is defined negatively, in terms of the absence of distributivity.

3.1 Thematic vs. nonthematic collectivity

On the first view, which I will call thematic collectivity, collective predication is defined in terms of the presence of certain kinds of entailments about a plural entity which cannot be induced from what we know about the parts of this entity. For example, sentence (39) entails something about the Marines as an institution, an organized body which is able to take coordinated action and take responsibility, in this case for the action

of invading Grenada (Roberts, 1987, p. 147). The predicate *invade Grenada* exemplifies thematic collective predication because it gives rise to the entailment that the Marines as a whole were responsible for invading Grenada.

(39) The Marines invaded Grenada. *collective*

The discussion of collectivity that most explicitly conforms to this view is found in Landman (2000). Landman calls the relevant entailments "thematic", because he sees them as analogous to the entailments which many theories associate with thematic roles. For example, such theories typically assume that the thematic role *agent* gives rise to the entailment that the agent of an event is responsible for this event. Landman assumes that the entailment about the collective responsibility of the Marines in (39) is of the same nature as the entailment of the individual responsibility of the agent in a sentence like *Saddam Hussein invaded Kuwait.* As Landman acknowledges, it is difficult to identify or define thematic entailments exactly. Besides collective responsibility, he gives two other examples: collective body formation (*The boys touch the ceiling*) and collective action (*The boys carried the piano upstairs*). In both cases, the predicates license the same entailments about the boys as a whole that they do about individual boys in sentences like *The boy touched the ceiling* and *The boy carried the piano upstairs.* For example, one thematic entailment of *touch the ceiling* is that part of the agent is in contact with part of the ceiling, no matter if this agent is a boy or a group of boys (but see Brisson (1998) for a different view). Landman also notes that thematic entailments have a "non-inductive" character. A sentence like (39) does not become true if two, ten, or even a very large number of members of the Marine Corps land on Grenada in an unauthorized action. It requires that the Marines as an organization take responsibility for the invasion (Landman, 2000, p. 171).

On the second view, nonthematic collectivity, collective predication is defined in terms of the absence of distributivity. A collective predicate in this sense is defined as one that does not apply to the singular individuals of which the entity to which it applies consists. This view is similar to what Verkuyl (1994) calls *kolkhoz collectivity*, taking inspiration from Soviet collective farms owned by groups of people without any individual ownership. Verkuyl traces a precursor of this view back to Jespersen (1913). Nonthematic collectivity may allow the predicate to distribute down to subgroups but not down to the singular individual. For example, if a plurality of people is numerous (that is, if it has many members), some subpluralities of these people also have many members, but still *be numerous* exhibits nonthematic collectivity: it does not distribute down to individual people. In fact, it does not even make sense to apply the predicate *numerous* to a single person. (On the question of whether this should be modeled as a type mismatch or as a selectional restriction, see Scha (1981) and Winter (2001).) Landman (2000, p. 170) gives

examples of predicates which he considers not to have any thematic entailments: *look alike*, *separate*, and *sleep in different dorms*. These predicates are arguably nonthematic collective. stop here

3.2 *Be numerous* vs. *gather*

The two notions of thematic and nonthematic collectivity lead us to expect that the class of collective predicates is not homogeneous. Indeed the class of collective predicates is not homogeneous. There is a subclass of strong quantifiers, including *all* and *most of the*, which is compatible with some of them but not others. The relevant facts were first observed by Kroch (1974) and Dowty (1987) independently of each other:

(40) a. The boys gathered. / All the boys gathered.
b. The boys were numerous. / *All the boys were numerous. (Dowty, 1987)

This empirical distinction is tentatively associated in Champollion (2010b) with thematic and nonthematic collectivity respectively; Dowty (1987) may have a similar intuition when he calls predicates like *be numerous* "pure cardinality predicates". Besides these two authors, many others have made proposals how to account for the difference between the two predicates (Taub, 1989; Brisson, 1998; Winter, 2001; Hackl, 2002).

