Swarms: Spatiotemporal Grouping Across Domains*

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Abstract

This paper presents cross-domain evidence that natural language makes use of two types of group entities that differ in terms of how they cohere. The first kind of groups, which I call *swarms*, are defined in terms of the spatial and temporal configuration of their members. The second, which are the canonical group entities, are defined in terms of non-spatiotemporal notions. To motivate this distinction, I present systematic differences in how these two types of group entities behave linguistically, both in the individual and event domains. These differences support two primary results. First, they are used as tests to isolate a new class of group nouns that denote swarm individuals, both in English, as well as other languages like Romanian. I then consider a crosslinguistically common type of pluractionality, called *event-internal* in the previous literature (Cusic 1981; Wood 2007), and show that its properties are best explained if the relevant verbs denote swarm events. By reducing event-internal pluractionality to a type of group reference also available for nouns, this work generates a new strong argument that pluractionality involves the same varieties of plural reference in the event domain that are seen in the individual domain.

Keywords: groups, pluractionality, plurality, cross-domain parallels

1 Introduction

Two assumptions run through much modern work on the formal semantics of verbs: (i) verbs are predicates of events, just like nouns are predicates of individuals, and (ii) the domain of events has a similar lattice structure as the domain of individuals (Krifka 1989, 1992; Landman 2000; Lasersohn 1995; Link 1998; Rothstein 2004, among many others).[1] The formal similarity means that, in principle, the same kinds of denotations should be available for both nouns and verbs, as well as nominal and verbal modifiers. There is support

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[1] We cannot say the same lattice structure because there is some disagreement in the literature about the existence of atomic events and whether the event lattice should be complemented.

for this position, for instance, in the long strand of classic work on telicity and its formal similarity to the count/mass distinction (e.g., Bach 1981, 1986; Krifka 1989, 1992; Mourelatos 1978; Taylor 1977). What is still an open question, though, is how far these parallels go. Is it the case that there is a one-to-one mapping in natural language between subclasses of nouns and subclasses of verbs with similar denotations and attendant properties? While comprehensively addressing this question is clearly beyond the scope of this work, my more modest goal in this article is to show that taking a cross-categorial perspective on plural reference lets us draw new connections between a variety of under-studied constructions across multiple unrelated languages. In particular, this paper provides a unified analysis of a newly proposed class of group nouns, which I call *swarm*[2] nouns, and a typologically common class of pluractional verbs, called *event-internal* in the previous literature (Cusic 1981; Wood 2007). Not only are there deep denotational similarities between swarm reference and event-internal pluractionality, but there are swarm nouns in Romanian and Tzotzil (Mayan) which stand in the same derivational relationship to an underlying noun stem that pluractionals do to an underlying verb stem. The result is novel evidence for rich noun/verb denotational and compositional parallels, as well as insights into the semantics of pluractionality, which has been much less well studied than nominal plurality.

Before digging into the data, let's first consider in brief the phenomena that motivate the analysis. The nominals in (1) are classically known as collectives (Jespersen 1924/1992), but have come to be called *group nouns* (Barker 1992; Landman 1989a,b; Link 1983/2002). What sets them apart from standard count nouns is that, while they are morphologically singular, they behave in many ways as if they were plural.

(1) GROUP NOUNS

a. committee

b. team

c. squad

d. group

The central question that group nouns raise is how an expression can lead a double life, manifesting properties of both singular and plural reference. One of the primary empirical results of this work is that there is more than one way to do so. The evidence comes from a second class of nominals, illustrated in (2), which I call *swarm* nouns. Like group nouns, swarm nouns share properties with both singular and plural count nouns. (For this reason, when I need to refer to both group and swarm nouns together, I will use Jespersen's term, *collective noun*, as a macro-category). More importantly, I show that swarm nouns behave differently than canonical group nouns on a subset of the standard diagnostics, which motivates their assignment to a new, distinct semantic class.

(2) SWARM NOUNS

a. grove

b. bouquet

[2] I want to thank Jon Brennan, Ezra Keshet, Lisa Levinson, and Rich Thomason for suggesting this term.

c. horde

d. swarm

At an intuitive level, the core difference between groups and swarms—the kinds of individuals that fall in the extensions of (1) and (2), respectively—concerns the relationship that allows a plurality to cohere as a single individual. I will argue, for instance, that a *committee* is an individual that is related to a plurality via the notion of membership, while a *grove* is an individual that is related to a plurality via spatiotemporal superposition. That is, a grove is a grove because its constituent trees stand in a particular spatial configuration at a particular time. If the trees are moved, the grove ceases to exist. This is not just the case for a committee and its members; the noun *committee* places no conditions on the spatial or temporal relationships that hold between the members of committees in its extension. Once we formalize these notions of membership and spatiotemporal superposition, an account of the differences between group nouns and swarm nouns quickly follows.

The second major result of this work follows from the account of swarm nouns and links back to the larger questions I raised above concerning noun/verb denotational parallels. Many languages, especially those of Africa and the Americas, have morphologically derived pluractional verbs (see Cusic 1981; Wood 2007 for typological overviews). While various phenomena have been discussed under the heading of *pluractionality*, I use this term to refer to morphology that derives verbs that cannot be satisfied in single-event scenarios. If we assume that verbs are simple predicates of events, then at first glance, pluractional morphology looks similar to plural derivation in the nominal domain. It would derive verbal predicates with plural reference in the domain of events. What I will argue is that a crosslinguistically common type of pluractional, first called *event-internal* by Cusic (1981), derives verbal predicates with the same kind of plural reference as swarm nouns.

The following attested near-minimal pairs from the Mayan language Kaqchikel illustrate the phenomenon.[3] The verb *chuq'* means to wound or pierce with a sharp object. It can be used in a simple transitive clause like (3a) to describe a graceful slaughter in which the knife pierces the cow's neck only once. Crucially, example (3b), which bears the event-internal pluractional *–Ca'*, cannot faithfully describe a scenario like this. Instead, it requires multiple piercings in rapid succession. Speakers, asked to describe appropriate scenarios for (3b), imagine a butcher furiously hacking at the cow's neck, trying to remove its head, but making slow progress. While there are a variety of tests to determine whether a pluractional verb is event-internal (see §3), the core idea is that such verbs describe repetitions that take place within what is conceived of as a single event.

[3] Kaqchikel is one of about thirty extant Mayan languages spoken throughout Mesoamerica. Kaqchikel is a K'ichean language belonging to the Eastern Branch of the Mayan language family. In particular, Kaqchikel is spoken in the western highlands of Guatemala, north and west of Lago Atitlán, by over 500,000 people (Richards 2003).

(3) Event-internal Pluractional –Ca'

a. *Ri ajch'olöy wakx, n-Ø-u-chuq'-ij ru-qül ri wakx r-ichin*
The butcher cow ICP-A3s-E3s-pierce-SS E3s-neck the cow E3s-reason
ni-Ø-käm.
ICP-A3s-die
'The cow-butcher pierces the cow's neck to kill it.'(Cutzal Chacach et al. 1999: p.58)

b. *Ri ajch'olonel n-Ø-u-chuq'-**cha'** ru-qül ri mama' wakx.*
the butcher ICP-A3s-E3s-pierce-**Ca'** E3s-neck the big cow
'The butcher keeps stabbing at the big cow's neck.' (Cutzal Chacach et al. 1999: p.58)

There is still a lot of work to do to determine the truth conditions of the pluractional in (3b), work that I will do subsequently, but it should be clear from this rough comparison that the pluractional requires a plurality of events that would satisfy the underlying predicate. Moreover, this plurality must be of relatively large cardinality, and each member must take place within a circumscribed spatial and temporal location. After arguing that these properties are among the core features of event-internal pluractionals crosslinguistically, I will show that they are accounted for if *chuq'ucha'* in (3b), as well as event-internal pluractional verbs more generally, are given denotations that make them the eventive equivalent of swarm nouns.

2 Groups vs Swarms in the Nominal Domain

We start by noting that collective nouns are a subset of count nouns. That is, they participate in the singular / plural contrast. Swarm nouns pattern with group nouns in this way. We have *committee*/*committees* and *team*/*teams*, as well as *grove*/*groves* and *bouquet*/*bouquets*. This observation leads us to our first test, from Barker 1992, who classifies collective nouns as those that can take a bare plural *of*-complement, but not a singular one. The intuition behind the test is that *of*-complements specify what constitutes the head noun. For collective nouns, like (4-5), the head noun denotes individuals that must be constituted by a plurality, not mass or kind entities. This is not generally the case for singular count nouns, as (6) shows.

(4) a. a grove of trees
b. *a grove of tree
c. a horde of barbarians (swarm)
d. *a horde of barbarian
e. a bouquet of flowers
f. *a bouquet of flower

(5) a. a team of players
b. *a team of player
c. an army of children (GROUP)
d. *an army of child
e. a committee of scholars
f. *a committee of scholar

(6) a. *a piece of cookies
b. a piece of cookie
c. *a table of woods (SG)
d. a table of wood
e. a slice of pizza
f. *a slice of pizzas

While this first test clearly classifies group nouns and swarm nouns together, they begin to pull apart on tests which show that singular collective nouns have properties associated with plural reference. The conclusion we come to is that swarms are constituted by a plural individual, but that plurality is not as accessible to the grammar as it is for groups.

If collective nouns denote individuals that are constituted by a plurality, we might expect for them to be felicitous arguments of collective predicates, which require plural arguments. This appears to be the case. With collective predicates like *encircle*, *surround*, and *gather*, both group and swarm nouns pattern with plural count nouns, but contrast with vanilla singular count nouns.

(7) a. The students encircled a camp fire. (PL)
b. The committee encircled the boardroom table. (GROUP)
c. The grove encircled a small spring. (SWARM)
d. *The student encircled a camp fire. (SG)

(8) a. The soldiers gathered in the valley. (PL)
b. The platoon gathered in the valley. (GROUP)
c. The horde gathered in the valley. (SWARM)
d. *The soldier gathered in the valley. (SG)

(9) a. Mary separated the roses. (PL)

b. The coach separated the team (because they were fighting). (GROUP)

c. Mary separated the bouquet. (SWARM)

d. *Mary separated the rose. (SG)

While this is what we expect given our first test, there is something special about these collective predicates. They all involve spatial notions. *Encircle* requires the object to stand inside some spatial extent defined by the subject. Similarly, *gather* requires a plurality of individuals to be closer together at the end of an event than at the start of it, while *separate* requires the opposite. When we move to collective predicates that do not piggyback on notions of spatial arrangement, group nouns and swarm nouns begin to separate. In particular, swarm nouns pattern with singulars in being ungrammatical with the collective predicates in (10-11), as well as with the collectivizing adverbials in (12).

(10) a. Those trees look alike. (PL)

b. That family looks alike. (GROUP)

c. *That grove looks alike. (SWARM)

d. *That tree looks alike. (SG)

(11) a. Those players dress similarly.[4] (PL)

b. That team dresses similarly. (GROUP)

c. *That horde dresses similarly. (SWARM)

d. *John dresses similarly. (SG)

(12) a. Those flowers looks good together. (PL)

b. That family looks good together. (GROUP)

c. *That bouquet looks good together. (SWARM)

d. *That flower looks good together. (SG)

The correct generalization is that swarm nouns are only grammatical with collective predicates that care about the spatial arrangement of its (plural) argument. This fits well with our intuition that swarms are defined in terms of their spatiotemporal extent. Other collective predicates, which might need to access the individual members of a swarm, appear to be unable to do so.

This conclusion is strengthed by the next contrast, which is based on an observation by Brasoveanu & Henderson (2009). They notice that distributors like *one by one* are able to target plural count nouns and singular group nouns alike, to the exlusion of singular count nouns.

