# Distributivity, collectivity and cumulativity[*]

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**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 (exemplified by *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. Typological generalizations and examples from a wide range of languages are discussed throughout the article.

## 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 with an overview of overtly marked distributivity across languages (Section 2.1) and then provides an operational definition of the term *distributivity*, something which is missing from the literature (Section 2.2). Recent empirical work on the conditions under which distributivity occurs in sentences where it is not overtly marked is reviewed in Section 2.3. Section 2.4 brings observations from the theoretical and psycholinguistic literature to bear on the question whether the difference between distributive and nondistributive interpretations should be regarded as a case of ambiguity or of underspecification. Section 2.5 considers whether distributivity should be modeled as a property of arguments or of predicates. Taking the latter view as a starting point, Section 2.6 then distinguishes between lexical predicates (consisting of just one word) and phrasal predicates (which are expressed by a multi-word phrase). 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 may be taken to distribute either only over singular, "atomic" individuals or also over plural entities; Section 2.7 reviews these two positions.

**Collectivity** is the subject of Section 3. I start by reviewing two conceptual views of collectivity (Section 3.1). Collectivity is either defined in terms of the presence of certain entailments about a plural entity, or in terms of the absence of distributivity. Section 3.2 discusses the interaction of different collective predicates with 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 the *numerous* class and predicates in the *gather* class. I have attempted to collect them in one place here.

**Cumulativity**, the topic of Section 4, typically involves two plural entities and a relation that holds between their members in a non-scopal way. Section 4.1 discusses the availability of cumulative readings across languages. Like distributivity, cumulativity can be seen as a property either of entire sentences or of predicates. Section 4.2 discusses whether only lexical or also phrasal predicates can lead to cumulativity. Sections 4.3 and 4.4 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 formal theoretical frameworks in which many of the phenomena discussed in this paper are accounted for (see also Chapter XY [INSERT CROSS-REF: PLURALITY AND CUMULATION] in this volume). To mention a

few examples, Link (1998) (a collection of papers by the same author) provides accounts of plurals, mass terms, distributivity and events in the framework of algebraic semantics. (See also Chapter XY [INSERT CROSS-REF: COUNT NOUNS VS. MASS NOUNS] in this volume.) Winter (2001) presents a theory of plurality, morphological number, distributivity, coordination, copular verbs, the scope of indefinites, collectivity and the interaction between these phenomena. Schein (2008) develops a logical language for phenomena including reference to plurals and mass terms, distributive and collective predicates, cumulative readings, definite descriptions, partitives, reciprocals, and other topics. Parts of this paper build on Champollion (2010b, 2015a), in which I focus on parallels between the collective-distributive opposition, the telic-atelic opposition, and the intensive-extensive opposition.

## 2 Distributivity

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

(1)  a.  John and Bill carried a suitcase.
     b.  They carried a suitcase.
     c.  The men carried a suitcase.
     d.  Three men carried a suitcase.

This contrasts with interpretations on which these sentences only involve a single suitcase. For now I will only refer to them indiscriminately as nondistributive interpretations. Later, I will differentiate between inverse-scope, collective, and cumulative interpretations.

When understood as a property of predicates, distributivity is generally contrasted with 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 noun phrases coordinated by *and*. Predicates such as *smile* or *sing* lead to (near-)equivalent sentences when these different kinds of arguments are used, as in (2) (though see Section 2.2 for some caveats). For this reason,ÆŠ they are traditionally classified as distributive. (They are included in the class of "atom predicates" in the sense of Winter (2001), which also contains some collective predicates. I discuss this alternative characterization in Section 3.) Collective predicates are those for which this pattern breaks down because the combination with *every* and with singular proper names leads to a category mistake (3).

(2)  **Distributive predicates**

     a.    The ten girls smiled. ⇔ Every one of the ten girls smiled.

     b.    Kim and Sandy laughed. ⇔ Kim laughed and Sandy laughed.

(3)    **Collective predicates**

     a.    The ten girls gathered. ⇎ *Every one of the ten girls gathered.

     b.    Kim and Sandy met. ⇎ *Kim met and Sandy met.

## 2.1 Overt distributivity across languages

Distributive interpretations can be enforced by adding overt distributive markers such as *each* and *apiece* (Safir & Stowell, 1988; Zimmermann, 2002), as shown in (4a), and by using quantificational noun phrases headed by determiners like *every* or *each* (e.g. Scha, 1981), as shown in (4b). These sentences entail that the verbal predicate holds of each individual in the denotation of the noun.

(4)    a.    Three copy editors caught six mistakes { each / apiece }.

     b.    { Every / Each } copy editor caught six mistakes.

Determiners that force distributive interpretations are incompatible with collective predicates (by definition, see Section 3). This sets them apart from what I will call simple universals (Gil, 1995) such as English *all*, which are compatible with some collective predicates such as *gather*:

(5)    a.    *Every/*Each student gathered in the hall.

     b.    All the students gathered in the hall.

The observation that some collective predicates are compatible with *all* but not with *each* goes back at least to Vendler (1962). Keenan & Paperno (2012, p. 942) observe that the phonological distinction between simple and distributive universals is present in all 18 languages of their sample, consisting of Adyghe, Basque, Finnish, Garifuna, German, Greek, Modern Hebrew, Hungarian, Italian, Japanese, Malagasy, Taiwan Mandarin, Pima, Standard Russian, Telugu, Western Armenian, and Wolof. To this extent, the pattern exemplified by (5) is crosslinguistically robust. As Gil (1995) observes, some languages—such as Warlpiri—have neither distributive nor simple universal quantifiers. On the other end of the spectrum, Malagasy has been described as having seven or eight universal quantifiers (Keenan, 2008; Keenan & Paperno, 2012).

    Regarding distributive quantifiers such as *every*, Gil (1995) formulates the following typological universals: Their quantificational force tends to be universal; if they differ in morphological number from their simple counterparts, such as English *all*, then they are singular while the simple ones are plural; simple universal quantifiers are never

morphologically derived from distributive ones, but sometimes the other way around; and all languages with distributive universal quantifiers also have simple ones. (Though Gil does not mention explicitly what his sample is, his article mentions the following languages: Buginese, English, Galilean Arabic, Georgian, Hebrew, Hungarian, Japanese, Lakhota, Lezgian, Malayalam, Mandarin, Maricopa, Punjabi, Russian, Singlish, Spanish, Tagalog, Turkish, and Warlpiri.)

