Gather/numerous as a mass/count opposition

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Abstract

Predicates like *gather* and *be numerous* have both been described as 'collective predicates,' since they predicate something of a plurality. The two classes of predicates differ, however, with respect to plural quantifiers (e.g. *all*), which are grammatical with *gather*-type predicates but ungrammatical with *numerous*-type predicates. Here, I show that the *gather/numerous* opposition derives from mereological properties that are familiar from the domains of telicity and mass/count. I address problems of undergeneration and overgeneration with two technical innovations: first, I weaken the property of divisibility to Champollion's (2015) property of stratified reference; second, I provide mechanisms to rule out accidental satisfaction of the logical property. From a broader perspective, we place collective predication in a larger context by building empirical connections to mass/count and collectivity across semantic domains.

1 Introduction

1.1 Overview

Predicates like *gather* and *be numerous* have both been described as 'collective predicates.' Broadly speaking, collective predicates are predicates that work perfectly well with plural arguments, but are ungrammatical with atomic individuals, as evidenced in the contrast between (a) and (b) in the examples below.

(1) a. The students gathered.
b. * Marco gathered.

(2) a. The students are numerous.
b. * Marco is numerous.

However, not all collective predicates behave the same. In particular, there are two classes of predicates that differ in their grammaticality with plural quantifiers, such as *all*, *most*, and *several* (Kroch 1974; Dowty 1987; Winter 2001; Champollion 2010). I follow Champollion (2010) in

calling these classes *gather*-type predicates and *numerous*-type predicates. The contrast is shown in (3) and (4); the former are perfectly grammatical, but the latter are as bizarre as (2b), seeming to suggest that each student is somehow particulate.

(3) *Gather*-type predicates
   a. All the students gathered.
   b. Most of the students gathered.
   c. Several students gathered.

(4) *Numerous*-type predicates
   a. * All the students are numerous.
   b. * Most of the students are numerous.
   c. * Several students are numerous.

A slightly more precise and general characterization can be given in semantic terms. With *numerous*-type predicates, *all* forces distribution to atoms, analogous to *each*. For example, the sentence in (5a), with a definite plural, may be true in a situation where the boxes all together weigh 100kgs or in a situation in which each individual box weighs 100kgs. The sentence with *all* in (5c), however, only allows the distributive reading, thus showing that *weigh 100kgs* is also a *numerous*-type predicate. The sentence remains grammatical, but the collective reading is removed. On the other hand, in cases in which it is odd to predicate the verb phrase of an atomic individuals (e.g., *numerous*), the result is anomalous, thus turning the semantic judgment into an acceptability judgment, as in (4).

(5)	a. The boxes weigh 100kgs.	✓collective	✓distributive
	b. Each box weighs 100kgs.	* collective	✓distributive
	c. All the boxes weigh 100kgs.	* collective	✓distributive

The lists in (6) and (7) provide examples of predicates in the two classes, taken largely from the references above.

(6) *Gather*-type predicates: *gather*, *be similar*, *meet*, *disperse*, *hold hands*, *fit together*, *be consistent* (axioms), *agree*, *disagree*

(7) *Numerous*-type predicates: *be numerous*, *be a group of ten*, *form a pyramid/circle*, *suffice to defeat the army*, *return a verdict of 'not guilty'*, *be inconsistent* (axioms), *be a group of less than ten*, *be denser in the middle of the forest*

A number of authors have discussed the intuition that the *gather*/*numerous* distinction is connected to the mereological divide familiar from mass/count and atelic/telic distinctions (Löbner 2000; Winter 2001, p.224; Corblin 2008; Dobrovie-Sorin 2014; Champollion 2015). The basic observation is that *numerous*-type predicates generally involve an emergent property of a group. For example, to 'be a group of ten' depends on the number of individuals in the whole group; to 'return a verdict of not guilty' depends a legal property that holds only of the jury as a whole; to 'be

inconsistent' depends on the logical properties of the set as a whole. In contrast, *gather*-type predicates allow 'distributive sub-entailments' (Dowty 1987). For example, in a 'gathering' event, each individual went to the same place as someone else; in a 'fitting together' event, each puzzle piece connects with some other piece. In this paper, I argue that these intuitions are essentially correct. Specifically, I contend that the *gather*/*numerous* distinction is fundamentally the same distinction that distinguishes mass nouns from count nouns, and atelic verbs from telic verbs. By virtue of the fact that an individual is mud, there are small subparts which are also mud. Analogously, by virtue of the fact that a plurality gathered, there are small subpluralities which also gathered.

(8)

	nouns	**verbs** *(w.r.t time)*	**verbs** *(w.r.t. participants)*
mass	mud	sleep	gather
count	puppy	wake up	be numerous

Of course, collective predicates are more complex than this. What it means to be collective is to have an atomic part associated with a plurality. For both *gather*- and *numerous*-type predicates, there is a minimal part associated to a plurality of individuals. In this respect, *numerous*-type predicates are less like canonical count nouns like *puppy*, and more parallel to group-denoting count nouns like *team* or *swarm*, which also associate an atomic individual with a plurality, as well as to similar phenomena in the verbal domain (*i.e.,* event-internal pluractionality). Thus, on several fronts, we see parallels to mereological properties well known from other domains: mass/count distinctions, as well as the semantic association of atoms with pluralities.

Yet, the devil is in the details: it turns out that classical formulations of these mereological properties (as either divisiveness or cumulativity) both overgenerate and undergenerate the class of *gather*-type predicates; as a consequence, no account to date has provided a successful analysis based on independently observed semantic properties of the two kinds of predicates. In this paper, I define such a property, inspired by divisiveness, but repairing its problems with two innovations. First, in the spirit of Champollion (2015), I argue that *gather*-type predicates have stratified reference, a weakening of divisiveness. Second, I argue that 'accidental' satisfaction of the relevant property is not enough to allow compatibility with *all*: the fact that a predicate holds of the subparts of a plurality must be grounded in the fact that it holds of the whole plurality. The resulting analysis does strictly better at classifying predicates than the classical notion of divisiveness.

I then address the observation from Brisson (2003) that the grammaticality of *all* seems to be sensitive to the lexical aspect of the predicate. I show that the facts are somewhat more complex; although *aksionsart* does have a measurable effect on the interpretation of *all*, it is perhaps best seen as a secondary mechanism to rescue the collective reading in some cases. This is supported by new empirical data: I show that the adjective *same* has the same semantic restrictions as *all*, but without the *aktionsart* confound. The logical distinction that hold for states with *all* thus holds for both states and activities for *same*.

It bears noting that these three theoretical decisions are largely independent, so that each one can be argued for on its own terms, or can be replaced in a modular way by a competing analysis. On the other hand, the deeper thesis of this paper can be construed in a completely theory-neutral way. In particular, although classical analyses face certain puzzles in the categorization of *gather*-type predicates, we will observe that these puzzles are exactly analogous to puzzles faced in the

categorization of mass nouns and atelic predicates. Regardless of specific mechanics, I take these empirical parallels to be strong motivation for the unified, domain-general analysis exemplified in (8).

A bibliographic note: The domain-general connection between aspect and mass/count has long been observed (Allen 1966, Taylor 1977, Bach 1986, Krifka 1989, *i.a.*). The present extension to collective predication is closely intertwined with a body of recent work that argues that domain-general mereological properties provide a unified perspective regarding patterns involved in mass/count, aspect, measurement, and distributivity (Champollion, 2010; Husband, 2010; Henderson, 2012; Wellwood et al, 2012; Champollion, 2015; Wellwood, 2015; Champollion, 2017). The present article is an updated version of Kuhn (2014), an unpublished conference presentation which repaired some notable problems with Champollion (2010). These repairs—and in particular the extension of stratified reference to small pluralities—have since been adopted in subsequent work by Champollion. Of particular note, Champollion (2017) Chapter 10, reformulates arguments of Champollion (2010) by adopting the essential insights of Kuhn (2014). In this remainder of this article, I do not discuss Champollion (2017) in any more great depth, for the simple reason that there is no fundamental disagreement between the two works.[1]

1.2 Monotonicity and beyond

For both nouns and verbs, it has long been observed that language categorizes semantic concepts depending on their mereological structure. Nouns, for example, can be characterized as either *mass* or *count*, evidenced empirically by whether they can be pluralized and what determiners can be used to quantify them (as in (9)). With respect to temporal properties, verbs can be categorized as either *atelic* or *telic*, evidenced empirically by whether modification is possible with *for*- or *in*-adverbials (as in (10)).