[4] In the following examples I am only interested in the so-called internal reading. That is, the reading where the players dress similarly to a second, anaphorically retrieved individual is not at issue.

(13) a. The students voted one by one. (PL)

b. The committee voted one by one. (GROUP)

c. *George voted one by one. (SG)

(14) a. The students walked onto the field one by one. (PL)

b. The team walked onto the field one by one. (GROUP)

c. *George walked onto the field one by one. (SG)

If the individuals that make up a swarm are more difficult to access, then we expect for *one by one* to be unable to target swarm nouns for distribution. This is borne out, as example (15) shows.

(15) a. *I chopped down the grove one by one.

b. *The horde ascended the mountain one by one. (SWARM)

c. *Mary smelled the bouquet one by one.

The next test is based on a class of predicates, called *stubbornly distributive* by Schwarzschild (2011), which can only be predicated of atomic individuals. If collective nouns were like other count nouns, only their atomic elements should should fall in the extension of these predicates. Instead, we find a split between group nouns and swarm nouns. First, groups cannot be in the extension of a stubbornly distributive predicate, only the individuals that constitute a group. They are thus transparent to stubbon distributivity, like pluralities.

(16) Suppose that the players on a team are standing around in a circle.

a. #The players are circular. (PL)

b. #The team is circular. (GROUP)

(17) Suppose that the soldiers in an platoon are standing in middle of a hotel lobby and you have to walk quite a ways to get around them.

a. #Wow, these soldiers are wide! (PL)

b. #Wow, this platoon is wide! (GROUP)

Example (16) shows, for instance, that *circular* cannot be predicated of the group denoted by *the team*. Instead, it must distribute down to the team members, which cannot naturally be circular, accounting for its infelicity. In this way, the group noun behaves like a canonical plural count noun. Crucially, swarm nouns behave differently with respect to stubbornly distributive predicates. They can be predicated of a swarm without distributing down to its members.

(18) Suppose a large number of pine trees are standing close together in a circle.

a. That pine grove is circular. (SWARM)

(19) Imagine you are walking around pine grove and it is taking quite awhile to get around.

a. Wow, this pine grove is wide. (SWARM)

Examples (18) and (19) illustrate that assessing the properties of a swarm means considering the total configuration of the individuals that constitute it. In this way, swarm nouns are different than group nouns under stubbornly distributive predication. It confirms, once again, that while swarms are constituted by a plurality, the elements of that plurality are not as easily accessible to other expressions as the elements that compose groups.

The final difference between swarms and groups concerns the cardinality of their members. We have seen that both kinds of nouns behave as if they denote a plurality, but it can be further shown that only swarms require that plurality to have a large cardinality. To see this, consider the behavior of pseudopartitives that directly specify the cardinality of the plurality that constitutes the collection.

(20) a. John planted a grove of thirty redbud trees.

b. # John planted a grove of two redbud trees. (SWARM)

c. A horde of five-hundred undead attacked.

d. # A horde of two undead attacked.

(21) a. Doubles tennis pits one team of two players against another.

b. The board convened a select committee of two VPs. (GROUP)

c. Bill needs to learn to cook for a family of two.

When the pseudopartitive specifies mere non-atomicity, as in (20b-20d), the swarm nouns are infelicitous. This is not the case with groups nouns, like (21).

	SWARMS	GROUPS
plural pseudopartitives	✓	✓
spatial collective predicates	✓	✓
non-spatial collective predicates	✗	✓
one-by-one distributivity	✗	✓
stubborn distributivity	✗	✓
simple plurality	✗	✓

Table 1: SWARMS VS GROUPS

In these observations, summarized in table 1, we already have enough contrasts to begin constructing an analysis of the group/swarm distinction. We need to understand why swarm

nouns behave like collective nouns more generally with respect to *of*–complements and a subset of collective predicates, while explaining the fact that swarms, unlike groups, are opaque to various forms of distributivity, as shown by their interactions with *one by one* and stubbornly distributive predicates. Finally, the analysis must capture the underlying intuition that swarm nouns have a non-trivial spatial component. The next section introduces the account of group nouns in Barker 1992, which I borrow wholesale because it provides a nice point of contrast for my analysis of swarm nouns. Barker argues that group nouns denote group individuals that have no parts, but are associated with a plurality by a function mapping individuals to their "members". In §2.2, I propose that swarm nouns are different because they do not use this membership function. Instead, they are linked up with a plurality via a spatial trace function, which plays a similar role to the membership function, but is different in ways that will account for those properties that make swarms unique.

2.1 Barker's Account in Brief

Barker 1992 says that singular group nouns, like singular count nouns more generally, denote atoms in the lattice of individuals with respect to the 'part of' relation.[5] While they have no parts, they are distinguished by having a plurality of "members", where the members of an individual are given by a function. Formally, the membership function f is a surjective endomorphism on the domain of individuals.[6] In this analysis, group nouns just denote atoms that are mapped to pluralities under f. In figure 1, adapted from (Barker 1992: ex. 17), the arrows represent a partial membership function f for the lattice. For instance, b and c are normal singular entities because they are atoms and have themselves as members. The sum $b \oplus c$ is a normal plural entity because it is non-atomic and has a plurality for its members (namely the sum of its parts). Finally, a is a group because it is atomic, but has a plurality of members, namely $b \oplus c$.

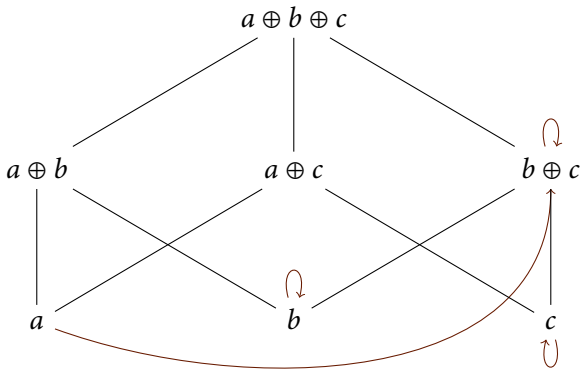

Figure 1: Atoms, Groups, and Pluralities

[5] The domain of individuals $\mathfrak{D}_e$ is taken to be a complete atomic Boolean algebra without a zero element. The join operator $\oplus$ on $\mathfrak{D}_e$ forms sums and induces a unique partial order $\leq$. Atoms are minimal elements with respect to $\leq$.

[6] Recall that an endomorphism is a function from a domain to itself that is structure-preserving, i.e., $f(a \oplus b) = f(a) \oplus f(b)$.

While I do not present all of Barker's results in detail, the analysis provides the power necessary to capture the core properties of group nouns. The idea is that they behave like singular count nouns for those processes that are sensitive to atomicity, like verb agreement. In contrast, they behave like plural count nouns in those constructions that have access to f, which can retrieve the pluralities associated with group atoms. For instance, suppose that collective predicates are distinguished in having no atomic individuals in their extension. Furthermore, suppose following Barker 1992 that collective predicates like (22) are lexically specified to pass their argument through f.

(22) looks alike $\rightsquigarrow \lambda x[\textsc{look.alike}(f(x))]$

This immediately captures the pattern in (10). If (22) is passed a group entity, like the one denoted by *that family* in (10b), f will map that individual to a plurality that can be in the extension of the collective predicate. At the same time, because f maps pluralities of non-group individuals to themselves, (10a) is predicted to be felicitous. The subject *those trees* denotes a plural individual that f will map to itself, and plural individuals can be in the extension of collective predicates. Finally, the membership function will do no good for (10d). Non-group atoms are mapped to themselves under f, but there are no atomic individuals in the extension of collective predicates. Thus, (10d) is predicted to be infelicitous

The explanation for the felicity of group nouns with *one by one* and their transparency under stubborn distributivity will have a similar account. For instance, *one by one* will not distribute over the atomic parts of an argument, but the atomic parts of the individual that f maps that argument to. In the same way, stubbornly distributive predicates will be satisfied by an individual e, just in case it is satisfied by every atomic part of $f(e)$. What is clear, though, is that if we take this path, the membership-based analysis of group nouns will not extend to swarm nouns. If swarms are atoms that are mapped under f to non-atomic individuals, we will not be able to explain how they contrast with group nouns, even if we add ancillary conditions to capture the spatiotemporal entailments of swarm nouns. We need a completely different approach. The next section develops just such an analysis, which will account for the similarities and differences between groups and swarms, but also easily extend to event-internal pluractional verbs.

2.2 Analyzing Swarms

Consider again a swarm noun like *grove*. We have the strong intuition that the individuals it denotes are composed of a plurality, yet these nouns can be grammatically distinguished from both plural count nouns and other collective nouns. The situation is reminiscent of superordinate mass nouns like *furniture* and their relation to the count nouns that they categorize. While any individual in the model that meets the criteria for being predicated of *chair* also meets the criteria for being predicated of *furniture*, the grammar treats individuals packaged as *furniture* completely differently. (They are uncountable, for instance.) Similarly, while an individual that falls in the extension of a predicate like *grove* would seemingly fall in the extension of *trees* (though not *tree*, crucially), the grammar treats individuals packaged as *groves* differently. We want to know what sort of packaging is at issue and how to model it formally. The primary conclusion of the previous section is that it must not be identical to that which we see with group nouns. We cannot simply relate swarms to their

constituent individuals via the endomorphism f, which encodes our intuitive notion of membership.

To meet the empirical challenges that motivate this conclusion, this section develops the idea that swarms are related to their constituent individuals via a structured form of spatiotemporal superposition. This will explain why the grammar treats swarms differently than both count pluralities and groups, and lay the foundation for analyzing event-internal pluractionality as this same distinguished subtype of collective reference. First, though, I want to make explicit a few core formal assumptions about space and time.

In addition to the domain of individuals $\mathfrak{D}_e$, I assume, building off of Bach 1986; Hinrichs 1985; Link 1998, that there are domains of *eventualities*, *times*, and *regions of space*—$\mathfrak{D}_\varepsilon$, $\mathfrak{D}_\tau$, and $\mathfrak{D}_\sigma$, respectively—which also have internal structure. For simplicity's sake, I take them to have the same part-whole structure as the domain of individuals, that is, they are complete atomic Boolean algebras without a zero element.[7] When it is not clear from context, I will use $\leq_\varepsilon$, $\leq_\tau$, and $\leq_\sigma$ for their intrinsic ordering relations. Usually, though, which is meant will be clear from what is ordered. In particular, I will use $e, e', \ldots$ as variables for events, $t, t', \ldots$ for times, and $s, s', \ldots$ for spaces. The big picture is that by structuring times and spaces in this way, we can immediately deal with notions of temporal and spatial containment, overlap, disjointness, etc.[8]

With these basic domains in place, we can make an easy extension to model the intuition that events occur in time and space. This is done with trace functions in the standard way. The temporal trace function $\tau : \mathfrak{D}_\varepsilon \mapsto \mathfrak{D}_\tau$ is a partial function from the domain of events to the domain of times, and the spatial trace function $\sigma : \mathfrak{D}_\varepsilon \mapsto \mathfrak{D}_\sigma$ is a partial function from the domain of events to regions of space.[9] Finally, we require both τ and σ to be complete sum-homomorphisms, that is, $\tau(e) \oplus \tau(e') = \tau(e \oplus e')$ and $\sigma(e) \oplus \sigma(e') = \sigma(e \oplus e')$.