Winter (2001) points out that the judgment in (40b) is dependent on the choice of noun. When a group noun like *committee* is used, the sentence becomes acceptable; moreover, in that case it exhibits distributive entailments (41a). In this respect, this kind of collective predicate is similar to distributive predicates (41b). Winter's observation, together with his criticism of the distributive-collective opposition discussed in Section 2.2, leads him to suggest an alternative classification based on whether or not a predicate is sensitive to the distinction between singular quantificational determiners like *every* and plural ones like *all*. Distributive predicates like *smile* are compatible with both kinds of determiners and lead to equivalent interpretations. Winter calls this class atom predicates (41). Some collective predicates, like *be numerous*, show the same behavior as distributive predicates like *smile*, while others like *gather*, which he calls set predicates (42), distinguish between both.

(41) **Atom predicates**
a. All the committees are numerous. $\Leftrightarrow$ Every committee is numerous.
b. All the girls smiled. $\Leftrightarrow$ Every girl smiled.

(42) **Set predicates**
a. All the girls gathered. $\not\Leftrightarrow$ *Every girl gathered.

b. All the committees gathered. $\not\Leftrightarrow$ Every committee gathered.

As shown in Table 1, Winter's test draws the boundary at a different place than the traditional distributive-collective criteria. For this reason, it is not useful as a characterization of distributive predicates, which it is not meant to be. On the other hand, by placing the boundary within the traditional class of collective predicates, Winter's test introduces a new and useful distinction within that class. The categories on the right of Table 1 represent a synthesis of both the traditional categories and those of Winter. Distributive predicates are kept as a category, and collective predicates are split into numerous-type and gather-type predicates.

Table 1: Comparison of the distributive-collective and atom-set typologies

Example	**Traditional**	**Winter**	**This paper**
smile	distributive	atom predicate	distributive
be numerous	collective		numerous-type
gather		set predicate	gather-type

The literature contains scattered examples of predicates in the *numerous* class and predicates in the *gather* class. I have attempted to collect them in one place below.

The *numerous* category has also been called *purely collective predicates*, *pure cardinality predicates* (Dowty, 1987), and *genuine collective predicates* (Hackl, 2002). In connection with definite plurals, numerous-type predicates easily give rise to collective interpretations. Indeed, the collective interpretation is often the only one available. For example, in (43a), the predicate *be numerous* can only be understood as applying collectively to the ants in the colony, because there is no sense in which an individual ant can be numerous. The sentence becomes ambiguous between a collective and distributive interpretation when its definite plural is headed by a group noun such as *committee* or *army*. For example, (43b) can mean either that each of the armies taken by itself was large in number of soldiers, or that the number of armies was large.

(43) a. The ants in the colony were numerous. **distributive, ✓ collective*
b. The enemy armies were numerous. *✓ distributive, ✓ collective*

Distributive quantifiers like *each* and *every* only allow the distributive interpretation of a predicate of this type. When there is no such interpretation in the first place, the sentence

becomes unacceptable altogether (44).

(44) a. *Each ant in the colony was numerous. **distributive, *collective*
b. Each enemy army was numerous. *✓ distributive, *collective*

The effect of *all* on this type of predicate is identical to the effect of *each*: if the sentence is acceptable at all, it only has a distributive interpretation. For example, (45a) is unacceptable, and (45b) can only be interpreted distributively as saying that every enemy army had many members.

(45) a. *All the ants in the colony were numerous. **distributive, *collective*
b. All the enemy armies were numerous. *✓ distributive, *collective*

Other examples of the numerous-type class include *be politically homogeneous, be a motley crew, suffice to defeat the army* (Kroch, 1974), *be a large group, be a group of four, be few in number, be a couple* (Dowty, 1987), *be denser in the middle of the forest* (Barbara Partee p.c. via Dowty 1987), *pass the pay raise, elect Bush, return a verdict of 'not guilty', decide unanimously to skip class, eat up the cake, finish building the raft* (Taub, 1989), *be too heavy to carry* (Brisson, 1998), *be a good team, form a pyramid, constitute a majority, outnumber* (Winter, 2001).