(9) a. too much mud (mass)
b. too many puppies (count)

(10) a. sleep for an hour (atelic)
b. wake up in an hour (telic)

Formally, both of these properties can be characterized by a logical property that relates the whole of an object or event to its parts. For nouns, the most relevant starting point will be Cheng's (1973) characterization in terms of divisiveness: if x has a mass-noun property N, then every subpart of x also has property N. To a first approximation, if x is mud, then every subpart of x is also mud. The analysis of verbal aspect zeroes in on the same logical generalization. Vendler (1957) offers a mereological characterization of atelicity that is formalized by Bennett and Partee (1972) as the 'subinterval property': if an atelic predicate holds over an interval I, then it also holds over every subinterval of I. To a first approximation, if an individual slept for an hour, then they slept for every minute of that hour.

Famously, Quine (1960) observes that this characterization of mass nouns runs into the 'minimal-parts problem': *water* is a mass noun, but a single hydrogen atom in a water molecule is itself no

[1]The present article, however, goes deeper than what is reported in Champollion (2017) in a number of respects. These include the analysis of measurement predicates, new data involving *same*, proofs regarding the logical relations between competing definitions, and connections to collective nouns.

longer water. Dowty (1979) observes a similar problem for the characterization of atelicity: *waltz* is an atelic verb, but waltzing requires at least three steps. Anticipating that the proposal in §2 will alleviate the minimal-parts problem in a more general form, let us provide a temporary patch in terms of *bounded* divisiveness, that states that a property holds of all *sufficiently large* subparts.

Turning to collective predicates, a useful starting point is the observation by Winter (2001) that *gather*-type predicates are often associated with 2-bounded divisiveness. In the definition below, and subsequently through the paper, $\preceq$ indicates mereological parthood ($x \preceq y$ is read 'x is part of y'), $|\cdot|$ measures set cardinality, $\leq$ compares two numerical values (standard 'less than or equal to'), and ε is a contextually-determined small numerical value.

(11) A predicate P has ε-bounded divisiveness iff
$\forall x[P(x) \quad \rightarrow \quad \forall y[(|y| \geq \varepsilon \wedge y \preceq x) \rightarrow P(y)]]$
'If P holds of x, then P holds of all sufficiently large parts of x.'

Take *gather* as a representative instance of a *gather*-type predicate. Bounded divisiveness states that, for any plurality x, if x gathered, then any sufficiently large subplurality of x gathered. As in the nominal and temporal domains, the use of bounded monotonicity avoids an instance of the minimal-parts problem: just as a single atom cannot be water, a single person cannot gather.

Figure 1 illustrates what it means for a predicate to have divisiveness over the participants. Figure 1(a) provides one instance of a gathering event: all the dots are going to the same location. Figures 1(b) – (d) show three subevents of (a) generated by taking subsets of the dots; each of these is also a gathering event. More generally, any subplurality of at least two or three dots will be the participants of a gathering subevent.

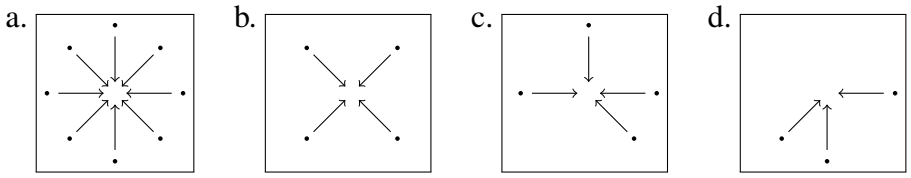

Figure 1: Four gathering events; (b) – (d) are subevents of (a).

At a first pass, divisiveness seems to do quite well as a defining property of *gather*-type predicates. Figure 1 gave an example with *gather*. The predicate *be similar* has the same property: if the members of some set are similar, then the members of any non-singleton subset are necessarily similar. In fact, this observation is not new: Winter (2001) very briefly considers (then dismisses) 2-bounded divisiveness as a possible defining property of *gather*-type predicates.[2] But, as promising as this diagnoistic seems with *gather* and *be similar*, it turns out that n-bounded divisiveness faces problems of at least two kinds. First is a problem of undergeneration: divisiveness incorrectly rejects some predicates from the *gather* class, including *hold hands*, *fit together*, and *disagree*. Second is a problem of overgeneration: divisiveness incorrectly admits some predicates to the *gather* class, including *be less than ten in number*.

[2]The actual sentence that Winter provides as a counterexample is "Exactly five girls drank together a whole glass of beer." I personally find the placement of *together* in this sentence to be quite unnatural, so I am hesitant to use it

Here, I will argue that these problems are not reason to give up hope; I will provide two amendments to divisiveness that will rescue the prospect of an analysis via the mereological properties of the lexical semantics. Furthermore, I will maintain the congruence between mass nouns, atelic verbs, and *gather*-type predicates: tellingly, the puzzles that are faced in the participant domain are versions of the same puzzles from the nominal and temporal domains.

2 The 'tricky-parts' problem and stratified reference

2.1 The 'tricky-parts' problem

The first puzzle that we will address is a problem of undergeneration: there is a set of predicates that are incorrectly rejected from the *gather* class. The basic observation is that certain collective predicates are grammatical with *all* but are technically not divisive, despite still intuitively having 'distributive sub-entailments.' *Hold hands* and *fit together* are two such predicates, grammatical with *all* as in (12).

(12) a. All the students held hands.
b. All the puzzle pieces fit together.

The pictures in Figures 2 and 3 illustrate the problem. In Figure 2(a), a plurality of six children are holding hands. In Figure 2(b), the three selected individuals form a subplurality of the students, but they are not holding hands. Divisiveness states that every subplurality must have the property of holding hands; this is not the case, so *hold hands* does not have divisiveness. An analogous situation holds for *fit together*, as seen in Figure 3: the puzzle pieces in (a) fit together, but the members of the subplurality in (b) do not. Thus, *fit together* is likewise not divisive.

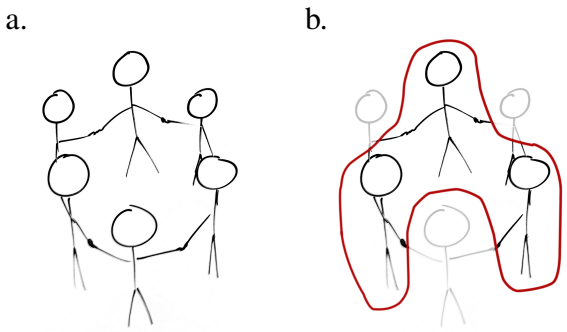

Figure 2: *Hold hands*

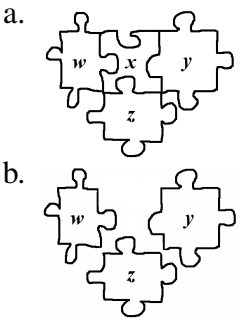

Figure 3: *Fit together*

In fact, *hold hands* is not n-bounded divisive for any n. To see this, consider a circle of $2n$ students holding hands. The set consisting of every other student in the circle is a subset of n students, and yet the predicate *hold hands* does not hold of it. Thus, what we have is not

as strong counter-evidence. Nevertheless, I think that more natural examples make a similar point: the most parallel examples will be discussed in §5.1.

an instance of the minimal-parts problem, since arbitrarily large subparts may still not have the relevant property. The same state of affairs holds for *fit together*. Thus, for both of these predicates, what we seem to have is instead a 'tricky-parts' problem: intuitively, the subpluralities that provide a counterexample to divisiveness are constructed in 'tricky' ways, built by considering unnatural or non-contiguous subparts.

As it turns out, this situation is exactly analogous to a problem in the nominal domain posed by heterogenous mass nouns like *succotash* or *fruitcake* (e.g., Taylor 1977). Succotash is a prepared food that consists of a mixture of beans and corn; however, any subpart (however large) consisting of only beans does not qualify, itself, as succotash. Thus, *succotash* does not have bounded divisiveness, despite the fact that it behaves as a mass noun (e.g., *too much succotash*). Again, a 'tricky' subpart (e.g. the discontinuous subpart with no corn) provides a counterexample to bounded divisiveness.