While these trace functions play a major role in §3, they are introduced now in order to contextualize the less common idea of defining spatial traces for individuals, which I pursue now. It is clear that something like this is necessary for analyzing the non-trivial spatial component of swarm nouns. We want to be able to say that a plurality of trees is a grove or that a plurality of flowers is a bouquet, in part, because those trees and flowers fill a circumscribed region of space. It is this location that is the spatial trace of the grove or bouquet. That said, we cannot just immediately extend the notion of event trace to the individual domain. The reason is that individuals are not identified with their spatial extent in the same way that events are. Consider, for instance, an event of John walking to the store. We have no problem saying that its spatial trace is all the space in which that event takes place. But what should be the spatial trace of John? It seems wrong to say that his

[7] If one is worried about the event lattice being complemented, we can relax this assumption without changing the analysis. The same can be said for the assumption that there are atomic stretches of time and regions of space. The analysis as presented, though, does require the existence of atomic events. Making the event lattice atomless will mean altering parts of §3. It would be possible, though, to make such alternations while preserving the intuition behind the analysis.

[8] This is not the only structure we assume for these domains. Otherwise, we would incorrectly treat, events, stretches of times, and regions of space as indistinguishable. For instance, to capture the fact that times are naturally ordered by precedence in ways that regions of space are not, we want to assume a linear order $\preccurlyeq$ on the atoms in $\mathfrak{D}_\tau$, and then use it to induce a strict temporal precedence order $\prec$ on all of $\mathfrak{D}_\tau$. See, for example, Landman 1991; Link 1998 for how to do so.

[9] Trace functions are partial because some eventualities, especially states, arguably do not take place in space and time.

spatial trace is every location he ever occupies. Instead, we want to say that an individual's spatial trace is only defined relative to some period of time—that is, the space the individual occupies over that time. Intuitively, the unmarked case of an individual's spatial trace is its spatial extent at an instant. For this reason, I propose that the individual spatial trace ς is a function from instants and individuals to spatial extents. That is, $\varsigma : \mathfrak{D}_e \times \mathfrak{D}_\tau^\circ \mapsto \mathfrak{D}_\sigma$, where $\mathfrak{D}_\tau^\circ$ are the atomic times, or instants, in $\mathfrak{D}_\tau$. Thus, we can use ς to give the spatial extent of an individual at a particular instance. While we could cumulatively close ς in order to track an individual's path in space over time, this will not be necessary in the analysis that follows. In fact, I will usually suppress the individual trace's time argument, taking it to be some contextually salient instant.

These background assumptions set the stage for analyzing swarm nouns. Thinking back to the analysis of group nouns in Barker 1992, the central idea is to treat groups as atomic individuals that are associated with a plurality via the membership function. I propose that swarms are formally similar, except that they are related to a plurality via the spatial trace function. In particular, they denote atoms whose spatial trace can be partitioned into small parts, each of which is itself the trace of an individual satisfying some lexically specified predicate.[10] The result for a noun like *grove* is provided in (25), given the definition of a partition in (23) and a fine partition in (24).[11]

(23) **part**(P, x) iff

a. $\bigoplus \mathsf{P} = x$

b. $\forall x(x \in \mathsf{P} \rightarrow \neg\exists y(y \in \mathsf{P} \wedge x \circ y))$

'P partitions x iff the elements of P sum to x and no elements of P overlap.'

(24) **fine**$_\mu(\mathsf{P})$ iff every $x \in \mathsf{P}$ is very small on measure μ, but $\bigoplus \mathsf{P}$ stands out on μ.[12]

(25) grove $\rightsquigarrow \lambda x \exists \mathsf{P}[\mathbf{atom}(x) \wedge \mathbf{contiguous}(\varsigma(x)) \wedge \mathbf{part}(\mathsf{P}, \varsigma(x)) \wedge \mathbf{fine}_{\mu=area}(\mathsf{P}) \wedge \forall s \in \mathsf{P} \exists y[\varsigma(y) = s \wedge \textsc{tree}(y)]]$

The translation in (25) has been split into two lines for perspicuity. The first says that *grove* will apply to atomic individuals whose contiguous spatial trace can partitioned to small parts.

[10] The analysis shows clear parallels with that developed by Champollion 2010 for a variety of distributivity phenomena under the heading *Strata Theory*. The major differences are that (i) my analysis must use partitions, not covers, and (ii) it quantifies over the parts of an entity's trace, not the parts of an entity directly. An important area of future research is to see whether we can at least partitially unify in some overarching theory the phenomena presented here with those discussed his work.

[11] Note that x and y overlap—$x \circ y$—just in case there is a z such that $z \leq x$ and $z \leq y$.

[12] There are various ways to formalize this notion of contextually specified comparative smallness. Here is one. Let μ be a measure function—a function from entities to degrees on scale—defined for the partitioned object. For example, if we partition a space, $\mu = area$ would map elements of $\mathfrak{D}_\sigma$ to degrees on a scale with dimension *area*. Now we say that a partition satisfies **fine** just in case for all x in the partition, $\mu(x) < d_{small} < d_{std} \leq \mu(\oplus \mathsf{P})$. If this condition holds, it follows that there must be many elements of the partition, each of which is very small, and very small compared to the partitioned object.

The second line requires that each element of the partition is the spatial trace of a tree.[13] This last condition is given as part of the lexical semantics of *grove* and will differ across various swarm nouns.[14] Not only does (25) capture the intuitively correct satisfaction conditions for a predicate like *grove*, it makes a series of correct predictions about the distribution and interpretation of swarm nouns.

First, the existence of a *grove* entails the existence of a plurality of trees, just as other collective nouns, like *committee*, entail the existence of a plurality of members. Even better, though, (25) correctly predicts that swarms have a large number of constituent individuals, not just a plurality, as the contrast in (20) requires. That is, while a *team*, *committee*, or *family* can felicitously have only two members, swarms always need many more. Two trees can never form a *grove*. This entailment follows from the definition of a fine partition and the fact that an individual's spatial trace is given by a function. To see this, consider the fact that if the partition of a space has only two parts, even if we try to minimize their individual sizes, neither will be very small compared to the whole. We can only ensure that every element of the partition is very small relative to the whole if we have a partition with a large cardinality. But then, because ς cannot map the same individual at the same time to two different regions of space, (25) requires the cardinality of the trees that compose the grove to equal the cardinality of the spatial partition. The result is that swarm nouns like *grove*, *horde*, and *bouquet* are correctly predicted to require, not just a simple plurality of constituent individuals, but a plurality of large cardinality.

The analysis of swarm nouns, as exemplified by (25), also correctly predicts that they should be ungrammatical with those collective predicates in (10-11), as well as the distributivity operator *one by one* in (15). The reason is that swarm nouns denote atomic individuals, but unlike group nouns, their constituent individuals are completely inaccessible. I established, following Barker 1992, that (a subset of) collective predicates and *one by one* can target group nouns because they can find the plural individual they require by feeding the group through the membership function. Since swarm nouns are not related to a plurality under the membership function, they fail to have the same distribution. Instead, swarms are related to a plurality by means of the individual spatial trace function. Crucially, this function, unlike the membership function, cannot be used to pick out a plural individual. It merely maps a swarm atom to a region of space.[15]

The analysis captures the fact that with respect to predicates and adverbials that select for pluralities, swarms act like atomic individuals. Their behavior with respect to stubborn distributivity strengthens this conclusion and receives a unified explanation. Recall that

[13] The lexical semantic representations of swarm nouns most likely include additional spatial conditions. For example, groves should be vaguely circular. Such conditions appear to be grammatically inert, though, so I will continue to leave them unspecified.

[14] In the final section, §4, I present examples from Romanian and Tzotzil in which swarm nouns are derived. In these cases, the lexical predicate in the schema in (25) is provided compositionally, not lexically.

[15] One might worry that maintaining this distinction between group nouns and swarm nouns is tied too closely to an analysis that makes use of Barker's membership function. This is not the case. For instance, Landman (1989b, 2000) provides an account where groups are derivable via the $\uparrow$–operator, which maps pluralities to group atoms. It is paired with the $\downarrow$–operator, which maps group atoms to plural individuals. Under this account of groups, we would say that *one by one* and collective predicates can use $\downarrow$ to access the pluralities that compose a group atom. If swarms are outside of the domain of $\downarrow$, that is, if they are pure atoms like the analysis in (25) maintains, they should be ungrammatical with *one by one* and the collective predicates in (10-11).

so-called stubbornly distributive predicates cannot be predicated of groups, but instead distribute down to their members. This is not the case for swarms, as examples like (18-19) show. A wide grove says nothing about the width of the trees that compose it. This is in stark contrast to a wide team. If stubbornly distributive predicates are those that can have only atomic participants, as Schwarzschild 2011 argues, then the analysis of swarm nouns in (25) correctly predicts that swarms should be able to fall in the extension of stubbornly distributive predicates. We have already seen through the behavior of group nouns and distributors like *one by one* that the individuals composing groups are accessible to the grammar. It is not surprising, then, that groups cannot be in the extension of stubbornly distributive predicates, only their atomic members.

The final difference between swarm nouns and group nouns concerns the existence criteria for the kinds of individuals they denote. When a committee finishes meeting and its members go home, the committee does not dissolve. Committees are not defined in terms of the spatiotemporal properties of the individuals that constitute them. They are defined in terms of membership and shared goals. The same is true for platoons, teams, and families. Swarms are different. If all of the warriors in a horde go home, the horde ceases to exist. Similarly for groves and bouquets. If we take the flowers in a bouquet and place them around the room, the bouquet is no more. Swarms are clearly defined in terms of the spatiotemporal properties of their members. They must fill some contiguous region of space. This insight is immediately captured in the analysis in (25), which is based on filling the contiguous spatial trace of an atomic individual with a plurality. In particular, the contiguity condition in (25) requires that for each two regions of space $s \leq \varsigma(x)$ and $s' \leq \varsigma(x)$, there is a third region $s'' \leq \varsigma(x)$ that overlaps both s and s'. This condition prevents two or more sets of non-contiguous trees from forming a grove, which is clearly absurd, though not ruled out by the definition of partition in (23) alone. Moreover, it captures that fact that while natural language allows singular reference to non-spatially-contiguous individuals, this is just not the case for swarm nouns. The fact that the analysis uses a trace function to make sense of the existence criteria of swarms, as well as to explain their opaqueness to distributivity and the large cardinality of their constituent individuals, is a major advantage of the proposal. An analysis that used different mechanisms to account for these three facts fails to explain why they co-occur, and as we shall see in subsequent sections, continually co-occur across languages, semantic domains, and syntactic categories.

This section started with a series of new empirical arguments motivating a distinct subclass of collective nouns, separate from canonical group nouns like *committee*. The rest of the section developed an analysis of these swarm nouns that is based on the idea that they denote individuals whose spatial trace has a particular structure to it. It must be divisible into small parts, each of which is the spatial trace of an individual satisfying a lexically specified predicate. Example (26) summarizes the analysis for an arbitrary swarm noun, where PRED is some predicate lexically specified by the noun in question.

(26) $\lambda x \exists \mathsf{P}[\mathbf{atom}(x) \wedge \mathbf{part}(\mathsf{P}, \varsigma(x)) \wedge \mathbf{contiguous}(\varsigma(x)) \wedge \mathbf{fine}_{\mu=area}(\mathsf{P})$
$\wedge \forall s \in \mathsf{P} \exists y[\varsigma(y) = s \wedge \textsc{pred}(y)]]$

With this background in place, the next section argues that denotations like (26) are not the providence of nominals alone. In particular, I show that event-internal pluractional verbs

have similar denotations, and that the peculiar properties of these verbs follow from the fact that they are predicates of swarms in the event domain.