Constructions with overt distributive markers differ in various ways from instances of covert distributivity such as the ones in (1). For example, (6a) does not easily license an internal construal of adjectives such as singular *different* (that is, a construal that can be paraphrased as …*than each other*), whereas we do find such a construal in both (6b) and (6c) (see Bumford, 2015, and references therein). Experimental surveys that study the varying ability of different licensors to give rise to internal readings are found in Dotlačil (2010) and Brasoveanu & Dotlačil (2012).

(6)     Examples adapted from Beghelli (1997, p. 363):
   a.     The students read a different book.
   b.     The students each read a different book.
   c.     Every/Each student read a different book.

Many languages provide morphological or syntactic means to induce covariation in indefinites and numerals. Examples include distributive numerals (Gil, 1982a, 2013), illustrated in (7) for Turkish, and dependent indefinites, illustrated in (8) for Romanian (Farkas, 1997; Brasoveanu & Farkas, 2011).

(7)     Her   çocuk   **ikişer**   **sosis**   aldı.
        Each child   two-Dɪsᴛ sausage bought.
        'Every child bought two sausages.' *(surface scope only)*

                                    (Tuğba Çolak-Champollion, p.c.)

(8)     Fiecare băiat a   recitat **cîte**  **un poem**.
        Every   boy   has recited Dɪsᴛ a   poem.
        'Every boy recited a poem.' *(surface scope only)*

                                    (Brasoveanu & Farkas, 2011)

Some distributive markers can only distribute over individuals, such as English *each*, while others can also distribute over salient occasions (e.g. Zimmermann, 2002). In such cases they may be translated as *each time* or *on each occasion*, as (9) and (10) illustrate for the German distributive item *jeweils*.

(9)  Die Redakteure haben jeweils sechs Fehler entdeckt.
     The copy.editors have  DIST  six  mistakes discovered.

    a.  'Each of the copy editors caught six mistakes'
    b.  'The copy editors have discovered six mistakes on each salient occasion'

(10)  Der Redakteur hat jeweils sechs Fehler entdeckt.
    The copy-editor has DIST  six  mistakes discovered.
    'The copy editor caught six mistakes each time'

In a detailed crosslinguistic study, Zimmermann (2002) analyzes the syntactic and semantic properties of adverbial and adnominal distributive markers. Zimmermann's sample includes Bulgarian, Czech, Dutch, English, French, Georgian, German, Hungarian, Icelandic, Irish, Italian, Japanese, Korean, Norwegian, Romanian, Russian, and Turkish. One of his findings is that those markers which can also be used as distributive determiners, such as English *each*, are never able to distribute over salient occasions the way German *jeweils* does. Possible explanations are that distance-distributive elements must find a syntactically overt element with which they can agree (Zimmermann, 2002) or that they inherit the atomicity of distributive determiners (Champollion, 2015a).

## 2.2   An operational definition of distributivity

In general, distributivity can be diagnosed by the presence of what I will call *distributive entailments*. For example, the distributive interpretation of (11a), repeated here from (1a), entails the conjunction in (11b):

(11)  a.  John and Bill carried a suitcase.
    b.  John carried a suitcase and Bill carried a suitcase.

In fact, the entailment also goes in the other direction, from (11b) to (11a). This direction is analogous to the entailment triggered by plural predicates such as *pop stars*:

(12)  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 *cumulative reference*: Whenever a pluralized predicate applies to each of two entities, it also applies to the two entities taken together. In the case of (12), 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 in various ways, be it explicitly as sets or sums, or implicitly

through the resources of plural logic (cf. Winter & Scha, 2015, and references therein). Sums—at least in the sense of mereology, Link (1983)—are different from sets in that they are "flat" and have no structure. That is, they are like unions of sets of individuals, but unlike sets of sets of individuals. For example, the sum of the two entities just mentioned is also the sum of the four individuals David, Chris, Jerry, and Tina. An introduction to mereology, its axiomatic definitions, and its applications in formal semantics, is found in Champollion & Krifka (to appear). 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.

The traditional distinction between distributive and collective predicates is criticized by Winter (2001, 2002), who notes that the entailment patterns in (2) and (3) are only valid if one abstracts away from a number of factors. First, conventionalized coordinations like *Simon and Garfunkel* do not always give rise to distributive entailments, as shown in (13), which Winter bases on a similar example he attributes to Fred Landman (p.c.).

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

The point of the example is that only Garfunkel may be singing while Simon is playing the guitar.

Second, distributive entailments can be harder to diagnose when the definite plural has a nonmaximal interpretation (14).

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

The point here is that in a typical press conference, only a few reporters will get to ask questions.

Third, collective predicates can acquire a distributive reading in the presence group nouns like *committee* or *army* and noun phrases like *the committee* or *the first army* (Barker, 1992; de Vries, 2015). Because of this reading, their entailment properties are similar to those of distributive predicates that were illustrated in (2). (I draw the arrow in only one direction because the sentences on the left also have a collective reading, on which they do not entail the sentences on the right.)

(15)     a.   The ten armies gathered. $\Leftarrow$ Every one of the ten armies gathered.
         b.   The first army and the second army met. $\Leftarrow$ The first army met and the second army met.

While Winter does not consider the distinction between distributive and collective predi-

cates well-motivated, it is useful to have an operational definition of a distributive predicate. To address Winter's concerns about the reliability of the traditional tests, we must control for effects related to conventionalized coordinations, nonmaximal interpretations, and group nouns.

Indefinite numerals, particularly those involving small numbers, are not as likely as definite plurals to give rise to nonmaximal interpretations. For example, in a scenario like the one in (14), the entailment in (16a) can fail because of nonmaximality, but not the entailment in (16b).

(16)　　a.　The reporters spoke up. $\not\Rightarrow$ Each of the reporters spoke up.
　　　　b.　Three reporters spoke up. $\Leftrightarrow$ Three reporters each spoke up.

We can now refine the traditional definition of a distributive predicate in a way that avoids constructions involving coordinations and definite plurals:

(17)　　**Operational definition: Distributive predicate**
　　　　A distributive predicate is a predicate for which (18a) and (18b) are acceptable and entail each other when it is substituted for PRED.