2.2 Stratified reference

Formally, the tricky-parts problem arises because there is a universal quantifier in the definition of divisiveness that is necessarily sensitive to even these irrelevant subparts. The definition in (11) states that if a predicate P holds of x, then P holds of *all* sufficiently large parts of x. To solve the undergeneration problem for *gather*-type predicates, we will thus adopt the solution that Champollion (2015) proposes for analogous problems in other domains: we will change the troublesome universal quantifier to an existential.

Champollion's (2015) proposal, called stratified reference (SR), can be formulated in a number of equivalent ways; here, I will do so in terms of covers, to highlight the relation between divisiveness and stratified reference. Given a set of entities S, let $\bigoplus S$ ('the sum of S') be the smallest individual y such that $x \preceq y$ for all $x \in S$. A *cover* of x is a set of (possibly overlapping) entities whose sum is x.[3]

(13) X is a cover of x iff $\bigoplus X = x$.

Restating divisiveness in terms of covers, we say that a predicate P has divisiveness if, for every plurality in P, *every* cover of sufficiently large subpluralities has cells that are also in P. In constrast, a predicate P has stratified reference if, for every plurality in P, there is *some* cover of sufficiently small subpluralities with cells that are also in P. A definition of stratified reference is provided in (14).[4]

[3]Technically, this is the definition of a 'tightly-fitting' cover; more commonly, a cover of x is defined to be a set of plural entities whose sum *contains* x. At the risk of abusing terminology, I will nevertheless use the term 'cover' to refer to the concept defined in (13), which will map more easily onto the logical translation of divisiveness and stratified reference. Further discussion about the linguistic use of tightly-fitting covers versus loosely-fitting covers appears in Schwarzschild (1996), Lasersohn (1995), and Brisson (2003).

[4]The observant reader might notice a second difference between these two definitions that relates to the epsilon condition: in divisiveness, the parts must be 'sufficiently large'; in stratified reference, the parts must be 'sufficiently small'. The reason is directly related to the force of the quantifier: in the former case, the epsilon condition removes the threat of guaranteed falsity that would arise from considering singleton sets in the definition. In the latter case, the epsilon condition removes the threat of considering only the trivial cover consisting of only the set itself. More discussion of the epsilon condition can be found in Champollion (2010).

(14) A predicate P has stratified reference iff
$\forall x[P(x) \rightarrow \exists X[\bigoplus X = x \wedge \forall y \in X[|y| \leq \varepsilon \wedge P(y)]]]$
'For every plurality in P, there is a cover of sufficiently small subpluralities that are also in P.' (cf. Champollion 2015, (20))

There is one notable difference between this formulation and the one in Champollion (2015): the definition in (14) defines stratified reference as a property of individual predicates, whereas the one in Champollion (2015) redefines it as a property of event predicates. For most of this paper, the two definitions are equivalent, although §4.1 shows that the definition of stratified reference in terms of events is strictly stronger than the one in term of individuals, a fact which can potentially be employed as an alternative account to a problem of overgeneration.

2.3 Examples

To confirm that stratified reference has the desired effect, we will work through several examples: we will show that *hold hands* and *fit together* are now correctly categorized as *gather*-type predicates, but that the weakening of the condition seems to avoid accidentally admitting any new *numerous*-type predicates (though an absolute proof of this fact is impossible without a comprehensive list of every single *numerous*-type predicate). Two pairs of examples will provide a nice minimal case study: *be consistent* vs. *be inconsistent*, and *agree* vs. *disagree*. The former pair acts differently with respect to *all*; the latter two do not. We will find that these contrasts come automatically from the new analysis in terms of stratified reference.

Since stratified reference is a strict weakening of divisiveness, the change from a universal quantifier to an existential quantifier does not exclude any predicates from the *gather* class that were previously admitted. Thus, *gather* and *be similar* automatically have stratified reference; for example, any gathering event can be decomposed into (i.e. is the sum of) small gathering events involving overlapping groups of two or three individuals. As we saw before, *hold hands* and *fit together* do not have divisiveness; nevertheless, they do have stratified reference. Any holding-hands event can be decomposed into small holding-hands events (overlapping pairs of adjacent people); any fitting-together event can be decomposed into small fitting-together events (overlapping pairs of adjacent pieces). Figure 4 makes this concrete by returning to the example from Figure 3: the same configuration of puzzle pieces that provided a counterexample to divisiveness does not provide a counterexample to stratified reference: the fitting-together event containing puzzle pieces w, x, y, and z can be divided into one fitting-together event containing w and x, one containing x and y, and one containing y and z. These small subevents comprise a cover of the larger event. More generally, any fitting-together event can be decomposed in a similar way: by the lexical semantics, if some plurality fits together, then each atomic part fits together with another atomic part; a cover can be constructed by taking cells containing every such pair.

In contrast, the *numerous*-type predicates discussed before do not have stratified reference. For example, *be numerous* can clearly not be divided into a cover of small *numerous*-subevents, since the participants in any subevent which is sufficiently small will by definition not be numerous. Likewise, *return a verdict of not guilty* does not have stratified reference, because any event with only a subset of the participants cannot be (by legal definition) an event of returning a verdict.

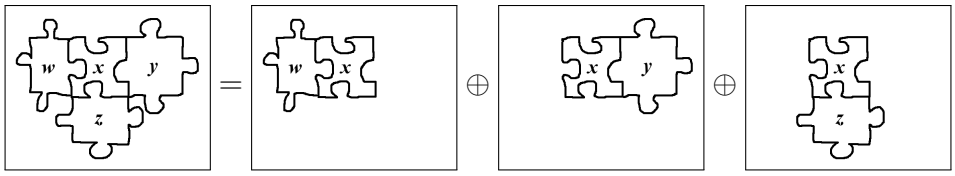

Figure 4: A fitting-together plurality decomposed into a cover of small fitting-together pluralities.

Stratified reference gets similarly correct results for *gather*-type predicates *meet*, *disperse*, *disagree*, and for *numerous*-type predicates *be a group of ten*, *form a pyramid/circle*, *suffice to defeat the army*, *elect the president*, among others.

A clean (novel) minimal pair is found in the contrast between *consistent* and *inconsistent*, and the parallel contrast (p.c. Benjamin Spector) between *compatible and incompatible*. In both cases, the former is compatible with *all*, but the latter, derived by the simple addition of a negative morpheme, is not. (Note: we are only concerned with the 'internal' reading of these predicates—'be compatible *with each other*'—as opposed to the 'external' reading that compares each member of the set to a contextually salient individual.)

(15) a. All the axioms are consistent.
b. * All the axioms are inconsistent.

(16) a. All the computer programs are compatible. (p.c. B. Spector)
b. * All the computer programs are incompatiable.

It turns out that this prediction follows immediately from the definition of stratified reference. By definition, if a set of axioms is consistent, then any subset is also consistent. (Otherwise, the inconsistency of the part would yield inconsistency of the whole.) Thus, for any 'consistent' event, it is perfectly easy to find a cover of small 'consistent' subevents. In an 'inconsistent' event, on the other hand, inconsistency may emerge from the set as a whole. For instance, consider a set of axioms that consists of the following five inequalities: $\{a > b,\ b > c,\ c > d,\ d > e,\ e > a\}$. In this example, it turns out that any strict subset is consistent; inconsistency arises only when all five are considered together. It is therefore not possible to find a cover of small 'inconsistent' subevents. An analogous situation holds for *compatible* and *incompatible*.

Given the contrast observed for *consistent*/*inconsistent* and *compatible*/*incompatible*, it is striking that *agree* and *disagree* do not show such a contrast—both are grammatical with *all* (despite the fact that they, too, are "opposites"). Nevertheless, it turns out that stratified reference makes exactly the right predictions.

(17) a. All the students agreed (about what book to read).
b. All the students disagreed (about what book to read).

The situation can be explained based a fundamental difference between inconsistency and disagreement: while inconsistency is a situation that may be contingent on the presence of every single part (as in the scenario above), disagreement entails that there is always a difference of opinions that can be instantiated by a single pair of individuals. For any disagreeing event, then,

we can construct a cover by including both of these opinions in each cell. Disagreement thus arises from properties of an event's subparts in a way that inconsistency does not.