3 Event-internal Pluractionals: Swarms in the Event Domain

It is best to first approach the notion of event-internal pluractionality through examples. Consider the case of Yurok, which has two pluractional morphemes that have been traditionally called the *iterative* and the *repetitive* (Garrett 2001). Examples (27-28) illustrate that the kinds of plural events they describe are very different.

(27) *Ko'moy-o' ('o)* ***prkw****prkwr*
hear-SG (LOC) **REP**.knock
'I hear knocking.' (someone's at the door) (Wood 2007: ex.7, p.148)

(28) *kipun kw**eg**eskwes-ek*
winter have.a.cold.**ITR**-1SG
'I get colds in the winter.' (Wood 2007: ex.5c, p.146)

The repetitive in (27), which is our event-internal pluractional, describes a plurality of events that appear to cohere together as a single event, especially in contrast to the iterative in (28), which has been called, in opposition to (27), an *event-external* pluractional. For instance, an event of knocking at the door has repetitions as part of its character. That is, each knock is not independent, but part of a single event of requesting entry, which takes place on just one occasion. In contrast, the iterative in example (28) describes a plurality of events that cohere less. The colds happen on different occasions and they are clearly independent. They do not add up to an event with a singular character like the knocking event and the knocks that compose it. It is because the repetitions in examples like (27) appear to take place internal to some macro event that Cusic (1981) first calls them *event-internal*.

While the contrast between (27) and (28) is interesting in its own right, one of the major results in the pluractionality literature is the discovery that this opposition in Yurok is crosslinguistically robust. Looking at large samples of such expressions, one finds that pluractional verbs tend behave either more like (27) or more like (28) (Cusic 1981; Lasersohn 1995; Wood 2007; Xrakovskij 1997). In particular, based on a typological survey, Wood (2007) develops a set of criteria that distinguish event-internal pluractionality from event-external pluractionality. These criteria play an important role in this section, whose goals are twofold. First, I show that the Kaqchikel pluractional introduced in (3) is a prototypical event-internal pluractional in virtue of meeting these previously established criteria. I then show, through analyzing the Kaqchikel facts, that the crosslinguistically stable properties of event-internal pluractional verbs follow immediately if they are the verbal equivalents of swarm nouns.

3.1 Kaqchikel –Ca' as an Event-internal Pluractional

Before I show you that event-internal pluractional verbs are the eventive counterparts of swarm nouns, I have to present the core data about a pluractional of this type. In particular,

I will focus on the verbal derivation *–Ca'* in Kaqchikel, illustrated by the following naturally occurring examples.[16]

(30) Cutzal Chacach, Armando Cali & Cojtí Maracario 1999: p. 245
*Jun ak'wal yalan n-Ø-u-qeb'-**eqa'** r-i' pan ulew.*
a child much ICP-A3s-E3s-rub-**Ca'** E3s-REFL P earth
'A child is rubbing himself on the ground.'

(31) Cutzal Chacach, Armando Cali & Cojtí Maracario 1999: p. 371
*Jun xti moy r-onojel q'ij n-Ø-u-tzin-**itza'** ri ru-q'ojon pa k'ayb'äl.*
a DIM blind E3s-all day ICP-A3s-E3s-strum-**Ca'** the E3s-guitar P market
'A blind person strums his guitar all day in the market.'

The rest of this section is devoted to showing that *Ca'*-marked predicates in Kaqchikel pattern with event-internal pluractionality crosslinguistically. In doing so, I simultaneously lay out the facts that the swarm-based analysis must capture.

The first generalization is that *–Ca'* is sensitive to the aktionsart of the stem it modifies. Like event-internal pluractionals crosslinguistically (Wood 2007), *–Ca'* is felicitous with semelfactive stems, but not accomplishments. This is illustrated by the contrast between examples (32a-c) and (33a-c).

(32) SEMELFACTIVES

a. *X-Ø-u-chap-acha' ri ch'atäl.*
CP-A3s-E3s-touch-Ca' the table
'He kept tapping the table.'

b. *X-Ø-u-k'oj-ok'a' ru-chi' ri jay.*
CP-A3s-E3s-knock-Ca' E3s-mouth the house
'He kept knocking at the door.'

c. *X-Ø-u-t'in-it'a' ri kem.*
CP-A3s-E3s-hammer(weft)-Ca' the weaving
'He kept hammering the weft of the weaving.'

[16] You will have no doubt noted that in addition to the copied consonant, a vowel is also copied from the root in the examples above. It is only necessary for phonological reasons. Roots that end in the velar fricative can be derived by *–Ca'* without vowel copying, as in (29). For this reason, I will write the vowels in the Kaqchikel examples, but not segment or gloss them.

(29) a. tzij**tza**, from $\sqrt{}$*tzij* 'light'
b. tz'aj**tz'a'**, from $\sqrt{}$*tz'äj* 'hit someone naked/wearing tight clothes'

(33) ACCOMPLISHMENTS

a. *#X-Ø-u-b'an-ab'a'* *ri* *jay.*
CP-A3s-E3s-build-Ca' the house
'He kept building the house.'

b. *#X-Ø-u-tz'ib'a-tz'a'* *ru-b'i.*
CP-A3s-E3s-wrote-Ca' E3s-name
'He kept writing his name.'

c. *#X-Ø-u-kem-eka'* *ri* *po't.*
CP-A3s-E3s-weave-Ca' the blouse
'He kept weaving the blouse.'

It is natural to think of semelfactives and accomplishments as polar opposites. Intuitively, accomplishments are temporally extended events that involve incremental progress toward a result state. Semelfactives are punctual events that entail no result state. In between these two extremes, we have achievements and activities. The former are not temporally extended, but they are like accomplishments in having a result state. The latter are like accomplishments in being temporally extended, but have no result state. The interaction of achievements and activities with *–Ca'* shows them to be somewhere between accomplishments and semelfactives. While these stems do not completely reject derivation by *–Ca'*, they are felicitous insomuch as they can have a semelfactive-like reading under aspectual coercion.

Let's start with achievements. An achievement is grammatical with *–Ca'* only if it can be treated as denoting events that fail to culminate as they usually do. This is illustrated in (34a-c), especially through the speaker comments.

(34) a. *X-Ø-in-ch'ar-ach'a'* *ri* *tros.*
CP-A3s-E3s-split-Ca' the stump
'I kept chopping at the stump.'
SPEAKER COMMENT: It's like if your axe is really dull.

b. *X-Ø-in-tzuy-utza'.*
CP-A3s-E3s-sit-Ca'
'I kept (making the motion of) sitting there.'
SPEAKER COMMENT: Your bottom doesn't really hit the chair.

c. *X-Ø-u-yuch'-uya'* *ri* *su't.*
CP-A3s-E3s-double.over-Ca' ri wrap
'I kept folding over the wrap.'
SPEAKER COMMENT: Like if you can't get it lined up even.

This aspectual coercion is not just pragmatic, but has detectable semantic effects. If *Ca'*-marked predicates denote events which must not culminate, it is predicted that a sentence with a coerced achievement should not entail a minimally different non-pluractional sentence. The reason is that, after coercion, the truth of the pluractional sentence will not

ensure the existence of an event that satisfies its non-pluractional counterpart. This prediction is borne out in (35-36). Note that we have the same verb stem across the positive and negative clauses in the following examples. The difference in meaning is attributable to the pluractional derivation.

(35) *X-Ø-in-ch'ar-ach'a'* *ri tros,* *po man* *x-Ø-ch'ar* *ta.*
CP-A3s-E1s-split-Ca' the stump, but NEG CP-A3s-split.PAS IRR
'I kept chopping at the stump, but it didn't split.'

(36) *X-Ø-u-tzuy'-utza',* *po man* *x-Ø-tzuy-e'* *ta.*
CP-A3s-E3s-sit-Ca', but NEG CP-A3s-sit IRR
'She kept sitting up and down there, but she didn't sit.'

As a control, note that the entailment goes through with *Ca'*-marked semelfactives. This is because each of the repeated events that the pluractional requires will satisfy the non-pluractional predicate.

(37) *#X-Ø-u-k'ut-uk'a'* *ri po't* *ch-w-e',* *po man* *x-Ø-u-k'ut* *ta*
CP-A3s-E3s-look.at-Ca' the blouse P-E1s-DAT but NEG CP-A3s-E3s-point IRR
ch-w-e'.
P-E1s-DAT
'She kept showing me the blouse, but she didn't show it to me.'

(38) *#X-Ø-u-pitz'-ipa'* *ri pix,* *po man* *x-Ø-u-pitz'* *ta.*
CP-A3s-E3s-squeeze-Ca' the tomato, but NEG CP-A3s-E3s-squeeze IRR
'She kept squeezing the tomato, but she didn't squeeze it.'

The case of activities is similar. An activity cannot be derived by *–Ca'* without greatly altering the character of the events that the stem usually denotes. Activities have no result state, making them like semelfactives in this way, but they are temporally extended. The following examples show that activities are felicitous with *–Ca'* if it is possible to construe the verb stem as denoting non-temporally extended events. The following examples illustrate the generalization. The comparison between the (a) and (b) examples below shows that the pluractional derivation prevents the activity from progressing.

(39) a. *X-Ø-u-chok-ocha'* *ri ch'ich'.*
CP-A3s-E3s-push-Ca' ri car
'He kept pushing on the car.'
Speaker Comment: It's like it's stuck and keeps rocking back into place.

b. *Oxi'* *hora* *x-Ø-u-chok-omij* *pe* *ri* *ch'ich'.*
three hours CP-A3s-E3s-push-VTD DIR the car.
'He pushed the car here for three hours.'

(40) a. *X-Ø-u-sir-isa'* *ri koloch'*.
CP-A3s-E3s-roll-Ca' ri ball
'I kept rolling the ball (back and forth in place).'

b. *X-Ø-u-sir-irej* *ri koloch'* *r-ichin* *n-Ø-etz'a-n* *r-ik'in.*
CP-A3s-E3s-roll-VTD ri ball E3s-for ICP-A3s-play-AP E3s-with
'He rolled the ball to play with it.'

(41) a. *X-i-ru-tz'et-etz'a'*.
CP-A1s-E3s-look.at-Ca'
'He kept glancing at me.'

b. *Jun hora x-i-ru-tz'et.*
one hour CP-A1s-E3s-look.at
'He looked at me for an hour.'

Another way to characterize the effect of the pluractional is that it requires the repetition of some initial subpart of an event that would satisfy a similar non-pluractional predicate. Once again, the type of coercion observed makes these stems approximate a semelfactive. The repeated events are not normal activities, but events that cannot be temporally extended.

Summarizing, *–Ca'* is sensitive to the aktionsart of the stem to which is applies. Event-external pluractionals tend not to care about aktionsart, but it is well-attested for event-internal pluractionals to preferentially target semelfactives (Wood 2007). This is precisely what we see with *–Ca'*. It is grammatical with semelfactives, ungrammatical with accomplishments, and acceptable with achievements and activities insomuch as they can be coerced into predicates of events that are short and do not culminate—that is, events with a semelfactive profile. Plausibly, the reason why accomplishments like (33a-c) cannot be successfully coerced is that even if their end states are removed, they have complex, heterogeneous preparatory processes, which cannot be easily reduced to a single, punctual, repeatable event. A core goal for the analysis developed in the following section is to show that the preference for semelfactive verbs, and the need for semelfactive coercion in other cases, is a consequence of the fact that event-internal pluractionality is swarm reference in the event domain.

The second way that *Ca'*-marked predicates pattern with event-internal pluractional verbs crosslinguistically is that the parts of the plural events they denote are nearly contiguous. The following examples illustrate this point in a controlled manner, but even the naturally occurring examples in (30-31) and (3) describe scenarios that could only involve contiguous repetitions.