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

Distributive quantifiers can then be defined as those which are compatible only with distributive predicates.

Another noun will sometimes need to be substituted for *people* because of animacy requirements and other selectional restrictions. That noun should not be a group noun like *committee* or *army*. An operational definition of English group nouns is 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 team of rivals/*rival* etc.).

Here are a few examples of predicates for which the entailment from (18a) to (18b) and back is obligatory: *sleep, run, sneeze, get up*, and *take a breath*. This makes them distributive according to the definition in (17). With predicates like *eat a pizza, carry a suitcase* and *ask a question*, the entailment from (18a) to (18b) does not or not always go through. Such predicates are generally called *mixed predicates* and are seen as having a distributive and a collective interpretation. Collective predicates like *meet* and *be numerous* are also correctly classified as nondistributive: At least (18b) is not acceptable, except if the word *people* is replaced by a group noun. But we have agreed not to allow group nouns for the purpose of the test.

Distributivity can be generalized from intransitive to transitive predicates, but in

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that case we must distinguish between different argument positions. For example, *kill* is distributive on its theme role but not on its agent role: A plural entity of people can only be killed if each of its members is killed, but a plural entity of people can kill a person together without each of them killing that person (Lasersohn, 1988; Landman, 2000). To illustrate, the two outlaws Bonnie and Clyde were killed by a posse of six police officers, which included Sheriff Jordan. Given this, (19a) entails (19b) but not (19c), because Sheriff Jordan's actions might not have been sufficient by themselves to kill anyone.

(19)     a.     Six police officers killed two outlaws.
           b.     ⇒ Bonnie was killed.
           c.     ⇏ Sheriff Jordan killed someone.

## 2.3     The limited availability of covert distributivity

Distributive interpretations of sentences without explicit distributive markers, such as those in (20)—repeated here from (1)—are often judged marginal or even unavailable.

(20)     a.     John and Bill carried a suitcase.
           b.     They carried a suitcase.
           c.     The men carried a suitcase.
           d.     Three men carried a suitcase.

Dotlačil (2010, ch. 2) lists an impressive array of mutually incompatible opinions in the literature about whether similar instances of covert distributivity are available. Dotlačil also reviews a number of relevant findings across languages, sometimes coming from control conditions in acquisition experiments. Here is an expanded list of these findings:

- Truth-value judgment tasks suggest that the distributive reading exists but its availability is limited. Pagliarini et al. (2012) found that 97 adult Italian speakers accepted sentences with definite plurals like (20d) as a correct description of a picture that depicted the distributive interpretation only 50% of the time, compared with 98% of the time for the collective interpretation. Syrett & Musolino (2013, Experiment 1) used English speakers, videos, and indefinite numerals as in (20d). The 12 adult speakers they asked judged the sentences true in the distributive scenario 79.2% of the time, and in the collective scenario 100% of the time.

- Picture-matching tasks indicate a strong preference for collective interpretations. Brooks & Braine (1996, Experiment 2) presented English sentences like (20d) to 20 adult speakers and asked them whether it went best with a picture that illustrated a

distributive or a collective interpretation. Participants chose the collective interpretation in 97.5% of their responses. Syrett & Musolino (2013, Experiment 2) asked a similar question. Of their 12 adult participants, 11 consistently preferred collective interpretations while the remaining one did not have a preference.

- Kaup et al. (2002, Experiment 1), a questionnaire study with 60 German participants, used sentences like (20b) that involved the plural pronoun *they* (German *sie*) accompanied by questions like "How many suitcases were carried" followed by an empty space. The 270 freeform answers were then sorted into the following categories: nondistributive only (212 answers), nondistributive preferred (21 answers), no preference (9 answers), distributive preferred (7 answers), distributive only (11 answers). Speakers were also asked to rate the sentences for acceptability. The more they could access a distributive interpretation, the lower they tended to rate them.

The availability of distributive readings in sentences without overt markers varies dramatically across languages. The experiments described above by Pagliarini et al. (2012) on Italian and Syrett & Musolino (2013) on English might already suggest this, but they are not directly comparable. The variation is confirmed by three questionnaire studies administered to 49 Dutch, 141 Hebrew, and 26 Bengali native speakers (Gil, 1982b). Participants were asked to judge sentences like *Three boys saw two girls* in various kinds of distributive and nondistributive scenarios, presented as diagrams together with verbal explanations. In a distributive scenario where three boys each saw a different set of two girls, such sentences were judged to be either true or possibly true by 65% of Dutch speakers, 40% of Hebrew speakers, and only 4% of Bengali speakers. Bengali is not the only language that appears to lack distributive interpretations. The Chinese equivalents of (20b) have been described as unambiguously collective (Liu, 1990; Lin, 1998, p. 201).

On the whole, the facts described in this section do confirm that some languages, including English, make distributive interpretations available even in sentences like (20) that lack overt distributive markers. This is in line with common assumptions in the theoretical literature. However, the results also indicate that nondistributive interpretations tend to be preferred over distributive ones. This preference was confirmed and further investigated in an eye-tracking experiment by Frazier et al. (1999), to which I turn shortly.

## 2.4 Ambiguity or underspecification?

As we have seen, sentences like *The men carried a suitcase* 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 suitcases were carried? An implicit

assumption in a lot of the theoretical literature is that the sentence is truly ambiguous, but this is not self-evident. The distributive reading of a sentence like (21a) is true not only in scenarios where many boxes were lifted and (21b) is false, but also in scenarios where each of the boys lifted the same box in turn and (21b) is true (Winter, 2000).

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

According to many theories of scope, the indefinite object could be read as taking 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. The distributive reading, then, does not entail the existence of more than one box. It is merely compatible with their existence. All that it entails is the existence of as many lifting events as there are boys, as opposed to a situation where there is only one lifting event and the boys all take part in it together. The relevant distinction is not easy to model unless one uses a framework that combines distributivity and event semantics, such as Schein (1993, 2008), Moltmann (1997), Landman (2000), or Champollion (2015a). When testing for the presence of distributive readings, 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.