Notably, stratified reference is a property of predicates (i.e. sets of individuals), and not a property of the plural individuals themselves. Notably, there are some instances of *be inconsistent* for which one *can* find a cover of sufficiently small inconsistent pluralities. Consider, for example, the following set of equalities: $\{a = 1, a = 2, a = 3, a = 4, a = 5\}$. Here, any subset of at least two equalities is inconsistent; thus, it is perfectly easy to find a cover of sufficiently small inconsistent pluralities (any cover with non-singleton cells will work). Nevertheless, in such a scenario, it is still ungrammatical to say '*All the equalities are inconsistent.*' This is predicted on the present analysis: in order for a predicate P to have stratified reference, it must be the case that every plurality in P can be divided into small pluralities in P. The fact that some 'inconsistent' pluralities cannot be divided into 'inconsistent' subpluralities is sufficient for the predicate to not have stratified reference.

3 Grounded stratified reference

3.1 A problem with measurement predicates

The previous section resolved a problem of undergeneration by shifting from divisiveness to stratified reference. In the present section, we address a problem of overgeneration: without any further assumptions, divisiveness and stratified reference both incorrectly predict that *all* will be grammatical with certain predicates having to do with measurement. The problem for stratified reference can be illustrated with the predicates *number less than ten*, *be denser in the middle of the forest*, and *weigh less than 100kgs*.

(18) a. * All my social media followers number less than ten.
b. * All the trees are denser in the middle of the forest.
c. All the boxes weigh less than 100kgs. * collective ✓distributive

Stratified reference says that any event in P can be divided into a cover of subevents which are also in P. But this seems to get the wrong prediction for the predicates in (18): any plurality that satisfies the predicate *number less than ten* can be divided into a cover of small subpluralities; clearly each of these subpluralities will also satisfy the predicate *number less than ten*. (And equivalently for *weigh less than 100kgs*.) A similar problem holds for *be denser in the middle of the forest* (provided that the epsilon condition admits large enough subpluralities for density to be well defined). For any plurality of trees that is denser in the middle of the forest, let each cell in the cover be a uniform sampling of these trees; this sampling will also be denser in the middle. Both of these predicates thus appear to satisfy stratified reference, yet are ungrammatical in sentences with *all*.

An even more striking demonstration of this problem is brought out by certain 'tautological' predicates like *be a group of more than four or less than five* and *be a group of at least two* (adapted from related examples in Higginbotham 1994 and Lønning 1987). Critically, both of

these predicates denote properties that hold of every single non-singleton plurality. Thus, for any plurality, it will trivially be the case that the predicate will hold of all subpluralities.

(19) a. * All the students are a group of more than four or less than five.
b. * All the students are a group of at least two.

Just as with the 'tricky parts' problem, an exactly analogous problem holds in other domains—specifically, in the atelic/telic distinction. Here, (20a) is constructed to be analogous to (18a); (20b) is constructed to be analogous to (19b). The basic observation is that the predicates *ran less than three miles* and *drank some quantity of beer* are telic (evidenced by their ungrammaticality with *for*-adverbials), despite the fact that they have the properties of divisiveness and stratified reference.

(20) a. * John ran less than three miles for one hour.
b. * John drank some quantity of beer for twenty minutes.

Take an event in which John ran less than three miles that has a runtime τ. Consider any subevent that transpires over a subinterval of τ. Necessarily, this will also be an event in which John ran less than three miles. Thus, *ran less than three miles* has divisiveness and stratified reference. Similarly, any event in which John drank some quantity of beer can be divided into a cover of temporally small events, each of which contains the consumption of some quantity of beer. Thus, *drink some quantity of beer* also has divisiveness and stratified reference.

3.2 Grounded stratified reference

I would like to suggest the following intuition: in (18)–(20), divisiveness or stratified reference holds, but for the wrong reasons; the semantics of these predicates yields *accidental* satisfaction of these logical properties.

To make this more concrete, consider the sentences in (18). Observe that, in fact, any plurality, regardless of whether it satisfies the predicate itself, nevertheless can be divided into subpluralities that do. For *number less than ten*, this is transparent: we choose any cover with cells containing less than ten individuals. Even pluralities satisfying the predicate *be a group of 100* can be divided into small pluralities with less than ten individuals. For *be denser in the middle of the forest*, the cover needs to have heavily overlapping cells, but the same thing is true: in each cell, include all the trees in the middle of the forest, plus one or two others on the outskirts. This strategy provides a way to find a cover of 'denser in the middle' cells, even for events that do not satisfy the predicate themselves.

We would thus like to formalize the intuition that a cover of P-events exists *by virtue of* the fact that P holds for the sum. In the nominal domain, it is by virtue of the fact that x is water that it can be divided into small water parts. In the collective predicate domain, it is by virtue of the fact that e is a gathering event that it can be divided into small gathering events. But it is not by virtue of the fact that an event is in the denotation of *number less than ten people* that it can be divided into small events also in this denotation; this trivially follows for a group of people of any size.

In order to spell this out, we take our cue from work on 'missing-link' conditionals. It has been observed that conditional sentences are strange when the truth of the antecedent is irrelevant to the truth of the consequent. The sentence in (21) seems to suggest that what the capital of France is depends in some way on arithmetic facts.

(21) If 2 plus 2 is 4, then Paris is the capital of France.

The 'relevance' inference can be captured in a number of ways (Stalnaker, 1968; Fine, 2012; Krzyzanowska et al, 2017; Douven et al, 2018, *i.a.*). For our present purposes, we will adopt a technically simple modification: we will say that q holds by virtue of p if p implies q and there is at least one accessible world in which q does not hold, as schematized in (22).

(22) $p \Rightarrow q$ iff $p \rightarrow q \wedge \Diamond \neg q$

We can now modify our definition of stratified reference to replace material implication with this revised implicative relation, as in (23).

(23) A predicate P has grounded stratified reference iff
$\forall x[P(x) \Rightarrow \exists X[\bigoplus X = x \wedge \forall y \in X[|y| \leq \varepsilon \wedge P(y)]]]$
'By virtue of the fact that a plurality is in P, there exists a cover of sufficiently small subpluralities that are also in P.'

It follows that predicates like *number less than 10* do not have grounded stratified reference. For any plurality, however large, there exists a cover of small subpluralities of less than ten individuals. There is no world in which the consequent in (23) is false, so the property is not satisfied, as desired.

One theme that emerges here is the idea that natural language is insensitive to accidents. Both of the moves that I have made thus far have made the analysis more resilient to irrelevant edge cases. In §2, the move to stratified reference removed a universal quantifier that was accidentally considering 'tricky' ways of dividing up a plurality. In the present section, we ensured that the reason that a predicate holds of a sum is grounded in the reason it holds of its parts. Both of these theoretical moves, then, are formal ways to encode the idea that the ontology of natural language only cares about the big picture.

4 Measurement predicates in event semantics

4.1 Stratified reference of events

There are alternative ways in which the relevance inference can be spelled out. Notably, in event semantics, events are taken to be small packets of information about the world (e.g., Davidson 1967; Carlson 1984). Events are related to their arguments via thematic role functions; thus if e is an event in which Edith ate lunch, then agent(e) = Edith and runtime(e) might be the interval from 12:00 to 1:00pm. Events, like individuals, have mereological structure. Following Krifka (1989), we assume cumulativity of thematic roles: for any thematic role θ and events e, e', $\theta(e \oplus e') = \theta(e) \oplus \theta(e')$.

Event mereology provide us with a very clear way in which some cases of grounded inference can be spelled out. In particular, an event e certainly holds in virtue of e' if e is a subpart of e'. Here, I show that event mereology provides an alternative strategy to spell out the relevance relation discussed in §3.2.

In §2, we defined stratified reference as a property of individuals, as events have so far played no critical role in our analysis. On the other hand, Champollion (2015) in fact defines stratified reference as a property of events, as in (24).

(24) An event predicate P has stratified reference iff
$\forall e[P(e) \rightarrow \exists E_{\langle v,t\rangle}[\bigoplus E = e \wedge \forall e' \in E[\mu(e') \leq \varepsilon \wedge P(e')]]]$
'For every event in P, there is a cover of sufficiently small subevents that are also in P.'

As it turns out, stratified reference defined in terms of events is strictly stronger than stratified reference in terms of individuals. To relate the two definitions, we employ the following correspondence: for an event predicate P, we define the individual predicate θ_P as $\lambda x.\exists e[P(e) \wedge \text{agent}(e) = x]$.