(42) Suppose Juan knocks on the door once every 10 seconds for 10 minutes.
#A Xwan x-Ø-u-k'oj-ok'a' *ru-chi'* *ri jay.*
CLF Juan CP-A3s-E3s-knock-Ca' E3s-mouth the door
'Juan kept knocking at the door.'
Speaker Comment: No, it has to be continuous.

(43) Suppose Juan has a rash on his arm and every so often it itches so he scratches it.
#A Xwan x-Ø-u-roch-ora' r-aq'a.
CLF Juan CP-A3s-E3s-scratch-Ca' E3s-hand
'Juan kept scratching his arm.'
SPEAKER COMMENT: No, it would be like this: [scratches vigorously back and forth on her arm].

(44) Suppose you see Juan every day and he gives you a dirty look.
#A Xwan x-i-ru-tz'et-etz'a'.
CLF Juan CP-A1s-E3s-look.at-Ca'
'Juan keeps looking at me.'
SPEAKER COMMENT: No, it would have to be like this: [speaker turns his head a bit and shoots a glance over and over].

The scenarios in (42–44) look at downtimes ranging from 10 seconds to days. Crucially, *–Ca'* cannot be used. Speakers' comments make this clear, especially when they act out scenarios in which *–Ca'* would be appropriate. They always use rapid, almost frantic, contiguous repetitions, which is expected from an event-internal pluractional.

Another distinguishing property of event-internal pluractionals, which is especially interesting if we want to assimilate them to a species of nominal plurality, is that the events they denote must have a large, though contextually specified cardinality. Examples (45-47) show that *Ca'*-marked predicates have this property. They require many repetitions.

(45) Suppose Juan looks over at you twice.
#A Xwan x-i-ru-tz'et-etz'a'.
CLF Juan CP-A1s-E3s-look.at-Ca'
'Juan keeps looking at me.'

(46) Suppose Juan taps the table 4 or 5 times.
#A Xwan x-Ø-u-chap-acha' ri ch'atäl.
CLF Juan CP-A3s-E3s-touch-Ca' the table
'Juan keeps touching the table.'

(47) Suppose Juan taps the table 15 or 20 times.
A Xwan x-Ø-u-chap-acha' ri ch'atäl.
CLF Juan CP-A3s-E3s-touch-Ca' the table
'Juan keeps touching the table.'

Another argument for this position is that *–Ca'* often occurs with high intensity adverbials in naturally occurring examples. For instance, (30-31) and (3) contain adverbials like *jeb'ël* 'good (e.g., I moved them good.)', *yalan* 'very/a lot', *ronojel q'ij* 'all day'. These adverbials can be treated as further fixing the contextually specified cardinality of repetitions. The fact that they uniformly indicate large numbers of repetitions supports the data in (45-47).

Finally, *Ca'*-marked predicates behave like event-internal pluractionals when interacting with distributivity. In particular, the parts of the plural event that satisfy the pluractional predicate are completely opaque to all flavors of distributivity. Because it is not possible to distribute the parts of one of these events over individuals, the result is that arguments of *Ca'*-marked predicates must participate in plural events under both distributive predication and distributive quantification. For instance, example (48) has no reading where each of the individuals in the extension of the plural subject participates in a single glancing event, even if the sum of those events has the appropriate cardinality and temporal profile. Instead, the most salient reading of (48) has each of the people repeatedly glancing at me.

(48) Suppose there is a large group of people across the street and they each turn and glance at me once.
#X-i-ki-tz'et-etz'a' *ri* *winaq-i'*.
CP-A1s-E3p-look.at-Ca' the person-PL
'The people kept glancing at me.'

(49) Suppose a bunch of people come by my market and pick up a particular tomato, squeeze it once, and put it down.
#X-Ø-ki-pitz'-ipa' *la* *jun* *xkoya'* *la'*.
CP-A3s-E3p-squeeze-Ca' that one tomato there
'They kept squeezing that tomato.'

Not surprisingly, appending a distributive quantifier like *chikijujunal* 'each of them' does not generate the target interpretation. For instance, examples (50-51) cannot have a reading where each individual in the extension of the plural subject participates in a single event. They must all participate in plural events.

(50) Suppose there is a large group of people across the street and they each turn and glance at me once.
#Chi-ki-ju-jun-al *ri* *winaq-i'* *x-i-ki-tz'et-etz'a'*.
P-E3p-one-RED-NOM the person-PL CP-A1s-E3p-look.at-Ca'
'Each of the people kept glancing at me.'

(51) Suppose a bunch of people come by my market and pick up a particular tomato, squeeze it once, and put it down.
#Chi-ki-ju-jun-al *x-Ø-ki-pitz'-ipa'* *la* *jun* *xkoya'* *la'*.
P-E3p-one-RED-NOM CP-A3s-E3p-squeeze-Ca' that one tomato there
'They each kept squeezing that tomato.'

All that the distributive quantifier does is rule out collective interpretations of pluractional predicates, which are otherwise licit.

(52) Suppose a group of people are trying to push a big bus, but are having trouble moving. It just keeps rocking back and forth.
X-Ø-ki-chok-ocha' *ri* *ch'ich'*.
CP-A3s-E3p-push-Ca' the bus
'They kept pushing on the bus.'

(53) Suppose a group of people are trying to push a big bus, but it is having trouble moving. It just keeps rocking back and forth.
#Chi-ki-ju-jun-al *x-Ø-ki-chok-ocha'* *ri* *ch'ich'*.
P-E3p-one-RED-NOM CP-A3s-E3p-push-Ca' the bus
'Each of them kept pushing on the bus.'

By resisting distribution over pluractional subevents, the suffix *–Ca'* behaves exactly as we would expect if it derived event-internal pluractional predicates. The swarm-based analysis developed in the following section is able to explain in a unified way, both the observed opacity to distributivity, as well as the aspectual and temporal generalizations presented above.

3.2 A Swarm-based Account of Event-internal Pluractionality

§2 argued that swarm nouns have a particular kind of group reference mediated by an individual's spatial trace. For instance, a grove is an atomic individual whose spatial trace can be divided into very small parts, each of which is the spatial trace of a individual satisfying a lexically given predicate, namely *tree*. I propose that *–Ca'* derives predicates with the same type of group reference in the event domain. In particular, (54) gives the denotation of *–Ca'*, which has the same core features of the schematic denotation for swarm nouns in (26).[17]

(54) $\text{–Ca'} \rightsquigarrow \lambda V_{\varepsilon t} \lambda e \exists \mathsf{P}[\mathbf{atom}(e) \wedge \mathbf{contiguous}(\tau(e)) \wedge \mathsf{Part}(\mathsf{P}, \tau(e)) \wedge \mathbf{fine}_{\mu=length}(\mathsf{P}) \wedge \forall t \in \mathsf{P} \exists e'[\tau(e') = t \wedge V(e') \wedge e[\tau]e']]$, where:

a. $e[\tau]e'$ means e and e' differ at most with respect to their temporal trace. That is, it is shorthand for $\mathrm{T}(e) = \mathrm{T}(e')$, where T ranges over all trace functions and thematic roles, excluding τ.

Most importantly, (54) is similar to (26) in that, after composing with a verb stem, it is a predicate of atoms that have a trace which is divisible into very small parts, each of which is the trace of another entity that satisfies a second predicate. This ensures that any event that satisfies a *Ca'*-marked predicate must have swarm reference.

While *Ca'*-marked verbs are swarm-denoting, there are three major differences between (54) and the schematic denotation of swarm nouns in (26). Crucially, though, none of them reflect deep differences between swarm nouns and event-internal pluractional verbs. They instead reflect accidental properties of the pluractional at hand, or ontological differences

[17] Since *–Ca'* makes use of a temporal trace, not a spatial trace, the μ employed in (54) measures the length of the interval.

between individuals and events that go beyond the analysis of swarm-based collective reference.

First, note that there is a type-difference between (54) and (26). Each event that constitutes the swarm must satisfy a predicate that is not lexically given, but provided compositionally by the verb stem that the pluractional affixes. §4 shows, though, that this is an accidental fact which cuts across both the nominal and verbal domains. There are languages with nominal derivations that derive swarm nouns from a wide variety of nominal stems, like the pluractional. Similarly, example (54) is different from (26) in that the swarm event is defined in terms of the temporal trace function, but there are event-internal pluractionals in other languages that make use of the event argument's spatial trace (Collins 2001; Wood 2007: p.64-70), smoothing out this apparent difference.[18]

The last difference between the analysis of event-internal pluractionality and the analysis of swarm nouns concerns the final condition in (54). While it is true that I do not make use of trace equivalence in (26), the point is moot. Individuals only have a spatial trace, and so adding a trace equivalence condition to (26) does no work. The larger point is that events and individuals are ontologically different, the former being individuated in terms of various trace functions, and so we do not expect expressions that make reference to swarms across domains to have the same exact representations. Instead, what is carried over from (26) to (54) are precisely those features that establish swarm reference, namely those conditions that superimpose an atomic entity on a plurality by means of a trace function. It is these conditions that explain the core properties of event-internal pluractionality that we have encountered.

I now want to show that the swarm-based analysis in (54) accounts for all of the properties of event-internal pluractionality. Recall the first three generalizations about *Ca'*-marked predicates. To begin, they only compose with semelfactive verb stems without coercion. Activities, achievements, and accomplishments are only acceptable if they can be coerced into a semelfactive. Second, these repetitions must be contiguous and take place on a single occasion. Finally, the number of repetitions is large and fixed by context. One of the strengths of the analysis I propose is that it draws these three generalizations together. All will have their explanation rooted in the fact that *–Ca'* derives swarm predicates, that is, by the way it relates an atomic event to a plurality by means of a trace function.

Consider a concrete example like (56), repeated from (43). Its truth conditions are given in (57). The first two lines are the result of applying (54) to the event predicate *roch* 'scratch'. The last line relates the pluractional event to its arguments via theta roles.[19]

[18] For instance, Collins 2001 describes a pluractional in ǂHoan, illustrated in (55), that derives verbs which can only be satisfied by a plurality of events taking place in a variety locations.

(55) a. ciu 'dig' → **kí'**-ciu-**q‖o** 'dig around'

b. 'am 'eat' → **kí'**-'am-**q‖o** 'eat around'

[19] Note that for reasons of space, I do not show how verbs compose with their arguments. Providing a compositional analysis is ancillary to the main goals of the analysis, and to do so would not be difficult given that the pluractional is merely a verb modifier of type $\langle \varepsilon t, \varepsilon t \rangle$.

(56) Suppose Juan has a rash on his arm and every so often it itches so he scratches it.
#A Xwan x-Ø-u-roch-ora' r-aq'a.
CLF Juan CP-A3s-E3s-scratch-Ca' E3s-hand
'Juan kept scratching his arm.'
SPEAKER COMMENT: No, it would be like this: [scratches vigorously back and forth on her arm].

(57) $\exists e \exists \mathsf{P}[\mathbf{atom}(e) \wedge \mathbf{contiguous}(\tau(x)) \wedge \mathbf{part}(\mathsf{P}, \tau(e)) \wedge \mathbf{fine}(\mathsf{P}) \wedge$
$\forall t \in \mathsf{P} \exists e'[\tau(e') = t \wedge \textsc{scratch}(e') \wedge e[\tau]e']]$
$\wedge \mathbf{ag}(e) = J \wedge \mathbf{th}(e) = x \wedge \textsc{arm}(x) \wedge R(J, x)]$

The formula in (57) is true if there is an atomic event e whose temporal trace can be partitioned into many very short intervals that are traces of scratching events. Each of those events have to have John as its agent and an arm as it patient, which must stand in the appropriate relationship to John (e.g., inalienable possession).