   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 the scope of negation (Schlenker, 2006a). In line with this method, Schwarzschild (1993) and Kratzer (2007) present the following type of command as a problem for the ambiguity view:

(22)    *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, Schwarzschild and Kratzer conclude that this is a problem for the ambiguity view and favors the underspecification view.

   Another possible problem for the ambiguity view is brought up by Moltmann (1997, p. 52) on the basis of sentences like the following:

(23)    The men lifted the piano individually and together.

Moltmann argues that if a sentence can be modified both by a distributive and a collec-

tive marker, it cannot be ambiguous because once its ambiguity is resolved, it will be incompatible with one of the markers.

On the other hand, Heim (1994, p. 9) cites the following case as an argument against underspecification and for the ambiguity view (cf. also Moltmann, 2005). In a scenario where Jim and Ed each weigh 125 lbs., we can truthfully say:

(24)     It's not the case that Jim and Ed weigh 250 lbs. They only weigh 125 lbs.

The first sentence in (24) is false only if it is interpreted distributively. If it was underspecified, then we would expect it to be judged true on the basis that its collective interpretation is true. Unlike ambiguity, underspecification cannot be used as the basis of arguments like the one in (24), as shown by (25). A similar point is made by Moltmann (2005, p. 637).

(25)     #It's not the case that John is a child. He is a boy.

The eye-tracking study reported in Frazier et al. (1999) lends further support to the ambiguity view. In conjoined noun phrases whose distributive and nondistributive interpretations are equally natural, such as *Sam and Maria* in sentences like (26), readers who encounter the distributive marker *each* a few words later, as in (26a), tend to slow down and look back. Adjusting for word length, they do so to a greater extent than when they encounter *together* instead of *each* (26b). When the two words are moved next to the noun phrase, as in (27), the effect that distinguishes them disappears. This suggests that it is not the presence of *each* by itself that makes the sentence harder to read, but only its late appearance.

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

(27)     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 underspecification unresolved as long as possible, Frazier et al. conclude that a sentence like *Sam and Maria carried one suitcase at the airport* is indeed ambiguous between a distributive and a nondistributive interpretation. Readers who encounter a plural noun phrase without an adjacent distributive marker initially assume a nondistributive interpretation and revise their decision only when they encounter a distributive adverb a few words later, as in (26a)—a typical garden-path effect. The preference for nondistributive interpretations that is used here to explain the slowdown in (26a) is also consistent with the limited availability of distributive interpretations that was discussed in Section 2.3.

In the rest of this paper, I will adopt the ambiguity proposal, which is also the standard

assumption in the theoretical literature.

## 2.5 Distributive subjects or distributive predicates?

It is not always clear whether a given instance of covert distributivity, for example the distributive reading of a sentence like (28), should be classified as due to a silent determiner, a silent predicate modifier, or as something else. The first two options can be represented schematically as follows:

(28)    Three boys built a raft.

(29)    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 (28) derives from an ambiguity in the way the subject is interpreted, or from an ambiguity in the verb phrase. On the first view, illustrated in (29a), the subject either introduces a number of singular entities or one plural entity (Bennett, 1974; Hausser, 1974; Heim et al., 1991). This view fits well with the way plural noun phrases like *three boys* have traditionally been analyzed in generalized quantifier theory. For example, Barwise & 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, and Sentence (28) will be true in that case. 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. Obligatorily distributive verb phrases like *take a breath* and obligatorily collective ones like *gather* will lead to nonsensical readings on one of the two interpretations of *three boys*.

On the second view, the ambiguity is located in the verb phrase, as in (29b) (Dowty, 1987; Lasersohn, 1995; Moltmann, 1997; Winter, 2000). The distributive reading of (28) results from interpreting the verb phrase as a property which 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:

(30)    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 (see Chapter XY [INSERT CROSS-REF: BOOLEAN AND NON-BOOLEAN CONJUNCTION] in this volume), such sentences cannot be modeled by the first view. The second view has no problem: It can rely on whatever property or process distinguishes distributive from collective interpretations of *build a raft* and distinguish the two verb phrases in (30) from each other in the same way. This is the most prevalent view nowadays.

## 2.6   Lexical and phrasal distributivity

As the following examples show, we find distributive and collective interpretations among lexical predicates (denoted by just one word) as well as phrasal predicates (denoted by multiple words).

(31)   **Lexical distributivity/collectivity**

    a.    The men smiled. *distributive*

    b.    The men met. *collective*

(32)   **Phrasal distributivity/collectivity**

    a.    The men are taking a breath. *distributive*

    b.    The men 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 discussed in Winter (1997, 2001); de Vries (2015). P-distributivity refers to those cases of distributivity which can, in principle, be derived from some property of the meaning of the relevant word, as opposed to Q-distributivity, which is usually taken to require an operator-based approach (see below). For example, the difference between (31a) and (31b) can be described in terms of the meaning of *smile*, which is P-distributive, versus the meaning of *meet*, which is not. The difference between (32a) and (32b), by contrast, involves whether the quantificational object covaries or not, and therefore involves Q-distributivity. (I assume here that indefinites are analyzed as quantifiers. Other analyses treat them as properties or their individual correlates, see de Vries (2015) and references therein. To keep the discussion simple and in line with most of the literature, I will continue to treat *a deep breath* and similar indefinites as quantifiers.)

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 is that while both can apply to singular as well as plural entities, distributive predicates always

also apply to the singular parts of these entities. On this purely lexical approach to distributivity, a sentence like *The men smiled* can be treated as ascribing the property *smile* to the referent of *the men*, just like *The men 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 plural entity smiles, so do their members, while there is no such property for *meet*.

In the case of phrasal distributivity, this approach is not generally seen as viable because the distributive predicate may contain a scopal element such as a quantifier. Suppose as above that the indefinite object *a deep breath* in (32a) is interpreted as a quantifier. Then to entail that each girl takes a different breath, the entire verb phrase *take a deep breath*, and not just the verb *take*, must be regarded as distributive so that the quantifier introduced by the indefinite can covary. On traditional views of verbal denotations, only phrasal constituents can contain quantifiers. This means that Q-distributivity is by necessity always phrasal, setting aside proposals where verbs denote event quantifiers (Champollion, 2011, 2015b).