We would like to show that $\text{SR}_{\text{event}}(P) \rightarrow \text{SR}_{\text{indiv}}(\theta_P)$, but that $\text{SR}_{\text{indiv}}(\theta_P) \nleftarrow \text{SR}_{\text{event}}(P)$. Going the first direction, we assume that P has stratified reference of events. Choose an arbitrary x in θ_P; by definition, this is the agent of some event e in P. By assumption, there is a cover E of e such that $P(e')$ for all e' in E. Let $X = \{\text{agent}(e') : e' \in E\}$, i.e., the set of individuals attained by mapping each cell in E to its agent. By definition, $\theta_P(y)$ holds for all y in X. By cumulativity of thematic roles, $\bigoplus X = x$. Choice of x was arbitrary, so this holds for all x in θ_P. Thus, θ_P has stratified reference of individuals.

To go the other direction, it suffices to observe that there exist events e_1, e_2, and e_3 such that $\text{agent}(e_1) \oplus \text{agent}(e_2) = \text{agent}(e_3)$ but $e_1 \oplus e_2 \neq e_3$. We can make this linguistically plausible with the *numerous*-type predicate *comprise a committee*. Assume that in e_1, Alicia and Mary make up the tenure committee; in e_2, Alicia and Talia make up the colloquium committee; in e_3, Alicia, Mary, and Talia make up the job search committee. The denotation of *comprise a committee* includes e_1, e_2, and e_3. The participants of e_3 are the sum of the participants in e_1 and e_2, but, since each commitee is independent, e_3 is not the sum of e_1 and e_2.

Let us flag an important observation: in the example above, we said that $e_1 \oplus e_2 \neq e_3$ because the fact that *comprise a committee* holds of e_3 is irrelevant to whether it holds of e_1 and e_2. A similar notion of relevance played an important role in our analysis of predicates like *number less than 10*. Below, we will capture this intuition of irrelevance through the denotations that are assigned to measurement predicates within an event semantics.

4.2 The event mereology of measurement predicates

A unifying property of the problematic predicates discussed in this section is the fact that they have to do with measurement. In an event semantics, what logical form should we assign to measurement predicates, like the ones in (25)?

(25) a. The dwarves are seven in number.
b. The children weigh 120 kilograms.

Following the assumption that all verbs introduce an event argument, I will adopt a system in which measurement predicates introduce a particular kind of event; these events relate two thematic arguments: the entity being measured ('stuff(e)'), and its measurement ('$\mu(e)$'). I will thus adopt (26) as the denotations of the sentences in (25). This use of events for stative properties bears similarities to Kim (1976).

(26) a. $\lambda e.\text{number}(e) \wedge \text{stuff}(e) = \bigoplus \text{dwarves} \wedge \mu(e) = 7$
b. $\lambda e.\text{weigh}(e) \wedge \text{stuff}(e) = \bigoplus \text{children} \wedge \mu(e) = 210\text{kg}$

What kind of object are entities like '7' and '210kg'? Following much work on degree semantics, I will assume that these are atomic degrees—points on an ordered scale (Cresswell, 1976; Kennedy, 2007, *i.a.*). As objects on a scale, degrees can be compared to each other. We let $>$ compare two atomic degrees on a measurement scale; i.e., it is standard arithmetic 'greater than.' Note that linguistic items might denote sets of degrees. For example, the adjective *tall* is commonly taken to denote the set of heights greater than some standard degree. This, though, is a property of linguistic denotations, not of degrees themselves. 7 is greater than 6 on the measurement scale, but both 7 and 6 are atomic degrees, so neither is part of the other. $7 > 6$, but it is not the case that $7 \succ 6$.

On the other hand, following Dotlačil and Nouwen (2016), we allow the possibility of degree pluralities. The plurality $7 \oplus 6$ has two atomic parts. Such plural degrees are involved the denotations of cumulative readings of measurement predicates, as in (27). Dotlačil and Nouwen (2016) provide further motivation of degree pluralities to explain the cumulative reading of sentences like, '*The girls were faster than the boys were*.'

(27) a. The two children weigh 25 kgs and 30 kgs.
b. $\lambda e.\text{weigh}(e) \wedge \text{stuff}(e) = \bigoplus \text{children} \wedge \mu(e) = 25\text{kg} \oplus 30\text{kg}$

We can now ask what the denotation is for predicates with non-specific measurements: *be more than ten in number* instead of *be seven in number*. Following standard analyses of measurement (Heim 1985, Kennedy and McNally 2005), I assume that these expressions include existential closure over a degree variable. Translated into our event semantics, we thus get the denotations in (28).

(28) a. $[\![\text{number less than ten}]\!] = \lambda e.\text{number}(e) \wedge \exists n[n < 10 \wedge \mu(e) = n]$
b. $[\![\text{weigh more than 5kg}]\!] = \lambda e.\text{weigh}(e) \wedge \exists n[n > 5\text{kg} \wedge \mu(e) = n]$

These independently motivated decisions give us everything that we need to explain the behavior of measurement predicates with *all*. Recall the puzzle with the predicate *number less than ten*: if this predicate holds of a plurality of individuals, it necessarily holds for each cell in a cover of that plurality. The predicate is nevertheless incompatible with *all*. What we will show now is that the predicate does not have stratified reference of *events*: that is, when we consider the events that witness the fact that the predicate holds for sub-pluralities of participants, the sum of these events does not witness the fact the predicate holds for the whole.

For concreteness, consider two events e_1 and e_2, with the properties in (29). By the definition in (28a), these are in the denotation of *be less than ten in number*.

(29) a. number$(e_1) \wedge \mu(e_1) = 3$
b. number$(e_2) \wedge \mu(e_2) = 4$

By cumulativity of thematic roles, we know that $\mu(e_1 \oplus e_2) = 3 \oplus 4$. But critically, this is as far as we can simplify this expression; notably, if x is a group of three and y is a group of four, we cannot conclude that $x \oplus y$ is a group of seven, since there may be overlap between x and y. Because $<$ in (28) is defined as the comparison of atomic degrees, it is not the case that $3 \oplus 4 < 10$. The event $e_1 \oplus e_2$ thus does not witness *be less than ten in number*.

4.3 Measured thematic arguments

A similar overgeneration problem holds for sentences in which the main verb is not a measurement predicate (e.g. *weigh*), but in which a thematic argument is measured. This is the case both for collective predicates, as in (30), and for telicity, as in (31).

(30) All the kids drank less than a liter of lemonade. ✓distributive *collective

(31) * I ran less than one kilometer for ten minutes

In standard event semantics, all VP modification is modeled as the intersection of event modifiers, so the events witnessing the sentence in (30) are drinking events, and the events witnessing the sentence in (31) are running events (Davidson, 1967). On this assumption, the sentence '*I ran less than one kilometer*' is assigned the LF in (32).

(32) $\lambda e.\text{run}(e) \wedge \text{ag}(e) = \text{me} \wedge \text{extent}(e) < 1\text{km}$

However, it is easy to see that this denotation runs into the same problem that was faced earlier. Let e_1, ..., e_{90} be non-overlapping events in each of which I ran 10 meters. Each of these events is in the set denoted by (32), as is their sum, since the distance ran in each case is less than one kilometer. Thus, a standard theory of event modification via restriction does not get the correct predictions.

On the other hand, restriction of an event predicate is only one way for information to grow in event semantics. Additionally, because events themselves are small packets of information about the world, information can grow by summing events. The contrast can be shown by contrasting instrumental modification with VP conjunction, as shown in (33) and (34). In terms of knowledge about the world, note that the underlined constituents in (33) and (34) have very similar effects: both restrict the set of possible worlds that are compatible with the information provided. On the other hand, the events witnessing the two sentences are rather different: the events witnessing (33) are playing events, but the events witnessing (34) are neither playing events nor singing events: they are each the sum of a playing event with a singing event.

(33) a. Sam played with matches.
b. $\lambda e.\text{ag}(e) = \text{sam} \wedge \text{play}(e) \wedge \text{matches}(\text{instr}(e))$

(34) a. Sam played and sang.
b. $\lambda e.\text{ag}(e) = \text{sam} \wedge \exists e' \exists e''[e = e' \oplus e'' \wedge \text{play}(e') \wedge \text{sing}(e'')]$

In order to remedy the overgeneration of (32), we can thus adopt a semantics in which measured thematic arguments are assigned LFs closer to the one in (34) than to the one in (33). A witness of the predicate *drink less than a liter of lemonade* incorporates a measurement event of the same kind as the ones in (26). Thus, a witness of the predicate in (30) is the mereological sum of an event witnessing the fact that lemonade was drunk, and an event witnessing the fact that it was less than a liter in volume. A witness of the predicate in (31) is the mereological sum of a running event with an event witnessing the fact that it was less than a kilometer in distance.[5]

(35) a. $[\![\text{drink} < \text{1L of lemonade}]\!] = \lambda e.\exists e', e''[e = e' \oplus e'' \wedge \text{th}(e') = \text{stuff}(e'') \wedge \text{drink}(e') \wedge \text{lemonade}(\text{th}(e')) \wedge \text{volume}(e'') \wedge \exists n < \text{1L}[\mu(e'') = n]]$

b. $[\![\text{run less than 1 km}]\!] = \lambda e.\exists e', e''[e = e' \oplus e'' \wedge \text{extent}(e') = \text{stuff}(e'') \wedge \text{run}(e')) \wedge \text{distance}(e'') \wedge \exists n < \text{1km}[\mu(e'') = n]]$

Of importance, the predicates in (35) do not have stratified reference, following the same reasoning as above. We thus correctly predicts the collective reading to be incompatible with *all*.