First of all, the analysis immediately explains why (56) is only true in scenarios that have John scratching his arm a large number of times. The explanation is parallel to how the analysis accounts for the fact that a grove must consist of a large number of trees. Because P in (57) must be a fine partition of the pluractional event's temporal trace, we know that P must have many members. But each of those members must be the temporal trace of a scratching event, which means that (57) entails a large number of repeated scratchings. Moreover, the particular number of repetitions is predicted to be context dependent. The reason is that P is defined as a set of temporal intervals, each of which is very short relative to $\tau(e)$, which is a gradable, and thus contextually dependent notion.

The analysis further predicts that the repetitions should be contiguous. This immediately follows from the contiguity condition and the definition of a partition. In particular, $\tau(e)$ must be a temporal interval with no gaps, and so its partition will be a finite number of adjacent intervals, each of which must be the temporal trace of a scratching event. The analysis thus predicts the infelicity of (56) in the offered context. There can be no downtime between each scratching event. As a corollary, the analysis accounts for one of the core differences between event-internal and event-external pluractionality, namely only the latter can be satisfied by a plurality of events that take place on difference occasions (see 27-28 and surrounding discussion). The reason is that occasional readings, like that exemplified in (28), permit downtime between the events that constitute the pluractional event.

Even more striking, the combination of the previous two points—the need for short, and thus many events, and the fact that the repetitions are contiguous—provides an explanation for the fact that *–Ca'* targets only semelfactives without coercion. First, consider the case of activities. We have seen that *Ca'*-marked activities are only satisfied by repetitions of a short initial segment of an event that the relevant activity verb would usually denote. This is immediately predicted by the definition of swarm reference. By the definition of a fine partition, each of the events composing the swarm must have a very short temporal trace, much shorter than the trace of the pluractional event as a whole. Furthermore, each must satisfy the verb stem *–Ca'* suffixes. If the verb stem is semelfactive, these conditions can be is immediately met. Semelfactive events are already short, and so they can surely fall in

the extension of a semelfactive stem that *–Ca'* suffixes. If the stem is an activity, though, which naturally denotes events that are temporally extended, coercion takes place. The pluractional event will have to be composed of a large number of very short events that fall in the extension of the activity stem. If it is possible to find such events, even if abnormal ones, the expression will be felicitous. This is exactly what we find in examples like (39-41).

The kind of coercion observed with achievements has a different explanation than that which we see with activities. In particular, I attribute it to the contiguity condition on swarms. Recall that achievements are only grammatical with *–Ca'* if they can be construed as denoting events that do not culminate. The analysis I propose follows from an idea of Rothstein 2004 (rooted in early work by Kamp 1979), which is that semelfactive events, in virtue of entailing no significant result state, are inherently repeatable. This is because the occurrence of the event cannot have an effect that interferes with the prerequisites of a similar event immediately occurring again. That is, when I give the door a single knock, nothing happens to my hand or the door that precludes immediately appending another knocking event. The same is true for events in the extension of predicates like *rop* 'flap', *roch* 'scratch', *chäp* 'touch', *pïtz'* 'squeeze', etc., which are all readily affixed by *–Ca'* in Kaqchikel.

In contrast, the normal course of an achievement event entails that an end state must hold, precluding the immediate repetition of the same event. For example, a sitting event usually ends with the subject have the property of being seated for some appreciable amount of time. During that time, that individual is clearly not sitting again. The same is true for *yuch'* 'double over' or *ch'ar* 'split'. Once an object is split or doubled over, to repeat the same event, it must be undoubled or unsplit. The idea, then, is that the pluractional, in virtue of requiring contiguous repetitions, requires the downtime between events in the swarm to be minimal. This means that the result state entailed by achievements must be minimized. This is precisely what we see with examples like (34a-c). For instance, the pluractional expression in (34b), which is built on the stem *tzuy* 'sit', requires repetitions of sitting events where the subject does not get seated. This makes sense if each sitting event in the swarm must be contiguous with another sitting event; all of the time spent seated will be time separating the previous sitting event from the next one, interfering with the satisfaction of the contiguity condition. By coercing the achievements so that their result states are minimized, they become like semelfactives, which are inherently repeatable in a contiguous manner.

The swarm-based analysis of *–Ca'* clearly captures the temporal and aspectual properties of event-internal pluractionality, both in Kaqchikel and more generally. It also makes a series of correct predictions about the interaction of distributive operators and pluractional predicates. This is especially important because distributivity is a domain that cuts across the event/individual divide, allowing us to run the same tests on both swarm nouns and event-internal pluractional predicates.

First, though, recall examples (48-51), which show that the pluractional is opaque to both predicative and quantificational distributivity. The analysis correctly predicts the inability to pair atomic individuals with non-pluractional events under various flavors of distributivity. I start with quantificational distributivity. Example (58) shows that *chikijujunal* 'each' forces distributive readings of so-called mixed predicates. Example (59) captures the truth conditions of (58) if *chikijujunal* is translated with a universal quantifier that scopes over the event quantifier. In particular, (59) requires each of the women to participate in their own event of lifting Irma.

(58) *Chikijujunal ri ixoq-i' x-Ø-ki-jot-ob'a ri xta Irma.*
Each the woman-PL CP-A3s-E3p-elevated-SS the CLF Irma
'The women each lifted Irma.'
FALSE if there was a collective lifting event

(59) $\forall x[\textsc{girl}(x) \rightarrow \exists e[\textsc{left}(e) \wedge \mathbf{th}(e) = I \wedge \mathbf{ag}(e) = x]]$

When we move to an event-internal pluractional example like (50), each individual must be paired with a pluractional event, exactly as required. Its truth conditions are given in (60), where Sp is a distinguished variable that picks out the speaker in a context.

(60) $\forall x[\textsc{person}(x) \rightarrow \exists e \exists \mathsf{P}[\mathbf{atom}(e) \wedge \mathbf{contiguous}(\tau(x)) \wedge \mathbf{part}(\mathsf{P}, \tau(e)) \wedge \mathbf{fine}(\mathsf{P}) \wedge$
$\forall t \in \mathsf{P} \exists e'[\tau(e') = t \wedge \textsc{look.at}(e') \wedge e[\tau]e']] \wedge$
$\mathbf{th}(e) = \mathsf{Sp} \wedge \mathbf{ag}(e) = x)]$

We have the same result when turning to distributive predication. One prominent class of accounts of distributive predication takes it to be the consequence of cumulative closure via the $*$-operator defined in (61).

(61) Cumulative Closure (following Krifka 1989).
The cumulative closure of P is the smallest predicate $*P$ such that:

a. $P \subseteq *P$

b. if $a \in *P$ and $b \in *P$, then $a \oplus b \in *P$

To see how this works, consider an event predicate V that has in its extension two atomic events e_1 and e_2. Further suppose that John is the agent of e_1 and Bill is the agent of e_2. The distributive reading of *John and Bill V-ed* is derived by cumulatively closing the event predicate, as in (62).

(62) $\exists e[*V(e) \wedge \mathbf{ag}(e) = J \oplus B]$

Example (62) is true just in case there is an event e, namely $e_1 \oplus e_2$, that is in $*V$, whose agent is $J \oplus B$. Cumulative closure ensures the former condition, while the fact that theta roles are sum-homomorphisms ensures the latter. Note, though, that this account of distributive predication will not allow us to distribute the parts of a plural individual over those events that make up an event-internal pluractional event. The reason is that event-internal pluractional predicates denote swarms, namely atomic entities that are superimposed on a plurality via a trace function. Thus, cumulatively closing such a predicate will leave the members of this plurality untouched. Consider (63), which gives the translation of the pluractional verb in (48).

(63) $*\lambda e.\exists \mathsf{P}[\mathbf{atom}(e) \wedge \mathbf{contiguous}(\tau(x)) \wedge \mathbf{part}(\mathsf{P}, \tau(e)) \wedge \mathbf{fine}_{\mu=length}(\mathsf{P}) \wedge$
$\forall t \in \mathsf{P} \exists e'[\tau(e') = t \wedge \textsc{look.at}(e') \wedge e[\tau]e']]$

It is clear that (63), in virtue of the $*$-operator, is a predicate of atomic pluractional events as well as their sums. This means that (63) will allow the attested distributive reading of (48) to be derived. It need merely be the case that each person is the agent of some pluractional event of looking at the speaker, and then due to cumulative closure, the sum of these events will satisfy (63). Crucially, though, no simple atomic looking events can satisfy (63). Such events are merely related to the pluractional events by the temporal trace function. They are not in the extension of the pluractional verb, and thus cannot be accessed through distributive predication or distributive quantification.

The swarm-based account of event-internal pluractionality not only explains why it should be opaque to core types of verbal distributivity, it predicts its behavior with respect to other kinds of distributors that cut across the event/individual divide. The analysis predicts that event-internal pluractionals should behave exactly like swarm nouns with respect to these operators, which is the case. Recall that one of the primary differences between canonical group nouns and swarm nouns is that adverbial modifiers like *one by one* are only able to distribute over the former (see 13-15). What is special about *one by one* as a test, though, is that it simultaneously distributes over the event argument as well. Brasoveanu & Henderson (2009) say that it places atomic events and atomic individuals in correspondence, which means that it has a similar effect in both the domain of individuals and the domain of events. My analysis thus predicts that *one by one* should not be able to distribute over the plurality that makes up an event-internal pluractional event, but it should be able to "look inside" other kinds of complex events. Both of these predictions are borne out. Note first that *pa jujun* 'one by one' in both Kaqchikel and English is able to look inside complex events, distributing its parts over the parts of a plural argument. In particular, a *gathering* could be thought of as a sequence of arrivals that has been grouped into an event with a singular character. Example (64) shows that the distributive operator has access to these arrivals, as well as the individuals who make up the group-denoting individual argument.

(64) *Pa ju-jun ri moläj x-Ø-ki-mol ki' pa k'ayb'äl.*
P one-RED the group/team CP-A3s-E3p-group REFL P market
'The group/team arrived in the market one by one.'

In contrast, the same distributor cannot target the pluractional subevents of an event-internal pluractional, which is parallel to its behavior with swarm nouns.

(65) *Pa ju-jun x-Ø-ki-k'uy-uk'a' pa jay.*
P one-RED CP-A3s-E3s-knock-Ca' P house
#'One by one they kept knocking at the door (each person knocks once).'
'One by one they kept knocking at the door (each person knocks many times).

(66) *X-e-chok-ocha pa ka-ka.*
CP-A3p-push-Ca' P two-RED
#'Two by two they kept pushing on it (each pair pushes once).'
'Two by two they kept pushing on it (each pair pushes many times).'

Finally, just for contrast, example (66) shows that event-external pluractionals, like *–löj* in Kaqchikel (Henderson 2012), pattern with bona fide plurals and group nouns. This shows that pluractionality in general does not lead to opaqueness with respect to distributivity operators. It is a particular property that unites event-internal pluractionality and swarm reference.

(67) *Ri aj x-e-b'oj-löj pa ka-ka.*
The fireworks CP-A3p-explode-löj P two-RED
'The fireworks kept exploding two by two.'

An analysis that assimilates event-internal pluractional verbs to swarm nouns, like the one developed here, immediately captures the generalization that the two classes of predicates behave similarly with respect to cross-categorial distributive operators. Just like swarm nouns, event-internal pluractionals denote predicates of atomic entities that are related to a plurality via a trace function, not the membership function that accompanies group nouns. Thus, the adverbial distributive operator is unable to access the plurality whose existence is entailed by the existence of the swarm.