Gather-type predicates are like other collective predicates in that their collective interpretation is blocked by *every* and *each*. However, this interpretation is not blocked by *all*:

(46) a. All the students gathered in the hall. **distributive, ✓ collective*
b. *Each student gathered in the hall. **distributive, *collective*

(47) a. All the committees gathered in the hall. *✓ distributive, ✓ collective*
b. Each committee gathered in the hall. *✓ distributive, *collective*

The observation that some collective predicates are compatible with *all* but not with *each* goes back at least to Vendler (1962). The numerous-gather opposition has been subsequently discussed in Dowty (1987), Taub (1989), Brisson (1998, 2003), Winter (2001, 2002), and Hackl (2002), among others. Gather-type predicates have also been called *essentially plural predicates* (Hackl, 2002) and – as we have seen – *set predicates* (Winter, 2001). Other examples of this type of predicate are *be similar, fit together* (Vendler, 1957), *meet, disperse, scatter, be alike, disagree, surround the fort*, the object argument of *summarize* (Dowty, 1987), and *form a big group* (Manfred Krifka p.c. via Brisson 2003).

Taub (1989) hypothesizes that all gather-type predicates are activities and accomplishments, while all numerous-type predicates are states and achievements. Following this observation, Brisson (1998, 2003) proposes a syntactic account of the numerous-gather

opposition that implements this in terms of a silent predicate DO. Brisson assumes this predicate is assumed to be present only on activities and on accomplishments. Taub's observation is not without problems, since the predicate *reach an agreement* is an achievement predicate, but it is gather-type since it is compatible with *all* on what is arguably a collective reading:

(48) All the parties involved reached an agreement.

It is not easy to draw the boundary of the class of gather-type predicates. If one includes all collective predicates into this class as long as they are compatible with *all*, as does Winter (2001), one ends up with a heterogeneous class, including reciprocally interpreted predicates such as *admire each other*, and predicates formed with collectivizing adverbials such as *perform Hamlet together*. Dowty (1987) and Brisson (2003) exclude these predicates from consideration. Winter furthermore includes any predicate that is compatible both with *all* and with *each* as long as they bring about a difference in truth conditions. This difference cannot always be easily attested. For example, mixed predicates like *build a raft* and *perform Hamlet* belong to this class, so long as their collective reading remains available with *all* and can be distinguished truth-conditionally from their distributive reading. This is the case according to the judgment of D. Dowty as shown in (49), but Dowty (1987) also reports that other speakers find these sentences completely synonymous, as shown in (50). It is an open question whether this split in dialects also extends to other mixed predicates like *build a raft*, as (Winter, 2001) conjectures.

(49) **Dowty's dialect**

a. All the students in my class performed Hamlet. ✓ *distributive,* ✓ *collective*
b. Each student in my class performed Hamlet. ✓ *distributive,* * *collective*

(50) **Other dialects**

a. All the students in my class performed Hamlet. ✓ *distributive,* * *collective*
b. Each student in my class performed Hamlet. ✓ *distributive,* * *collective*

4 Cumulativity

Cumulativity is similar to collectivity in that it does not involve a scopal dependency, but they involve two entities in a symmetric cross-product-like relation, as in the following canonical example:

(51) 600 Dutch firms use 5000 American computers. (Scha, 1981)

The cumulative reading of (51) can be paraphrased as *600 Dutch firms each use at least one American computer, and 5000 American computers are each used by at least one Dutch firm.*

Cumulative readings were first discussed independently by Kroch (1974) and Scha (1981), and are studied among others by Krifka (1992), Landman (2000), Winter (2000), and Beck and Sauerland (2000). They typically involve two plural entities A and B and a relation R that holds between the members of these plural entities in a certain way. In canonical examples of cumulative readings as the term is nowadays understood, A and B are introduced by two plural definite or indefinite arguments of a verb that is distributive on both these arguments, and R is introduced by this verb.

Scha assumed that the *exactly* component of sentence (51) (that is, the fact that exactly 600 firms, and exactly 5000 computers, are involved, and not more than that) is part of its literal meaning. Following Krifka (1999), most authors assume today that the component is a scalar implicature and needs to be separated from the phenomenon of cumulative quantification. This is not a trivial issue, as shown by recent investigations about the entailment relations between various cumulative sentences with *exactly* components (Brasoveanu, 2010; Robaldo, 2011; Kanazawa and Shimada, 2014).

Cumulative readings, or at least something very similar to them, can also occur with definite plurals:

(52) The men in the room are married to the girls across the hall. (Kroch, 1974)

Although the most likely reading of this sentence (given that polygamy is implausible) can be described using the same kind of "cross-product" paraphrase as before, the status of this reading as cumulative has been disputed, with Winter (2000) arguing that it is the result of anaphoric dependency of the plural definite, similarly to the definites in (53). Beck and Sauerland (2000) in turn argue in favor of a cumulativity-based analysis of these examples. The debate is still open, see for example Kratzer (2007) and Beck (2012).