4.4 Comparison to other analyses

Zucchi and White (2001) and Champollion et al (2017) provide alternative analyses to the puzzle posed measurement predicates, primarily focusing on the domain of telicity, as exemplified by the contrast in (36).

(36) a. John ate apples for an hour.

b. * John ate some number of apples for an hour.

c. * John ate less than ten apples for an hour.

Zucchi and White (2001) explore two possible analyses. On the first analysis, indefinite NPs like *some number of apples* in (36b) introduce a free variable; the resulting interpretation is analogous to one in which the NP takes high scope and the sentence is predicted to act similarly to a sentence with an exact measurement (e.g. *John ate that number of apples*), thus yielding ungrammaticality with *for*. For examples that don't involve indefinites, like (36c), Zucchi and White (2001) observe that the meaning of *less than ten apples* must include a statement of maximality: there is an event of John eating less than ten apples, and, critically, this plurality of apples is the largest plurality of apples eaten by John in the contextually-provided reference time. Zucchi and White (2001) propose that subintervals are evaluated with respect to *the same contextually-provided reference time*; the predicate will no longer come out true for these subintervals, because the apples eaten in a given subinterval are no longer the maximum plurality of apples eaten in the reference time as a whole.

Champollion et al (2017) posit that the difference in behavior between (36a) and (36b-c) arises from a difference in the dynamic contribution of the noun phrase. The theory is built within a

[5]Compositionally, adding an argument in subject position will indicate that the agent of e is that argument. Since, by stipulation, measurement events do not have agents, cumulativity of thematic roles guarantees that it is the agent of the drinking/running subevent e'.

dynamic semantics with plural information states (van den Berg 1996, *i.a.*); the authors posit that 'specified noun phrases' (i.e., those that introduce measured thematic arguments) pair dynamic introduction with a filter that ensures that the value of the variable is constant across the assignment functions in an information state. The preposition *for* puts the subintervals of the event runtime in correspondence with the values of the variable introduced by the noun phrase. When the variable is required to be constant, this yields the absurd truth conditions for (36b-c) that the same apples were eaten in each subinterval of the event. A similar story is told for collective predicates by assigning *all* a semantics parallel to *for*. The sentence, '*all the boys ate less than ten apples*,' is ungrammatical on the collective reading because it would entail that multiple distinct subpluralities of boys ate the same apples.

There are a number of challenges to these analyses when we try to translate them to collective predication. For example, if attempting to extend Zucchi and White (2001)'s maximality analysis to collective predication, there is no obvious contender to play the role of reference time. Turning to Champollion et al (2017), the proposal predicts the availability of an additional reading that is not clearly attested. In particular, world knowledge about eating events makes it impossible for a single thing to be eaten twice, but when a verb is used that does not have this property, a 'specific' reading is predicted for the sentence. For example, (37) is predicted to have a reading on which every dog found the same collection of less than five bones. It is not clear to me that such a reading exists.[6]

(37) All the dogs found less than five bones.

Most significantly, what is shared between both alternative analyses is that they relate the pattern of ungrammaticality to the interpretation of noun phrases, whether it be due to their dynamic potential or their maximality. However, we have seen that analogous results hold for plain measurement predicates that do not have a noun phrase in a relevant argument position, such as *weigh less than 100 kgs*, *be fewer than 50 in number*, and *be denser in the middle*. Neither alternative analysis has a clear extension to these predicates.

5 Collective predicates, *aksionsart*, and *same*

5.1 *Aksionsart* and collective predication

Taub (1989) observes that accomplishment predicates (i.e. those denoting an process that results in a change of state), are often exceptionally grammatical with *all*, regardless of whether they have stratified reference or not.

The puzzle is exemplified by (38), which is reported to have a collective reading in which all the boys collaborated on a single raft-building event. What is of relevance here is that it's not possible to divide the set of boys into small subsets that each built a raft; the emergence of a raft

[6]Here, looking at collectivity instead of telicity may be helpful, since it is possible that a distinct operation of aspectual coercion may make a similar reading available in sentences with *for*, confounding the judgments in that domain.

depends on the contributions of each member involved in its construction. It therefore apparently does not have stratified reference, so the analysis, as it stands, gets the wrong prediction.

(38) All the kids built a raft. ✓distributive ✓collective

Taub's generalization is that there is a systematic difference based on the *aksionsart* of the predicate in question: according to her, activities and accomplishments admit *all*, while states and achievements do not. The most compelling evidence for this generalization are minimal pairs like the one in (39). Here, the verb *form* is ambiguous between a stative meaning and an accomplishment. Only the accomplishment meaning is available with *all*.

(39) a. * All the dots form a circle. (based on Krifka p.c. via Brisson 2003)
b. All the kids formed a big group.

This generalization seems to be accurate—but only to a point. Namely, as we have already seen, states can appear in both *gather* and *numerous* classes. Among the clearly stative *gather*-type predicates, for example, we have seen *be similar* and *be compatible*. The *consistent*/*inconsistent* contrast provides particularly clear evidence against this generalization, since the two predicates differ only in the presence of a single morpheme. A more accurate generalization, then, is that, whatever property determines the category of collective predicates in general (e.g., stratified reference), something special happens with accomplishments that allows them to appear grammatically with *all*.

In support of this perspective, Kuhn (2019) reports a somewhat more nuanced empirical picture, based on judgments of such sentences on a 7-point scale. As expected, with definite plurals, accomplishments are perfectly fine with collective interpretations, and with the quantifier *each*, they are completely incompatible with collective interpretations. Collective interpretations of accomplishments with *all*, however, are neither as good as *all* with *gather*-type predicates, nor as bad as *all* with *numerous*-type predicates. (These differences are statistically significant.) These results are not due to dialects of speakers: survey respondents showed no evidence of a bimodal distribution. Thus, accomplishments like *build a raft* occupy a distinct third category, receiving middling judgments for the collective reading with *all*. The results also show that there is some variation at the level of the particular predicate chosen. On the one hand, the eight *gather*-type predicates patterned almost identically, with uniformly good ratings across the board. On the other hand, the set of eight *numerous*-type predicates and the set of eight accomplishment predicates both showed a wider range of variation, with a heavy overlap between the two classes of predicates. All together, these results suggest a situation in which accomplishments like *build a raft* are indeed part of the *numerous*-type class, but that there is a mechanism to rescue *numerous*-type predicates with *all* that is particularly easily available for accomplishments.

5.2 *Same*: another window into mereological structure of collective predicates

If indeed *gather* and *numerous* differ in their mereological structure, we may expect evidence of this to be found elsewhere besides just with plural quantifiers like *all*. Here, I argue that this is

indeed the case; I show that the adjective *same*, which is licensed by the existence of a plurality of events (Carlson 1987; Barker 2007; Hardt et al 2012; Hardt and Mikkelsen 2015), differs in its behavior with *gather*- and *numerous*-class collective predicates. This falls out immediately from the analysis proposed here.

The basic observation, dating back to Carlson (1987), is that *same* requires the existence of two distinct events to compare. A convincing example with an 'external' use of *same* (i.e., getting its antecedent from a separate sentence), comes from Hardt et al (2012); they observe that *same* is not grammatical in (40b), in which both sentences describe a single reading event.

(40) a. I read *War and Peace*, and I read it in a single sitting.
b. * I read *War and Peace*, and I read the same book in a single sitting.
(from Hardt et al 2012)

Barker (2007) makes a similar point for sentences with 'internal' readings of *same*. He observes that (41) only admits the reading in which John's buying and Mary's selling are not part of the same exchange.