In sum, this section has argued for two interrelated claims. First, I have demonstrated that the Kaqchikel derivation *–Ca'* is a canonical example of event-internal pluractionality. Second, I have shown that the properties of *Ca'*-marked predicates in Kaqchikel follow immediately if the pluractional derives predicates of swarm events. Most importantly, the analysis treats event-internal pluractional verbs in Kaqchikel as the verbal counterparts to the swarm nouns discussed in §2. This means that natural language reuses even fine-grained subtypes of plural reference across the individual and event domains. Finally, because the Kaqchikel pluractional exemplifies a common type of pluractionality attested crosslinguistically, the analysis is expected to extend to other languages. The fact that we can reduce a typologically common form of pluractionality to a species of collective reference that is identifiable in the nominal domain is a satisfying conclusion. The rest of the paper extends this result. First I show that the analysis improves over previous accounts of event-internal pluractionality. The final section then argues that there are languages with nominal derivations that generate swarm nouns. This means that not only are there languages that clearly grammaticalize swarm reference in the nominal domain, but their compositional semantics makes the parallels with event-internal pluractionality even clearer.

3.3 Comparing Previous Approaches

The previous accounts of event-internal pluractionality can be split into two camps. The first takes temporal structure to be primary, while the second takes plurality to be primary. Both groups, though, attempt to assimilate event-internal pluractionality to a type of plural reference in the nominal domain. In comparing these approaches, then, the goal is to show that event-internal pluractionality is best compared to the notion of swarm reference that this paper introduces.

The first formal work on event-internal pluractionality is Lasersohn 1995, which is situated within a larger work on plurality, events, and plural predication. It is meant to be a first pass and is used as an illustration of how his theory extends to unfamiliar phenomena.

Lasersohn approaches the problem by presenting a schema for giving the denotations of pluractional morphemes of all types. The parameters along which a particular pluractional morpheme can vary are lifted off of the typological literature, in particular, Cusic 1981. The core schema for the semantics of pluractionals is given in (68).

(68) $V\text{–PLRC}(X) \Longleftrightarrow \forall e \in X[P(e) \wedge CARD(X) \geq n]$

For Lasersohn, pluractional predicates denote sets of events whose cardinality exceeds n and whose members satisfy P. If n is set to 2, and $P = V$, then the pluractional would have a semantics similar to plural count nouns. If n is contextually set, the result is a pluractional with a 'many-event' reading. Finally, if $P \neq V$, then the pluractional subevents are not necessarily in the extension of the predicate to which the pluractional applies. Lasersohn uses this last contrast as the basis for the event-internal/event-external distinction. The idea is that event-external pluractionals will have $P = V$, while event-internal pluractionals will have $P \neq V$, where P describes a subphase of those events in V. Essentially, Lasersohn's account zooms in on the fact that event-internal pluractionals often require repetitions of events that would not satisfy the predicate that the pluractional derives (see, for instance, examples 35-36).[20]

The crucial point for comparing Lasersohn's analysis to my approach is that for him all pluractional predicates denote the same sort of model-theoretic objects—sets of events—which he also uses to model plural count nouns. This makes the prediction that event-internal pluractionals should behave like plural count nouns, which is not the case. We have seen, for instance, that event-internal pluractionals are opaque to all forms of distributivity. In contrast, adverbial modifiers like floated-*each* and *one by one* are able to manipulate the atomic parts of the individuals in the extension of count nouns. The second problem with Lasersohn 1995 is that, as we have seen, the pluractional further contributes a series of conditions that restrict which sets of events the pluractional denotes, but these conditions are clearly both independent of each other, and independent of the kind of plural individuals the pluractional denotes. That is, the setting of P relative to V in (68) is not related to the setting of any of the other parameters. Therefore, his analysis predicts, among other things, the existence of a pluractional where $P \neq V$ and $n = 2$. This would be an event-internal pluractional that did not require many repetitions, but only a simple plurality. Crucially, though, morphemes like this do not exist. The properties of event-internal pluractionality go together, which is why we can identify it as a crosslinguistically stable type. Ideally, we would want an explanation for why these properties cohere. Assimilating event-internal pluractionality to simple count plurality does not do this, but assimilating it to swarm reference does, as §2-3 argue. Thus, while we can give event-internal pluractionals the correct truth conditions in simple, non-distributive clauses using the schema in Lasersohn 1995, it does not explain why event-internal pluractionals have the properties they do or connect those properties to the particular species of plural reference associated with the pluractional.

The second class of accounts, exemplified by Wood 2007 and Tovena & Kihm 2008, are united by treating event-internal pluractionality as group reference in the event domain.

[20] Lasersohn 1995 proposes other contextually and lexically determined parameters that pluractionals can vary on, for instance, parameters controlling the amount of spatial and temporal overlap of the repeating events. Detailing these parameters is not important for comparing his core approach to the one developed here.

In particular, both claim that event-internal pluractional predicates denote group events that are formed by the groupification operator ↑ of Landman 1996, 2000, which is a partial function on D_ε mapping pluralities to groups.[21] The core idea behind these approaches is that event internal pluractional verbs denote sets of events that are groupified pluralities satisfying the underlying predicate. The following translations make this clear.

(69) a. $jump \rightsquigarrow \lambda e[jump'(e)]$

b. $jump$–PLRC $\rightsquigarrow \lambda e \exists e'[*jump'(e') \wedge e =\uparrow e']$

While the intuition is appealing, as a formal tool, groupification does not do much on its own. It serves only to block distributing pluractional subevents over a plural participant.[22] At the same time, it does not go far enough, for we have seen that modifiers like *one by one* are able to retrieve the atomic members of group individuals, but such modifiers are unable to access the repeating events that accompany event-internal pluractionality. In this way, the pluractional behaves more like swarm nouns than group nouns, even though they are all related in virtue of denoting collective entities.

Moreover, in these accounts, as in Lasersohn 1995, the rest of the properties of event-internal pluractionals have to be derived by putting additional conditions on what sorts of pluralities of events can be groupified. For instance, they should occur in the same time, in the same place, towards a similar goal, be internally simplex, etc. Once again, the cluster of properties that are found with event-internal pluractionals are independent in this analysis. Ideally, as many of these extra conditions as possible would follow from the properties of groups themselves. This cannot be done with an account that generates pluractional events using the groupification operator, but it is possible if event-internal pluractionals denote swarm events, which §3.1-3.2 show have similar properties to the independently established swarm individuals.

Finally, there are analyses of event-internal pluractionality that, instead of plurality, take the semantics of aspect and adverbials as a point of departure (van Geenhoven 2004, or Xrakovskij 1997 for a similar non-formal proposal). In particular, van Geenhoven (2004) is interested in the source of atelicity in natural language. She argues that it is the result of covert frequentative adverbials in English, which we can see overtly in the form of pluractionality in other languages. While not focused on event-internal pluractionality per se, van Geenhoven (2004) notes that all pluractionals, including event-internal pluractionals, derive atelic verb phrases. If atelicity is cumulativity with respect to times, as is assumed in that work, then all subtypes of pluractional verbs should have mass-like denotations in the temporal domain, that is, they are cumulative with respect to times (see Cusic 1981 for similar claim that event-internal pluractional verbs have mass reference).

Against this backdrop, all atelic predicates are analyzed as pluractional in van Geenhoven 2004 and certain cases of coerced atelicity in English is due to covert pluractionality operators, which we can see overtly in languages like Kaqchikel. This kind of analysis is

[21] See footnote 15 for more discussion of groupification and its relationship to the account of group nouns assumed here.

[22] This is only true relative to a particular set of assumptions in Landman 1996, 2000, in particular, the assumption that true thematic roles are not cumulatively closed and that distributive readings are generated with the help of special plural roles.

appealing, but once again, mass nouns have a variety of properties over and above their close connection to atelicity (most notably, by lending their cumulative reference to incremental theme verbs in classic accounts of verbs of variable telicity like Krifka 1989, 1992). Ideally, an analysis that gives event-internal pluractionals a mass denotation should show that they behave have like mass nouns on a variety of tests. Moreover, as many of the properties of event-internal pluractionality as possible should follow from general facts about mass reference.

While the analysis in van Geenhoven 2004 is correct to emphasize the importance of temporal reference for pluractionality, which comes through in my account in the way that swarm reference is made possible by temporal (and spatial) trace functions, assimilating event-internal pluractionality to mass reference has problems. The first is that, unlike mass nouns, event-internal pluractional verbs accept quantification without coericion. Examples (70-71) show that the entities in the extension of a pluractional can be counted, that is, pluractional verbs are atomated, unlike mass predicates.

(70) a. *all rice

b. *one rice

(71) a. *Jantape' ri a Xwan x-Ø-u-pitz'-ipa' ri xkoya'.*
always the CLF Juan CP-A3s-E3s-squeeze-Ca' the tomato
'Juan always squeezed the tomato repeatedly.'

b. *Jub'ey ri a Xwan x-Ø-u-pitz'-ipa' ri xkoya'.*
once the CLF Juan CP-A3s-E3s-squeeze-Ca' the tomato
'Juan squeezed the tomato repeatedly once.'

Second, while the mass analysis improves over other previous analyses in its handing of distributivity—in virtue of having no atomic parts, mass nouns cannot even be targeted by adverbial modifiers like *one by one*—it still encounters difficulties with those other properties of event-internal pluractionality. For instance, event-internal pluractional verbs denote events that have a large number of repetitions. In contrast, some mass predicates can be satisfied by individuals that are intuitively singular, as in examples (72-73).

(72) A plate comes out of the dishwasher with a single grain of rice still stuck to it.

a. This dish isn't clean! There is still rice on it.

(73) Your friend wants to return the truck you rented, but there is a still a single couch inside.

a. Don't take it back, yet! We still have furniture to move.

A mass analysis also makes incorrect predictions about the temporal entailments of event-internal pluractionals. Recall that the repetitions that make up an event-internal pluractional event must be contiguous. In this way, they are like the plurality that makes up a swarm individual, which must occupy a circumscribed region of space. In contrast, the

parts that make up a mass individual can be physically separated without disrupting the ability to refer to that individual with the mass term. For instance, if I knock over a jar of rice, it is possible to say (74). The same isn't true for a bouquet, illustrated by (75).

(74) I kept finding that rice for weeks all over the kitchen.

(75) #I kept finding that bouquet for weeks all over the kitchen.

These considerations show that it is not possible to account for all of the properties of event-internal pluractionality by reducing it to mass reference. The same is true for previous approaches that try to assimilate such pluractional predicates to group nouns or plural count nouns. Instead, I have argued in the past two sections that in order to identify event-internal pluractionality with a species of plural reference in the nominal domain, one must first acknowledge the existence of swarm nouns, a type of collective noun whose lexical semantics is based on the spatiotemporal superposition of a plurality and an atomic individual. Once we give event-internal pluractional predicates a similar analysis in the event domain, the various crosslinguistically stable properties of event-internal pluractionality receive a unified explanation. The next section shifts back to the nominal domain, where I show that there are languages in which swarm nouns are derivable from vanilla singular count nouns. This solidifies the argument that grammars distinguish swarm reference from other kinds of collective nouns, and shows that predicates with swarm reference can stand in the same kinds of derivational relationships across the event and individual domains.

4 Looking Broader

There is one small difference between the analysis of swarm nouns and event-internal pluractional verbs that has not yet been touched on. Digging deeper, though, we find that this surface difference is a further argument for the crosslinguistic similarity of these two classes of expressions. In particular, the swarm nouns presented thus far are lexical predicates, while event-internal pluractional verbs are morphologically derived. If there were complete morphosemantic unification between these two classes of expressions, there should be morphemes that derive swarm nouns out of arbitrary predicates. That is, just like pluractional affixes, the relevant morpheme should take a nominal predicate P and derive a predicate of atoms whose spatiotemporal trace is covered by P-individuals.