The distributive interpretation of verb phrases that contain quantificational objects, and Q-distributivity in general, involves a scopal dependency between the definite plural subject and the 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 and numerals to covary, as in (32a) and (33), it also optionally gives rise to other scopal interactions similarly to those created by distributive quantifiers. This is illustrated examples (33) through (36), all taken from de Vries (2015). As above, I draw the arrow in only one direction because the (a) sentences also have a collective reading, on which they do not entail the (b) sentences.

(33)  a.  The children admire someone famous.
      b.  ⇐ Every child admires someone famous.

(34)  a.  These artists dress in black one day a week.
      b.  ⇐ Every artist dresses in black one day a week.

(35)  a.  The children are singing or dancing.
      b.  ⇐ Every child is singing or dancing.

(36)  a.  The cows won fewer prizes at the fair than the pig.
      b.  ⇐ Every cow won fewer prizes than the pig.

Winter (2000) and others argue that the purely lexical approach to distributivity is unable to account for this type of optional scope interaction. The standard solution to this problem is to assume the optional presence of a covert distributivity ("D") operator in the logical representation. This operator essentially consists of a universal quantifier, which induces

covariation of indefinites and numerals as well as other scopally sensitive elements such as the ones in the verb phrases of (33) through (36). The D operator originates in Link (1991), which was written in 1984 (see Roberts, 1987, p. 157 for discussion). 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.

(37)   a.   ⟦build a raft⟧ = { x | there is a raft that x built }
       b.   ⟦D[build a raft]⟧ = { X | for all singular individuals y in X, there is a raft that y built }

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. Its meaning is essentially the same as the optional adverbial *each* in (29b), although as we have seen in (6), the two differ in their licensing abilities.

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 in order to derive an interpretation of (38) that allows for each of two girls to have received a pumpkin pie:

(38)   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 an application of quantifier raising (Lasersohn, 1998). However, distributivity operators can be generalized so that they can target sums and intervals other than those denoted by the subject, and so that they can modify arbitrary constituents and not just verb phrases (Lasersohn, 1998; Champollion, 2015a).

## 2.7   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 men are taking a breath*, the indefinite *a breath* covaries with respect to a covert universal quantifier that ranges over individual men. It 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 found in Gillon (1987, 1990), Verkuyl & van der Does (1991),van der Does & Verkuyl (1996), Moltmann (1997, 1998, 2005), Schwarzschild (1996, ch. 5), Brisson (1998, 2003), and Malamud (2006a,b). The nonatomic view originated from a discussion of sentences like the following, adapted from Gillon (1987):

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

This sentence plays on a particular fact of American culture: Rodgers and Hammerstein wrote the musical *Oklahoma* together, and Rodgers and Hart wrote the musical *On your toes* together. But the three composers never got together and wrote a musical, and none of them ever wrote a musical by himself. On the basis of these facts, the sentence is judged as true, although it is neither true on the collective interpretation nor on the "atomic distributive" interpretation that would be generated by a universal quantifier over individual composers. Gillon (1987, 1990) argues that in order to generate the reading on which (39) 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.

There are restrictions on the availability of nonatomic distributive readings. For example, suppose that John, Mary, Bill, and Sue are the teaching assistants. Each of them taught a recitation section, and each of them was paid exactly $7,000 last year. Then sentences (40a) and (40b) are both true (Lasersohn, 1989). Sentence (40a) is true on its distributive reading, and Sentence (40b) is true on its collective or cumulative reading. But sentence (40c) is false, which means that it does not have a nonatomic distributive reading.

(40)    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*

(Lasersohn's original example only involved three individuals, presumably in order to match example (39). I have added a fourth TA to avoid a separate issue, namely whether nonatomic distributive readings allow for overlap.)

The difference between the predicate *write musicals* in (39) and the predicate *be paid exactly $n* corresponds to the difference between P- and Q-distributivity (Winter, 2000). Unlike the atomic distributive reading of (40a), the nonatomic distributive reading of (39) does not involve covariation of an indefinite or numeral. As Lasersohn (1989) points out, it can be modeled by assuming that *write* is cumulative:

(41)    **Cumulativity of *write***
        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. Lasersohn's treatment of *write musicals* suggests
that when cumulative verbs that combine with cumulative objects such as *musicals*, the
resulting verb phrases will generally also be cumulative. Whenever the smallest entities
that these verbs relate are nonatomic, this will result in what may be called a nonatomic
distributive interpretation of verb phrases:

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

In example (42a), the predicate *have common interests* can be applied distributively, in the
sense that it describes several instances of having common interests. In that case, it applies
to nonatomic entities, because it does not make sense to say of a single company that it
has common interests with itself. In example (42b), the predicate *gather near Amsterdam*
can be applied distributively, that is, it describes several gatherings. In that case, it applies
to nonatomic entities, because a single person cannot gather.

   When the object is not cumulative, the verb phrase will not in general be cumulative.
Thus, *write musicals* is cumulative because the sum of two events in which musicals
is written is again an event in which musicals are written. But *write a musical* is not
cumulative, because the sum of two events in which a musical is written will typically
be an event in which two musicals are written (Champollion, 2010b, 2015a). This means
that in the actual world, *write musicals* is true of the plurality that consists of Rodgers,
Hammerstein, and Hart, but *write a musical* is not. Indeed, the following sentence is false
in the actual world, that is, it does not have the nonatomic distributive construal that (39)
has (Link, 1997).

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

If a nonatomic phrasal distributivity operator could apply to *write a musical*, (43) would
be true, contrary to fact. Lasersohn and others conclude from this and similar examples
that phrasal distributivity is always atomic (see 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 (44) can be interpreted as
saying that each pair of shoes costs fifty dollars, as opposed to each shoe or all the shoes
together.

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

In general, *shoes* does not seem to involve reference to pairs of shoes: Somebody who owns one pair of shoes cannot answer *How many shoes do you own?* by *One.* Given this, the relevant reading of (44) is nonatomic distributive: 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 (45), which can only mean that each suitcase weighs fifty pounds or that all of them together do so.

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

Schwarzschild (1996) suggests that the difference between (44), where a nonatomic distributive reading is available, and (45), 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 & White, 2001; Deo & Piñango, 2011; Champollion, 2010b, 2013):

(46)    a.    John found a flea for ten minutes.
        b.    The patient took two pills for a month and then went back to one pill.