(41) John bought and Mary sold the same book. (from Barker 2007)
a. ✓'There were two events; one in which John bought the book and one in which Mary sold it.'
b. * 'There was one event in which Mary sold John a book.'

Thus, *same* compares events, and must be licensed by the existence of a plurality of distinct events.

Given this as background, we make the interesting new observation that *same* is sometimes grammatical with collective predicates, as in (42).

(42) The students gathered around the same table.

Under an analysis in which *gather*-type predicates are treated as properties of (impure) atomic individuals (e.g. Champollion 2010), it is mysterious why these predicates license *same*, since then there is only a single event involved in the meaning of (42). On the other hand, given the analysis that we have developed here for *gather* and *numerous* predicates, this follows immediately, since any *gather* event can be divided into a plurality of subevents that can be compared by *same*. On the other hand, *numerous* events are defined by the fact that they *cannot* be divided into small subevents. The analysis therefore predicts that *same* should only be grammatical with *gather*-type predicates. As seen in (43) and (44), this prediction is borne out.

(43) *Gather*-type predicates are grammatical with *same*
a. Jose, Ellen, Brigitta, and Francis gathered in the same room.
b. The four of them collaborated on the same project.
c. These seven puzzle pieces can fit together at the same time.
d. One hundred children held hands in the same circle.

(44) *Numerous*-type predicates are ungrammatical with *same*

a. * Jose, Ellen, Brigitta, and Francis elected the same president.
b. * Those twelve jurors returned the same verdict.
c. * The trees surround the same lake.
d. * The six departmental representatives make up the same committee.

What is particularly striking about the examples in (44) is that the ungrammaticality has exactly the same flavor as the ungrammaticality of *numerous*-type predicates with *all*: there is a desire to interpret the sentence with atomic distributivity, even if, as in the case of (44c), this yields a bizarre interpretation. The compatibility of a collective predicate with *same* can thus serve as another window into the mereological properties of the predicate.

Returning to collective accomplishments, we observe that, unlike canonical *gather*-type predicates, collective readings of accomplishments like *build a raft* are ungrammatical with *same*. In contrast with the examples in (43), the sentences in (45) and (46) do not allow a collective reading. The sentences in (45) are admissible only under the distributive interpretation that each boy built his own raft. (In (45a), they must be the same *kind* of raft). These new facts lend credence to the claim that accomplishment predicates like *build a raft* do not in fact belong to the *gather*-class, despite their grammaticality with *all*.

(45) a. (All) the kids built the same raft. ✓dist *coll
b. (All) the kids built a raft at the same time. ✓dist *coll
c. (All) the kids built a raft in the same room. ✓dist *coll

(46) * The kids formed the same group.

It is beyond the scope of this paper to offer an analysis of the exceptionality of accomplishment verbs with *all*, but a likely possibility is the presence of ambiguity—either lexical ambiguity of *all* or structural ambiguity of quantified plural DPs (see, e.g., Buccola 2015). A second form of *all*, independent from the one discussed here, is sensitive to the predicate's *aksionsart*. (See, for example, Mari 2014's aspect-sensitive analysis of reciprocals.) Ambiguity of the DP is consistent with the behavior of the adjective *same*; since *same* has an entirely different syntax from the quantifier *all*, it is predicted not to be subject to the same ambiguity as *all*. *Same* thus removes the *aksionsart* confound: the logical distinction that hold for states with *all* holds for both states and accomplishments for *same*.

6 The broader view

6.1 A typology of collective predication

Let us now zoom back, to characterize of the space of verbal meanings from the present perspective. First, we provide a precise definition of collectivity. Intuitively, a collective interpretation is one in which a non-atomic plurality is interpreted as acting as an atom. Following Krifka (1989), atomicity is defined with respect to a predicate. An individual x in P is a P-atom if no proper parts of x are also in P.

(47) x is a P-atom iff $P(x) \wedge \neg\exists y[y < x \wedge P(y)]$

Under this definition of atomicity, we will say that a plural individual is interpreted collectively if it contains a subplurality that is non-atomic with respect its restrictor noun but which is atomic with respect to the predicate in its scope. For example, if two boxes collectively weigh 150 kgs, then the sum of the two boxes is not a *box*-atom, but it is a *weigh-150-kg*-atom, since no proper parts weigh 150 kgs. In an event semantics, we will say that an event is collective if it contains an atomic subevent that has a plurality as a thematic argument.

On this definition of collectivity, observe that cumulative readings of predicates are not collective. Consider for example sentence (48), which can be true in a situation in which each professor nominated one student. In this situation, there are three minimal nominating subevents; each of these atomic events has an atomic agent and an atomic theme. Thus, the event as a whole has a plural agent and theme, but is not collective.

(48) These three professors nominated those three students.

Numerous-type predicates, on the other hand, very clearly give rise to collective readings. As we saw earlier, sentence (49) has a reading on which the boxes all together weigh 100kgs. If we remove any one box, the predicate no longer holds, so the events in the denotation of *weigh 100kgs* are thus all atomic; the events in the denotation of the sentence are thus collective, since their thematic argument is nonatomic.

(49) The boxes weigh 100kgs.

Turning to *gather*-type predicates, the situation is slightly more complicated, since I have argued that these predicates have stratified reference. This means that many events in the denotation of the predicate are not themselves atomic – they can be decomposed. Under the characterization here, though, they are nevertheless collective, because they contain atomic events with a plurality as a thematic argument. In particular, any two-participant event in the denotation of *meet* will be atomic, since there is no proper subpart that is also a meeting event.

(50) The students met.

Interestingly, there are close parallels between *gather*-type collective predicates and distributive predicates like *smile*. In particular, distributive verbal predicates like *smile* are commonly assumed to be pluralized. The meaning of smile in (51a) is closed under sum formation, consisting of all singular or plural events in which one or multiple people smiled. Pluralization of verbal meanings also provides an immediate analysis for cumulative readings. In (48), the sum of three events in which a professor nominated a student is also a nominating event; assuming cumulativity of thematic roles (Krifka, 1989), the agent of this event is the sum of the professors and the theme of the event is the sum of the students. Where does this pluralization come from? On some theories, it is an actual syntactic operator (the star operator) that applies to verbal meanings (Sternefeld, 1998; Beck and Sauerland, 2000). On other theories, there is a meaning postulate on lexical predicates that they are inherently pluralized (Krifka, 1992; Kratzer, 2008). On this assumption, the star before 'smile' in the denotation in (51b) is just a mnemonic to remind us that the meaning of *smile* is pluralized.

(51) a. The students smiled.
b. $\lambda e.{}^{*}\text{smile}(e) \wedge \text{ag}(e) = \bigoplus \text{student}$

The result of this pluralization is that distributive verbal predicates will always have stratified reference. For any event in which a plurality of individuals smiled, there will be a cover of small subevents in which atomic individuals smiled. In this respect, there is no difference between *gather* and *smile*: both allow distribution down to small parts. Empirically, of course, this is what we want in order to capture the behavior of plural quantification: *all* is grammatical with either kind of predicate.

(52) a. All the students smiled
b. All the students gathered.

There is a critical difference, however, between the atoms of *gather*-type collective predicates and those of distributive verbal predicates like *smile*. The atomic events in the denotation of *smile* have an atomic agent. The atomic events in the denotation of *gather* or *meet*, as we have seen, have a plural agent. This has logical repercussions. Notably, the number of atomic smiling events will be equivalent to the number of individuals involved a smiling event, but the number of atomic meeting events will be far greater than the number of individuals involved in a meeting event, as two atomic meeting events may have overlapping agents. (A meeting event with n kids has $n!$ atomic subevents.)

In this respect, the difference between *gather*-type collective predicates and distributive verbal predicates is directly akin to the difference between mass nouns and plural count nouns. Both classes of nouns, of course, have stratified reference, which can be seen in the fact that they pattern together with respect to certain grammatical constructions (to the exclusion of singular count nouns). Pseudopartitives, for example, are fine with either: '*three pounds of rice*' or '*three pounds of apples*.' But other grammatical constructions distinguish the two, due the fact that plural count nouns have identifiable atoms, whereas mass nouns either do not have atoms, or have vague or overlapping atoms (Chierchia, 2010). One cannot, for example, count a mass noun (**three furniture*).