While English or Kaqchikel do not have such a suffix, there are languages that do, even other Mayan languages. For example, Tzotzil has the suffix *–tik* that derives predicates of "expansive" individuals (Laughlin 1975). For example, it applies to the plants and trees to form nominals similar to grove.[23]

(76) a. *chichol* 'tomato'

b. *chichol-tik* 'field of tomatoes'

[23] I would like to thank Judith Aissen for bringing this suffix to my attention.

(77) a. *la* 'bush nettle'
b. *la-tik* 'expanse of 'la'

(78) a. *lo'bol* 'banana'
b. *lo'bol-tik* 'banana grove'

(79) a. *te'* 'tree'
b. *te'-tik* 'forest'

(80) a. *tulan* 'oak'
b. *tulan-tik* 'oak grove'

In addition, it appears to apply more broadly to predicates of all sorts, deriving expanses filled with entities satisfying those predicates.

(81) a. *ton* 'rock'
b. *tontik* 'rocky place'

(82) a. *tuch'ulil* 'scrap'
b. *tuch'ultik* 'in shreds'

(83) a. *ka'ep* 'rubbish'
b. *ka'eptik* 'dump, *lit. expanse of rubbish*'

(84) a. *yi'al* 'river sand'
b. *yi'altik* 'expanse of sand'

Such suffixes are not limited to Mayan. For example, Romanian has the suffixes *–et* and *–iş*, deriving swarm nouns from predicates denoting species of trees (Chelaru-Ionita & Bantas 1978).

(85) a. *brad* 'fir tree'
b. *brăd-et* 'fir-tree grove/forest'
c. *fag* 'beech tree'
d. *făg-et* 'beech grove'

(86) a. *carpen* 'hornbeam tree'

b. *cărpin-iș* 'hornbeam forest'

c. *alun* 'hazel tree'

d. *alun-iș* 'hazel tree grove'

Although the Romanian suffixes do not apply as widely as their Tzotzil counterparts, the point still stands. It would be easy to give suffixes like these a denotation similar to an event-internal pluractional derivation. Just like *–Ca'* displaces a verbal predicate, Romanian *–iș*/*–et* and Tzotzil *–tik* would displace a nominal predicate, deriving a new predicate of atoms whose spatiotemporal trace is filled with individuals that fall in the extension of the predicate they compose with. That is, they would have a translation like (87), which has only one difference compared to (26), namely the individuals that make up the swarm have to satisfy a predicate that is supplied compositionally.

(87) $\lambda Q \lambda x \exists \mathsf{P}[\mathbf{atom}(x) \wedge \mathbf{part}(\mathsf{P}, \varsigma(x)) \wedge \mathbf{contiguous}(\varsigma(x)) \wedge \mathbf{fine}_{\mu=area}(\mathsf{P})$
$\wedge \forall s \in \mathsf{P} \exists y[\varsigma(y) = s \wedge Q(y)]]$

The analysis in (87) is not just supported by the intuitive translations in (76-86), but looking closer at the Romanian examples, we see that the derived swarm nouns have similar properties to their lexicalized counterparts in English.

First, Romanian derived swarm nouns, unlike simple plural count nouns, are ungrammatical with collective predicates.

(88) a. **Alun-iș-ul acela arată bine împreună.*
hazel-group-DEF that look well together
'That hazel grove looks good together.'

b. *Aluni-i aceia arata bine împreună.*
hazel-PL those look well together
'Those hazel trees look good together.'

(89) a. **Alun-iș-ul acela seamana unul cu altul.*
hazel-group-DEF that resemble one with other
'That hazel grove resembles one another.'

b. *Aluni-i aceia seamana unul cu altul.*
hazel-PL those resemble one with other
'Those hazel trees resemble one another.'

The second way that derived swarm nouns behave like their lexicalized counterparts, as well as event-internal pluractional verbs, is that they cannot be targeted by adverbials like *unul cit unul* 'one by one'.

(90) a. **Alun-iş-ul acela a căzut unul cîte unul.*
hazel-PL-DEF those have fallen one by one
'That hazel grove fell over one by one.'

b. *Aluni-i aceia au căzut unul cit unul.*
hazel-PL those have fallen one by one
'That hazels fell over one by one.'

(91) a. **Am numărat brăd-et-ul din doi în doi.*
I counted fir-group-DEF in two by two
'I counted the fir grove two by two.'

b. *Am numărat brazi-i din doi în doi.*
I counted fir-PL in two by two
'I counted the firs two by two.'

Finally, *–iş*/*–et* in Romanian derive predicates that pattern with swarm nouns with respect to stubbornly distributive predicates. They can only be predicated of the whole swarm, not the individuals that intuitively compose it.

(92) a. *Alun-iş-ul acela este circular.*
hazel-group-DEF that is circular
'That hazel grove is circular.'
SPEAKER COMMENT: This cannot mean that the trees themselves are circular.

b. *Aluni-i aceia sint circulari.*
hazel-PL those are circular
'Those hazels are circular.'
SPEAKER COMMENT: This can only mean that the trees themselves are circular.

These three test show that nouns derived by *–iş*/*–et* in Romanian have the properties of swarm nouns in English. Thus, there are languages that clearly permit swarm nouns to be derived from vanilla count nouns. This parallels the way that other languages derive event-internal pluractional verbs, which I have argued exhibit swarm reference in the event domain.

The broader conclusion is that swarm nouns are similar to event-internal pluractional verbs crosslinguistically, not just in their referential properties, but throughout their compositional morphosemantics. One might worry that we only find this uniformity in one direction. There might be derived nominals with swarm reference, but are there verbs which lexicalize swarm reference in the event domain? These would be monomorphemic verbs with the semantics of an event-internal pluractional. While investigating this issue in depth must be left for future work, there are reasons to believe that there are many such verbs. Most strikingly, many event-internal pluractional verbs crosslinguistically are best translated into English with monomorphemic verbs, not with the support of adverbials like *repeatedly* or *frequently*.

(93) Syrian Arabic (Cowell 1964: p. 253)
safa? 'to slap/clap' → *saffa?* 'to applaud'

(94) Central Alaskan Yup'ik (Jacobson 1984: p. 497)
nere– 'to eat' → *Neremciurtuq* 'He nibbled.' (lit. eat a little at a time)

(95) Kaqchikel
chup– 'to turn off' → *Xuchupüt"* 'It flickered.'

There is a case to be made that verbs like those in (93-95), which are derived by pluractional makers in other languages, denote swarm events in English. Consider *applaud*, for instance. An applauding event is clearly composed of a plurality of clappings that fill a circumscribed interval of time, just as an event-internal pluractional would require. Moreover, these individual clappings are inaccessible to distributivity operators. For instance, example (96) has no reading where each student claps once in rapid succession, forming an applause. The pluractional subevents are just not accessible.

(96) The students applauded one by one.

(97) The students gathered in the park one by one.

Note that the problem cannot be that *one by one* requires each event in a satisfying sequence to fall in the extension of the verbal predicate. It is perfectly acceptable to say things like (97). The answer has to be that *applaud* does not make accessible those clapping events that intuitively make up an applause. In this way, it behaves like an event-internal pluractional verb, though one that is clearly monomorphemic.

While there is more to be said about the semantics of these underived pluractional verbs, their existence rounds out the argument developed in this section. There are both derived and underived predicates of swarm individuals across both the event and individual domains. I have chosen to focus on the derived forms because they more forcefully argue for a new type of collective reference. It is a standard to argue for new categories of meaning by pointing to a language that morphologizes the relevant contrasts. This is what we see in the derived swarm nouns in Romanian and Tzotzil.

5 Conclusions

The existence of group nouns motivates two interrelated questions: How does natural language divide entities into groups, and how general is this process? This papers has answered the first question by showing that there is not just one way to do so. There are groups that are defined in terms of the spatial and temporal configuration of their members, called *swarms*, and there are groups that are defined in terms of non-spatiotemporal notions. I then argued that these processes of group formation were generalizable across semantic domains. Not only do we find nouns denoting swarm individuals, but we find verbs denoting

swarm events. In particular, I have shown that the crosslinguistically stable properties of event-internal pluractional verbs follow if they denote swarm events.

To make these arguments, especially the latter one, this paper has focused on pluractionality in the Mayan language Kaqchikel. First, it establishes for the first time that *–Ca'* in Kaqchikel is an event-internal pluractional derivation. It then argues that *–Ca'* derives predicates of swarm events. Crucially, all of the characteristics of event-internal pluractionality follow from this particular type of collectivity, which provides an improvement over previous approaches to the phenomenon. Finally, this paper showed that the kind of collective reference involved in event-internal pluractionality is mirrored in a split between types of collectives nouns we find crosslinguistically, exemplified by the contrast between predicates like *committee* and *grove*. The latter are eventually called *swarm* nouns. Accounting for the contrasts between swarm nouns and canonical group nouns means giving the former denotations that mirror event-internal pluractional verbs. Finally, I presented a few cross-categorial compositional similarities between swarm nouns and event-internal pluractionals that support a unified analysis.

An important consequence of reducing event-internal pluractionality to a species of group reference available in the nominal domain is that it supports a persistent intuition in the pluractional literature that pluractionality is the eventive counterpart of plurality in the individual domain. We know, though, from the extensive literature on nominal plurality that plural reference is not uniform. This immediately raises the question of which kinds of plural reference pluractional can verbs have. If the treatment of pluractionality in this work is on the right track, the answer is manifold. The fact that swarms can be used to account for the properties of certain nouns, as well as pluractional verbs argues that the varieties of plural event reference are just as rich as plural reference in the nominal domain. Moreover, we can use the analysis of expressions in one domain to inform the analysis of expression in the other, just like the analysis of Romanian *–iș* in (87) is supported by its close connection to pluractional derivations like *–Ca'* in (54). The fact that we can use pluractionality to substantiate new classifications of nominals demonstrates the methodological richness of this approach.

Finally, connecting event-internal pluractional verbs with swarm nouns reveals a telling asymmetry. The former have been discussed extensively, even though the data have mostly come from understudied languages, while swarm nouns in English, an extensively studied language, are new to the literature. This might be an accident, but it could also be because swarm nouns are less prevalent than their verbal counterparts, or less often morphologically distinguished, as they are in Romanian and Tzotzil. These observations raise the larger theoretical question of whether languages employ similar representations with the same frequency across categories. It might be that swarm-denoting expressions are more pervasive in the verbal domain because events, in contrast to individuals, are naturally individuated by means of their spatial and temporal traces. While this paper does not address these kinds of ontological issues, a careful typological study of the frequency and productivity of morphemes that derive swarm nouns, as compared to their pluractional counterparts, should provide insight into this larger question. The ultimate goal is to know, not just where we find the same kinds of representations across nouns and verbs, but whether each kind is equally marked or unmarked across categories.

Glossing Conventions:
1=First Person, 2=Second Person, 3=Third Person, A=Absolutive, ART=Article, CAUS=Causative, CLF=Classifier, CP=Completive Aspect, DIM=diminutive, DAT=Dative, DIR=Directional, E=Ergative, ICP=Incompletive, IMP=imperative, IRR=Irrealis, ITR=Iterative, NEG=negation, NOM=nominalizer, PAS=Passive, p=Plural Person, PL=Plural, RED=Reduplicant, REFL=Reflexive, REP=Repetitive, SS=Status Suffix, VTD=Derived Transitive Verb

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