(53) From Winter (2000):

a. The soldiers hit the targets.

b. Every orchestra player admires the conductor.

4.1 The scope of cumulativity

Like distributivity, cumulative readings can be attributed to various sources in the sentences that display them. The cumulative reading of the canonical sentence (51) can be modeled, for example, by adopting a meaning postulate that says that *use* is distributive on both its arguments, and another one that says that it is cumulative on both its arguments, analogously to the one proposed by Lasersohn (1989) for *write* in connection with

example (31). Similarly to the debates relating to P- and Q-distributivity and to atomic vs. nonatomic distributivity described above, there has been a debate about whether meaning postulates like the one suggested by Lasersohn (1989) for *write* are sufficient to handle cumulativity (Scha, 1981; Krifka, 1992) or whether a silent "cumulation" operator can be inserted in the syntax at various points similarly to the D operator (Sternefeld, 1998). This cumulation operator roughly amounts to closure of relational predicates under pointwise sum formation, though other definitions make it look more similar to the D opeator (Vaillette, 2001; Beck and Sauerland, 2000). Some authors identify it with the plural morpheme (Kratzer, 2007). A further debate concerns the question whether this operator can be applied in principle to anything which forms a constituent at LF (Sternefeld, 1998), though perhaps subject to pragmatic constraints (Beck and Sauerland, 2000), or that its distribution is restricted so that it applies very close to the verb and cannot take scope over nominal arguments (Henderson, 2012). The main issue is whether only coarguments of a verb can enter a cumulative relation, as in (51), or whether that relation can span more than one word. Beck and Sauerland (2000) argue for the latter in the following case, modeled on a sentence by Winter (2000):

(54) The two girls gave the two boys a flower.

Here, the relation that is distributed simultaneously over the two definite plurals in the manner of a cross-product is "X give Y a flower". This relation contains an indefinite, and is therefore arguably able to be Q-distributive, in the sense that there is a reading of (54) in which each of the two girls gave a different one of the two boys a flower. Beck and Sauerland (2000) also argue that, while the cumulative relation can span complex constituents, it is constrained by the same kinds of islands that also affect quantifier scope, such as (arguably) tensed clause boundaries. For example, they report that only (55a) but not (55b) has a cumulative reading:

(55) a. The two laywers have pronounced the two proposals to be against the law.
b. The two lawyers have pronounced that the two proposals are against the law.

4.2 The relation between cumulativity and collectivity

Unlike cumulative readings, collective readings do not have a "cross product" style interpretation, and the two-place predicate that relates the two plural entities is not interpreted distributively on either of its positions. This can be illustrated by using a two-place prediate that contains an indefinite, like *send an emissary to*, which on its distributive interpretation would be Q-distributive, similarly to example (54):

(56) The cowboys sent an emissary to the Indians. (Champollion, 2010b)

a. *Unavailable cumulative reading:* Each of the cowboys sent an emissary to one of the Indians, and each of the Indians was sent an emissary by one of the cowboys.

b. *Available collective reading:* The cowboys as a group sent an emissary to the Indians as a group.

Some authors do not consider cumulative and collective readings distinct from each other (Roberts, 1987; Link, 1998). Other authors, like Landman (2000), argue that both readings are available in sentences like the following:

(57) Three boys invited four girls.

a. *Cumulative reading:* Three boys each invited at least one girl, and four girls each were invited by at least one boy.

b. *Collective reading:* A group of three boys invited a group of four girls.

The boundaries between the readings are sometimes hard to identify. Depending on which notion of collectivity one adopts, criteria like the ones by which Landman (2000) proposes to identify thematic entailments may be used to diagnose collective readings. For example, on the collective reading of (57), the boys jointly carry out the invitation, which is an instance of collective action. Alternatively, one may adopt an view on which the verb introduces its own event quantifier (Champollion, 2010c, 2014b), in which case even ordinary verbal predicates like *invited* become potentially Q-distributive. The difference between the two readings of (57) can then be expressed in terms of whether there were many inviting events or just one.