Example (46a) is taken from Zucchi & White (2001), and example (46b) is based on observations in Moltmann (1991). Out of the blue, such examples are odd because they suggest that the same flea is found repeatedly, the same pills are taken repeatedly, and so on. Indeed, the status of (46a) is indicated as ?? in Zucchi & White (2001). But these examples improve to the extent that context provides a salient temporal partition that makes covariation of the indefinite or numeral plausible. Thus example (46b) 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. For more discussion of the connection between (44), (45) and (46), see Champollion (2015a).

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 is 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. 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 the empirical properties of distributivity.

# 3 Collectivity

Collectivity is often understood in opposition to distributivity, as a property of predicates. A collective predicate applies to a plural entity as a whole, as opposed to applying to the individuals that form this entity, as shown by examples (3a), (31b) and (32b), repeated here:

(47)    a.    The men gathered.
        b.    The men met.
        c.    The men are sharing a pizza.

As we have seen in (3), repeated here as (48), collective predicates are typically incompatible with distributive determiners and singular proper names:

(48)    a.    The ten girls gathered. $\not\Leftrightarrow$ *Every one of the ten girls gathered.
        b.    Kim and Sandy met. $\not\Leftrightarrow$ *Kim met and Sandy met.

    Beyond this general idea, the criteria for what exactly constitutes collective predication are usually not clearly spelled out.

## 3.1 Thematic vs. nonthematic collectivity

Two similar but not identical conceptual views on what constitutes collectivity can be distinguished (cf. Verkuyl, 1994). Collectivity is either viewed positively in terms of the presence of certain entailments about a plural entity, or negatively in terms of the absence of distributivity.

    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 (49) 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).

(49)    The Marines invaded Grenada.

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. 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 typically associated with thematic roles. For example, the agent of an event is often responsible for this event. Landman assumes that the collective responsibility of the Marines in (49) is of the same nature as the individual responsibility of the agent in a sentence like *Saddam Hussein invaded Kuwait.* Landman notes that thematic entailments have a "non-inductive" character. A sentence like (49) 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). As he 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*). Landman draws parallels between the entailments that these predicates license about the boys as a group and those that they license about individual boys in sentences like *The boy touched the ceiling* and *The boy carried the piano upstairs.* For example, one of the thematic entailments of *touch the ceiling* is that part of the agent is in contact with part of the ceiling. If this agent is a group of boys who are standing in a pyramid, then the relevant part may be the top boy. If the agent is just one boy, then the relevant part may be his outstretched hand.

On the second view, which I will call 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 individuals. For example, if a plural entity is numerous (that is, if it has many members), some subpluralities of this plural entity also have many members, but still *be numerous* exhibits nonthematic collectivity: it does not distribute down to individual atoms. 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 nonthematically collective.

## 3.2 *Be numerous* vs. *gather*

As we might expect based on the two notions of thematic and nonthematic collectivity 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) based on related observations by Dougherty (1970, 1971), and independently by Dowty (1987); cf. also Moltmann (1997, p. 128f.):

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

This empirical distinction is reminiscent of the conceptual opposition between thematic and nonthematic collectivity (Champollion, 2010b). This intuition may be what motivates Dowty (1987) to call 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 kinds of predicates (e.g. Taub, 1989; Brisson, 1998; Winter, 2001; Hackl, 2002; Kuhn, 2014; Champollion, 2015d). While it is an open question how widespread this pattern is, it is not limited to English and related languages. Korean *tul*, which has been analyzed as a plural or distributive marker, is sensitive to an analogue of the *gather*/*numerous* distinction (Park, 2008; Kim, 2015).

The judgment in (50b) is dependent on the choice of noun (Winter, 2001). When a group term like *enemy army* is used, as in (51b) below, the sentence becomes acceptable for some speakers, and in that case it exhibits distributive entailments (Kroch, 1974, p. 194). In this respect, this kind of collective predicate is similar to distributive predicates (51a). (For other speakers, *numerous* cannot be applied to singular group nouns. Krifka (2004) lists *The Jones family is numerous* as ungrammatical, with reference to Kleiber (1989).) Together with his criticism of the distributive-collective opposition discussed in Section 2.2, this observation leads Winter 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*. (As is common in the literature, I do not distinguish here between *all*, *all the*, and *all of the*.) Distributive predicates like *smile* are compatible with both kinds of determiners and lead to equivalent interpretations. Winter calls this class atom predicates (51). Some collective predicates, like *be numerous*, show the same behavior as distributive predicates like *smile*, while others like *gather*, which he calls set predicates (52), distinguish between both.

(51)   **Atom predicates**
       a.   All the men smiled. ⇔ Every man smiled.

    b.    All of the enemy armies are numerous. ⇔ Every enemy army is numerous.

<div align="right">(Judgment based on Kroch, 1974, p. 194)</div>

(52)    **Set predicates**

    a.    All the men gathered. ⇎ *Every man gathered.

    b.    All the armies gathered. ⇎ Every army gathered.

As shown in Table 1, Winter's test draws the boundary at a different place than the traditional distributive-collective criteria. It is not meant as a characterization of distributive predicates. The categories on the right of Table 1 merge the traditional categories with 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 |

Other names for the *numerous* category include *purely collective predicates*, *pure cardinality predicates* (Dowty, 1987), and *genuine collective predicates* (Hackl, 2002). These predicates easily give rise to collective interpretations; indeed the collective interpretation is often the only one available. For example, in (53a), 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 (or large in number).

(53)    From Kroch (1974):

    a.    The ants in the colony were numerous.    *distributive, ✓ collective*

    b.    The soldiers in the bataillon surrounded the fort.    *distributive, ✓ collective*

    c.    The people on this boat are a motley crew.    *distributive, ✓ collective*

Distributive quantifiers like *each* and *every* only allow the distributive interpretation of a predicate of this type (54a). When there is no such interpretation, the sentence becomes unacceptable (54b).

(54)  a.  Each/Every bataillon surrounded the fort.        *distributive, *collective*
      b.  *Each/*Every soldier in the bataillon surrounded the fort.