In a parallel manner, the logical difference between *gather*-type predicates and distributive predicates in the verbal domain turns out to generate empirical differences. In particular, we saw above that distributive predicates seem be pluralized at the verbal level (either lexically or by an operator). This means that if a predicate holds of x and holds of y, then it also holds for the sum of x and y, as seen in (53). In contrast, *gather*-type predicates do not have this property. If the boys agree and the girls agree, this does not entail that the children agree, as seen in (54). This seems to be a general property of *gather*-type predicates. In some cases, the precise lexical semantics obscure the facts[7], but the point can be seen clearly for a number of predicates, including *agree*, *be similar* and *be compatible*.

(53) The boys smiled.
<u>The girls smiled.</u>
$\rightarrow$ The children smiled.

[7]It is unclear whether '*The students gathered*' is true if they formed ten separate groups.

(54) The boys agreed.
The girls agreed.
$\not\rightarrow$ The children agreed.

These facts can be explained by the difference between smiling atoms and agreeing atoms. In the nominal domain, pluralization requires countable, non-overlapping atoms. In the verbal domain, exactly the same conditions hold. Pluralization of verbal event predicates only occurs when there countable, non-overlapping atoms. This is the case for distributive predicates like *smile* but not for *gather*-type collective predicates.

6.2 The landscape of mereology-sensitive items

The above discussion brings out the fact that the *gather*/*numerous* distinction is not a monolithic categorical distinction, but rather, the reflection of just one of several mereological properties. In taking this perspective, we converge with a large body of recent work that shows that count/mass and telic/atelic are similarly heterogenous semantic categories, with subcategories that act in distinct ways. On this view, the grammar is sensitive to a number of mereological properties, but each may be tracked by a distinct set linguistic phenomena.

In English, for example, 'fake mass' nouns like *furniture* pattern like canonical mass nouns with respect to quantifiers (e.g. *too much furniture*), but pattern with canonical count nouns with respect to stubbornly distributive adjectives (e.g. *small furniture*, *small apple(s)* vs. **small mud*) and quantity judgements (Barner and Snedeker, 2005). According to Deal (2017), this is because counting quantifiers and stubbornly distributive adjectives track related but distinct logical properties.[8](Note, for instance, that *furniture*-atoms are salient and perceivable but *mud*-atoms, if they even exist, are not.) Grimm (2012) shows that the situation is even more striking in Welsh, which has canonical count and mass nouns like *cadair*, 'chair,' and *llefrith*, 'milk,' but which also has a third morphological category in which the morphologically unmarked form picks out an aggregate individual (e.g., *chwynn*, 'weeds'), and a morphologically complex form picks out one unit in this aggregate (*chwynn-yn*, 'weed'). Grimm (2012) accounts for these categories using topological notions regarding the spatial connectedness between individuals. The Welsh unitizing suffix *-en/-yn* is restricted to those nominal predicates that denote spatially clustered individuals with parts that are 'maximally strongly self-connected,' the equivalent of atomicity in Grimm's system.

Henderson (2017) shows that similar topological concepts can distinguish between different types of English collective nouns. Specifically, both *committee* and *swarm* are count nouns that are associated with a plurality of individuals; they differ, however, in that *swarm* nouns entails that a large cardinality of individuals occupy a particular area of space. Henderson (2017) then shows that this characterization of *swarm* nouns carries over to the verbal domain in cases of event-internal pluractionality (Cusic, 1981; Wood, 2007). In Kaqchikel Mayan, for example, the suffix *-Ca'* indicates that a large plurality of events occur in rapid succession. On the analysis in Henderson (2017), *swarm* nouns and event-internal pluractionals are both atomic entities, whose spatial or temporal trace can be divided into small parts, each of which contains an individual or event of some kind.

[8]Deal (2017) proposes that fake mass nouns have cumulativity but not divisibility.

From the present point of view, there is a strong similarity between *swarm* nouns, event-internal pluractionals, and *numerous*-type collective predicates. For each phenomenon, an event or individual is related to a plurality of individuals or times, but these events do not end up having stratified reference. In each case, the lack of stratified reference arises from a similar source: an inference of multitudinousness, spatial/temporal arrangement, and/or a shared goal. As we have seen, it is impossible to divide a *numerous* event into small parts, each of which is still a *numerous* event. Analogously, it is not possible to divide a swarm into small parts, each of which is a swarm: both the multiplicity inference and the density/proximity inference require the full set of individuals. Event-internal pluractionals also often have the inference of a shared goal or result (Wood, 2007); for example, in Syrian Arabic, the event internal pluractional *kassar*, 'to break to pieces,' generates the inference that a plurality of breaking events yields a single result state (Cowell, 1964). This result state is not attained by any proper subplurality of breaking events.[9]

6.3 Why stratified reference?

When we the consider a given logical property to be relevant with respect to a particular linguistic construction, we can then ask the question: why is the particular construction sensitive to the particular property? In the case at hand, why are plural quantifiers sensitive to stratified reference?

I'd like to suggest that stratified reference is a presupposition that exists to avoid triviality in quantification structures. Brisson (2003) posits that plural quantifiers like *all* quantify over the cells of a cover of the plural noun; thus, *all the dogs* means roughly 'each relevant subset of the dogs,' where subsets must be small and can be atomic. The sentences in (55) and (56) provide two new pieces of data to support this claim. In (55), we observe that (55a) can be true in a scenario in which there are two opposing opinions (*Harry Potter* vs. *The Hunger Games*), but (55b) requires a larger number of opinions (perhaps even down to pairwise disagreement). Thus, *all* has a maximizing effect not only on *which students* are involved in the disagreement, but also on *which subsets* of students are in disagreement.

(55) a. The students disagreed about what book to read.
b. All the students disagreed about what book to read.

Relatedly, in (56), we observe that the sentence can be true in a scenario in which the total set of students who hung out with someone is the same in both weeks, just with different groupings. In order to get these truth conditions, *none* must be able to quantify over subsets of students.

(56) None of the students who hung out last week hung out this week.

As is hopefully apparent from the formulation of stratified reference in this paper, there is a deep connection between quantification over covers and stratified reference. Namely, stratified

[9]Henderson (2017), following Link (1983) and Chierchia (1998), assumes an ontology with atoms; thus, the atomicity of event-internal pluractionals must be written explicitly into their semantics. The present perspective, by defining atomicity with respect to a predicate (Krifka, 1989), opens the possibility that the relevant properties of these pluractional morphemes may be derived as a by product of other aspects of their meaning (e.g. multiplicity, shared goal).

reference guarantees the existence of a possible cover to quantify over. For *numerous*-type predicates, which involve an emergent property of the whole, there are events for which a sentence quantifying over a cover will be guaranteed to be false. The presupposition of stratified reference is therefore a grammaticalized way to avoid trivial falsity. This connection between ungrammaticality and triviality has been explored further with the notion of L-analyticity and G-triviality in Gajewski (2002) and Chierchia (2013).

7 Summary

This paper began with the insight that *gather*-type collective predicates show a formal congruence to mass nouns and atelic predicates; we thus explored an analysis in terms of the classic notion of divisiveness, as proposed for the other two domains. Although at a first pass, divisiveness was a surprisingly good definitional property for *gather*-type predicates, we observed that it was too strong in one way, and too weak in another. In Section 2, I addressed a problem of undergeneration (the 'tricky-parts problem'); I changed a universal to an existential, and moved from divisiveness to the weaker property of stratified reference. In Section 3, I addressed an overgeneration problem involving measurement; in order to rule out the pathological measurement predicates, I argued that the fact that a predicate holds of the subparts of a plurality must be grounded in the fact that it holds of the whole plurality. One implementation of this was spelled out using event semantics.

As indicated in the introduction, there are two general goals of this paper: the first consists of the technical solutions to various puzzles, including both the extension of stratified reference from Champollion (2015), and the novel use of the mereology of event semantics. The second goal has been to make a more general and theory-neutral point: whatever distinguishes *gather*-type predicates from *numerous*-type predicates, it is exactly the same property that distinguishes mass from count and atelic from telic. What I hope to have brought out throughout the paper is the observation that the puzzles that we face when distinguishing categories of collective predicates—regardless of whether one adopts the analysis here in whole or in part—are exactly those puzzles that we face when distinguishing mass from count and atelic from telic. Specifically, we saw direct analogues across several domains of (a) the minimal parts problem, (b) the tricky parts problem, and (c) the measurement problem. I thus take it as a desideratum of any theory of collective predicates to give an analysis that explains the parallels to these other domains. Drawing on existing work on mass/count and telicity, that is exactly what I have done here.

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