4.3 Interactions of cumulativity and distributivity

In sentences with more than two noun phrases, it can occur that one noun phrase stands simultaneously in a scopeless (cumulative or collective) relation with another one and in a distributive relation with a third one. In the following examples, the three noun phrases are labeled C, CD, and D, where C and CD stand in a cumulative relation and D is scopally dependent on CD.

(58) From Roberts (1987):

a. [$_C$ Five insurance associates] gave [$_D$ a $25 donation] to [$_{CD}$ several charities].

b. Intended reading: A given set of five insurance associates donated money to several charities, in such a way that each charity received a different $25

donation.

(59) From Schein (1993):
   a. [$_C$ Three video games] taught [$_{CD}$ every quarterback] [$_D$ two new plays].
   b. Intended reading: Three video games between them were responsible for the fact that every quarterback learned a potentially different set of two new plays.

These sentences are similar to examples like (54) in that they involve Q-distributivity and cumulativity at the same time. Such configurations have generated considerable theoretical interest (Roberts, 1987; Schein, 1993; Landman, 2000; Kratzer, 2000; Champollion, 2010a). First, they pose challenges for certain theories that locate the cumulative/distributive ambiguity exclusively in noun phrases. Second, modeling them turns out to require either the adoption of thematic roles in the syntax (Schein, 1993), at least as far as the agent role is concerned (Kratzer, 2000), or a representation of *every* that makes the plural individual available for cumulative relations (Champollion, 2010a). Finally, the fact that distributive quantifiers like *every* can take part in a cumulative readings, as in (59), is surprising on many formal accounts. As the following examples suggest, the position and/or the thematic role of *every* influences its ability to license cumulative readings. For more discussion, see Kratzer (2007) and Brasoveanu (2010).

(60) From Kratzer (2000):
   a. [$_C$ Three copy editors] caught [$_C$ every mistake] in the manuscript.

(61) From Kratzer (2000):
   a. Every copy editor caught 500 mistakes. *(*cumulative)*
   b. 500 mistakes were caught by every copy editor. *(*cumulative)*

(62) From Bayer (1997):
   a. *Gone with the Wind* was written by every screenwriter in Hollywood. *(OK cumulative)*
   b. Every screenwriter in Hollywood wrote *Gone with the Wind. (*cumulative)*

(63) From Zweig (2008):
   a. The Fijians and the Peruvians won every game. *(OK cumulative)*
   b. Every game was won by the Fijians and the Peruvians. *(*cumulative)*

5 Other review articles and related work

A number of relevant review articles and other sources that complement this one have appeared in other handbooks. Here are some notes on these articles and how they differ in focus from this one.

- In "Mereology", Champollion and Krifka (2014) provide an introduction to mereology in formal semantics and discusses linguistic applications in the nominal domain, in the expression of measurement functions, and in the verbal domain.
- In "Plurality", Landman (1996) discusses many of the topics for which I have cited its book-length elaboration, Landman (2000), such as the relationship between collective and cumulative readings and the nature of thematic entailments. Landman also provides an explicit formal framework for a compositional semantics of distributive, collective, and cumulative readings.
- In "Mass nouns and plurals", Lasersohn (2011) covers much of the same ground I have, including the atomic/nonatomic debate on distributivity in which Lasersohn himself played a major part, and also discusses connections to genericity and coordination.
- In "Plural", Link (1991) provides an early systematic overview of plural semantics. The distributivity operator discussed informally in Section 2.5 appears here for the first time. The article appeared originally in German; an English translation appears in Link (1998), a collection of papers by the author.
- In "Plurals and collectivity", Lønning (1997) focuses on implications of collectivity phenomena on the underlying logic and ontology of natural language, and provides a useful discussion of mass terms and nonatomic distributivity.
- In "Plurality", Nouwen (2014) presents many of the same topics covered here, and sheds light on the relationship between plurality and distributivity from a theoretical point of view.
- "Quantification", a monograph by Szabolcsi (2010), includes chapters on existential vs. distributive scope of indefinites (ch. 7) and on distributivity and scope (ch. 8). The latter also provides an overview of several sources of distributivity other than the ones discussed here, such as stressed coordinations and floating quantifiers.
- In "Plurals", Winter and Scha (2014) place special emphasis on how to represent plural individuals in the ontology, on nonatomic distributivity, and on the interaction with generalized quantifier theory.

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