                                                            **distributive, *collective*

*All* has the same effect on this type of predicate as *each*: if the sentence is acceptable at all, it only has a distributive interpretation (Winter, 2001). For example, (55a) is unacceptable. As mentioned above, Kroch (1974) accepts (55b)—repeated here from (51b)—and interprets it distributively as saying that every enemy army was large in number.

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

Other examples of the *numerous*-type class that have been given in the literature 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* (can be said of trees, 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). Not all of these predicates behave alike, however, particularly if the context is manipulated. A reviewer offers the following examples of contexts in which the relevant predicates were judged acceptable on a collective construal by native speakers of American English. This may be taken to suggest that these predicates are classified as *gather*-type in the grammars of those speakers (see below).

(56)  a.  Some of the boys were crying, but eventually (and after much discussion), all the boys formed a (nice) pyramid.
      b.  There was a lot of discussion, but eventually, all the boys decided unanimously to skip class.
      c.  I know it sounds kind of crazy but in fact all the weapons in this little village would suffice to defeat the US Army.

*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*, as shown by the examples in (5), repeated below as (57).

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

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

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*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, summarize* with respect to its object argument (Dowty, 1987), and *form a big group* (Manfred Krifka p.c. via Brisson 2003).

Taub (1989) suggests that the distinction between *gather*-type and *numerous*-type predicates corresponds to aspectual classes in the sense of Vendler (1957): *Gather*-type predicates are activities or accomplishments, and *numerous*-type predicates are states or achievements. This observation leads Brisson (1998, 2003) to develop a syntactic account of the distinction in terms of a silent predicate DO, which is assumed to be present only on activities and accomplishments. The achievement predicate *reach an agreement* appears to be a counterexample:

(59)    All the parties involved reached an agreement.            (Champollion, 2010b)

More recently, Dobrovie-Sorin (2014) and Kuhn (2014) suggest that all *gather*-type predicates distribute down to certain subpluralities (cf. Champollion, 2015d).

As was already noted, the precise boundary between *numerous*-type and *gather*-type predicates is difficult to determine. Winter (2001) considers any collective predicate which is compatible with *all* to be a *gather*-type predicate. This includes predicates built from reciprocals, such as *like each other*, as well as predicates formed with *together*, such as *perform Hamlet together*. Dowty (1987) and Brisson (2003) exclude these predicates from consideration. Furthermore, Winter regards as a *gather*-type predicate any predicate that is compatible both with *all* and with *each*, as long as there is a truth-conditional difference between the two cases. It is not always easy to detect such a difference. For example, Winter will include mixed predicates such as *lift a box* and *perform Hamlet* in this class as long as the collective reading remains available with *all* and can be distinguished truth-conditionally from the distributive reading. This is the case according to the judgment of D. Dowty as shown in (60), but Dowty (1987) also reports that other speakers find these sentences completely synonymous, as shown in (61).

(60)    **Dowty's dialect**
        a.    All the students in my class performed Hamlet.    ✓ *distributive,* ✓ *collective*
        b.    Each student in my class performed Hamlet.    ✓ *distributive,* \**collective*

(61)    **Other dialects**
        a.    All the students in my class performed Hamlet.    ✓ *distributive,* \**collective*
        b.    Each student in my class performed Hamlet.    ✓ *distributive,* \**collective*

It is an open question whether this split in dialects also extends to other mixed predicates

like *build a raft*, as conjectured by Winter (2001). A reviewer suggests that the dialectal difference might have to do with the context and prosodic structure, and reports the following judgments by American English speakers:

(62)    a.    It was a great evening. Some of the teachers played some early $20^{th}$ century music, the others staged The Turn of the Screw and all the students performed Hamlet.

*collective possible*

        b.    A: So how was your class today?
             B: Great! All the students (in my class) performed Hamlet.

*only (?) distributive*

## 4  Cumulativity

Cumulativity is similar to collectivity in that it does not involve a scopal dependency. Cumulative readings involve two entities in a symmetric non-scopal relation, as in the following canonical examples:

(63)    a.    600 Dutch firms use 5000 American computers.        (Scha, 1981)
        b.    Three boys saw two girls.

The cumulative reading of (63a) 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*. The cumulative reading of (63b) can be paraphrased as *There are three boys and two girls, each of the three boy saw at least one of the two girls, and each of the two girls was seen by at least one of the three boys.*

Cumulative readings were first discussed independently by Kroch (1974) and Scha (1981). In a sense, they also appeared in Langendoen (1978) under the heading of weak reciprocity. They have subsequently been discussed by Krifka (1992), Landman (2000), Winter (2000), and Beck & Sauerland (2000). Cumulative readings typically involve two plural entities A and B and a relation R that holds between the members of these plural entities in such a way that no members of either A or B are left out. 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 (63a) (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 this 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 of the entailment relations between various cumulative sentences with *exactly* components (Brasoveanu, 2010; Robaldo, 2011; Kanazawa & Shimada, 2014).

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

(64)    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 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 the following examples:

(65)    From Winter (2000):
        a.    The soldiers hit the targets.
        b.    Every orchestra player admires the conductor.

Beck & 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).

## 4.1   Cumulative readings across languages

Cumulative readings are found in many languages. Two of the scenarios in the crosslinguistic questionnaire study by Gil (1982b) that was already mentioned in Section 2.3 exemplified the cumulative reading. In the scenario Gil refers to as C, both boys see all the three girls. In the scenario Gil refers to as D, each of the three girls is seen by only one of the two boys. Gil's results show that Dutch, Hebrew, and Bengali speakers overwhelmingly judge (63b) true in Scenario C, with over 90% accepting the sentence in each case. Scenario D is more mixed: 57% of Dutch speakers, 67% of Hebrew speakers, and 84% of Bengali speakers judged the sentence as true or possibly true.

This discrepancy between scenarios C and D suggests that some speakers who cannot access the cumulative reading can nevertheless interpret (63b) on some reading or combination of readings which C verifies but D falsifies. One reading which has this property is the distributive reading of (63b), but as we have seen in Section 2.3, this reading appears to be practically unavailable in Bengali. Gil suggests that the discrepancy is evidence for the so-called *branching reading*, a putative reading which is true in C but false in D (Hintikka, 1974; Sher, 1990, 1997). However, the status of this reading is controversial (Beghelli & Stowell, 1997; Schlenker, 2006b). It has also been suggested that the discrepancy might simply reflect artefacts introduced by Gil's methodology, such as the abstract nature of

the diagrams or possible order effects (Dotlačil, 2010, Section 2.2.2).

Items such as *between them* and *in total / a total of* can be added to force cumulative readings:

(66)    Three boys (between them) saw (a total of) two girls.

Such items are also widespread across languages, as described in many of the contributions to Keenan & Paperno (2012). Here are a few examples:

(67)    Három tanár          {összes-en  / összesség-é-ben      / együtt   /
        three  instructor-nom total-en$_{Adv}$ / totality-possessive-in / together /
        együtt-es-en         / együtt-véve}  száz      dolgozatot osztályozott le$_{particle}$
        together-adj-en$_{Adv}$ / together-taken hundred exam-acc  graded       down
        'Three instructors graded 100 exams total'

                                          (Hungarian, Csirmaz & Szabolcsi, 2012, p. 455)

(68)    Gli assistenti hanno corretto 60 esami  in tutto
        the assistants have   graded   60 exams in all
        'The assistants graded sixty exams between them'

                                               (Italian, Crisma, 2012, p. 503)

(69)    Tri    prepodavatelja proverili v  obščej složnosti sto  rabot.
        three instructors      graded    in total          100 exams
        'Three instructors graded 100 exams between them / in total'

                                               (Russian, Paperno, 2012, p. 756)

## 4.2   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 (63a) 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 (39). 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 in order to account for cumulative readings it is sufficient to appeal to lexical properties of the verb (Scha, 1981; Krifka, 1992), such as cumulativity of *write* as suggested by Lasersohn (1989), or whether a silent "cumulation" operator can be inserted in the syntax at various points similarly to the D operator (Sternefeld, 1998). In Sternefeld's definition, this cumulation operator essentially generalizes Lasersohn's cumulativity postulate for *write* in (41) to arbitrary predicates. Other definitions make it look more similar to the D operator

(Vaillette, 2001; Beck & Sauerland, 2000). Some authors identify it with the English plural morpheme (Kratzer, 2007). A further debate concerns the question whether this operator can only apply to the verb, or whether it can be applied in principle to anything which forms a constituent at LF, subject to syntactic and pragmatic constraints (Sternefeld, 1998; Beck & Sauerland, 2000). The main issue is whether only coarguments of a verb can enter a cumulative relation, as in (63a), or whether that relation can span more than one word. Beck & Sauerland (2000) argue for the latter in the following case, modeled on a sentence by Winter (2000):

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

On the reading that comes out true if each of the two boys received a different flower from (only) one of the two girls, the relation that is distributed simultaneously over the two definite plurals is not simply "give" but "give a flower to". This relation contains an indefinite, and is therefore arguably Q-distributive.

    Beck & Sauerland (2000) 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 (71a) but not (71b) has a cumulative reading:

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

Most research into the scope of cumulativity operators has focused on English. One exception is Kaqchikel Mayan, a language with a rich inventory of pluractional morphemes (see also Chapter XY [INSERT CROSS-REF: PLURACTIONALITY] in this volume). These morphemes include the following (Henderson, 2012, p. 5). In the glosses, COM stands for completive aspect, A for absolutive, E for ergative, and 1s and 3s for first and third person singular.

(72)     X-∅-in-tzuy-**utza'**
        COM-A3s-E1s-sit-**utza'**
        'I made the motion of sitting there repeatedly.'

(73)     X-i-tzuy-**ulöj**.
        COM-A1s-sit-**ulöj**
        'I sat a lot.'

Henderson (2012) identifies the highlighted pluractional in (72) as event-internal and the one in (73) as event-external in the sense of Cusic (1981). Roughly, an event-internal

pluractional subdivides an event described by the root on which it appears, while an event-external pluractional introduces multiple events that are each described individually by the root. On the basis of various scopal facts, he argues that event-internal pluractionals apply to the verb root directly, below the cumulativity operator, while event-external ones apply only above that operator. As Henderson shows, event-external pluractionals can be Q-distributive (they can take scope over other arguments of the verb such as indefinites and cause them to covary), but event-internal pluractionals and the cumulativity operator are unable to do so. This suggests that the cumulativity operator cannot induce Q-distributivity because is too close to the verb root, even though it can be separated from the root by something else, namely an event-internal pluractional.

## 4.3   The relation between cumulativity and collectivity

The boundaries between collective and cumulative readings are sometimes hard to identify. Some authors do not regard cumulative and collective readings as distinct from each other (Roberts, 1987; Link, 1998). Other authors, like Landman (2000), argue that both readings are distinct, and that sentences like the following are ambiguous rather than underspecified:

(74)    Three boys invited six girls.

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

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

The word *together* appears to force collective readings when it is used adverbially and cumulative readings when it is used adnominally, though this characterization is debatable (cf. Moltmann, 2004):

(75)    a.   Three boys invited six girls together.                                    *(collective)*

    b.   Three boys together invited six girls.                                    *(cumulative)*

Depending on which notion of collectivity one adopts, collective readings may be diagnosed through criteria like the ones by which Landman (2000) proposes to identify thematic entailments. For example, on the collective reading of (74), the boys jointly carry out the invitation, which is an instance of collective action. Alternatively, if the verb introduces its own event quantifier, even ordinary verbal predicates like *invited* become potentially Q-distributive. The difference between the two readings of (74) can then be expressed in terms of whether there were many inviting events or just one Champollion (2015b).

## 4.4 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.

(76) From Schein (1986, 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.

(77) 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.

These sentences are similar to examples like (70) in that they involve Q-distributivity and cumulativity at the same time. Such configurations have generated considerable theoretical interest (Roberts, 1987; Schein, 1993, 2008; Landman, 2000; Kratzer, 2000, 2007; Brasoveanu, 2010; Champollion, 2010a, 2015c). 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 reading, as in (76), is surprising on many formal accounts.

# 5 Other review articles and related summaries

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.

- "Mereology" provides an introduction to classical extensional mereology in formal semantics and discuss linguistic applications in the nominal domain, in the expres-

sion of measurement functions, and in the verbal domain (Champollion & Krifka, to appear).

- 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 (2010) 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 2.6 appears there 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 (to appear) 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 & Scha (2015) 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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