

Acts, occasions and multiplicatives: A mereotopological account *

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Abstract In this paper, I argue for the relevance of structured part-whole configurations in the domain of events. The evidence comes from the well-known event-internal/external distinction, which concerns multiplicative adverbials quantifying either over separate occasions or occasion-internal acts, respectively (e.g., Cusic 1981; Andrews 1983; Cinque 1999; Zhang 2017). In order to capture this distinction, I postulate that the relationship between the two categories is based on a part-whole relation. In particular, inspired by proposals advocating the role of eventive higher-order units (Landman 2006; Henderson 2017) and building on the theories of Grimm (2012) and Mazzola (2019), I propose to extend mereotopology to the domain of events. I argue that this allows for capturing acts as simplex events conceptualized as bounded integrated MSSC wholes, whereas occasions as clusters, i.e., temporally structured configurations of such simplex events.

Keywords: multiplicatives, event-internal/external quantification, acts, occasions, mereology, mereotopology

1 Introduction

During the four decades of the formal research on parthood and pluralities in natural language, a recurring idea put forward independently multiple times is that mereological relations are a core semantic property of different kinds of linguistic expressions, and thus hold not only between individuals (as originally proposed by Link 1983) but can be also identified in more abstract domains. So far, various proposals have argued for part-whole structures in the domains of events (Bach 1986), information states (Krifka 1996), times (Artstein & Francez 2003), degrees (Dotlačil

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& Nouwen 2016), roles (Wagiel 2021a) and even propositions (Lahiri 2002) and functions (Schmitt 2019). It seems that we find evidence for part-whole structures everywhere we look (with the possible exception of worlds; see Schmitt 2023) and numerous results indicate the relevance of mereology across natural language semantic representations.

On the other hand, the last decade of the research on nominal semantics showed that pure mereology is insufficient for capturing the meaning of at least some types of linguistic expressions. This is because there are a number of grammatical phenomena that seem to be sensitive to the manner in which parts of a whole are arranged, and this is something that purely mereological systems cannot describe (Casati & Varzi 1999: 10–11). So far, structured part-whole constellations were argued to be crucial for capturing the semantics of collective/singulative number systems in languages like Welsh and Dagaare (Grimm 2012), atomizers such as *a grain of rice* (Scontras 2014), notional mass nouns in Yudja (Lima 2014), subatomic quantifiers in entity partitives like *a part of that flag* (Wagiel 2021b), Slavic derived collective nouns (Wagiel 2021a) and the German adjective *ganz* ‘whole’ (Igel 2021).

Combining the two sets of results described above invites a question whether structured part-whole configurations can also be found in abstract domains. The aim of this paper is to argue for the relevance of structured parthood in the domain of events. Though eventive part-whole structures attracted a lot of attention, which resulted in many important developments and influential theories (e.g., Bach 1986; Krifka 1998; Landman 2000; Champollion 2017), the research so far has focused mainly on unstructured parthood, as in arbitrary pluralities, and has been mostly pursued within purely mereological frameworks. In contrast, Moltmann (1997) emphasized the role of structured parthood in the domain of events; however, her account entirely rejects mereology (for a critical review of her system, see Pianesi 2002). For this reason, I will pursue an entirely different approach based on the theory of structured part-whole configurations called MEREOTOPOLOGY, which extends standard mereology with topological notions such as connectedness (for an overview, see Casati & Varzi 1999). Early formulations of mereotopology date back to the work by Whitehead (1920, 1929) whose proposals were followed up in developments in formal ontology and artificial intelligence (e.g., Clarke 1981; Smith 1996; Roeper 1997). The theory was introduced to formal semantics by Grimm (2012) and since then inspired a number of proposals in nominal semantics (Lima 2014; Scontras 2014; Wagiel 2021a,b; Igel 2021). Drawing on Mazzola (2019), I will propose to extend a mereotopological approach to events.

The empirical motivation for my proposal concerns the so-called event-internal/external distinction in sentences such as (1) (Cusic 1981: 61).

- (1) The salesman rang the doorbell three times.

Under the EVENT-EXTERNAL reading, the multiplicative *three times* quantifies over so-called OCCASIONS, which are usually assumed to be entire events or situations. On this interpretation, (1) means that there were three separate instances of the salesman ringing the doorbell (once or more than once). On the other hand, under the EVENT-INTERNAL reading, *three times* counts so-called ACTS, which are typically taken to be some sort of subevents that are relevant parts of the whole. In this case, (1) conveys that on one occasion, the salesman rang the doorbell three times.

The goal of this paper is to account for the event-internal/external distinction by extending linguistic applications of mereotopology to events. Inspired by proposals arguing for the relevance of eventive higher-order units in natural language semantics (Landman 2006; Henderson 2017), I build on Grimm's (2012) notion of a cluster and Mazzola's (2019) theory of time. My claim is that event-internal quantification is in fact quantification over simplex bounded events, which are modelled as integrated mereotopological objects. On the other hand, event-external quantification is quantification over clusters of simplex events. Under the proposed approach, the event-internal/external distinction turns out to be a misnomer since both acts and occasions are eventualities (type ν) with the only difference being their internal part-whole structure.

The outline of the paper is as follows. In §2, I will discuss the well-known event-internal/external phenomena regarding the distinction between acts and occasions and the corresponding ontological puzzle. In §3, I will describe the mereotopological framework adapted for the purpose of the analysis. In §4, I will briefly propose how to extend mereotopology to the domain of events via the notion of temporal connect-edness. In §5, I will propose an analysis based on the distinction between simplex integrated events and clusters thereof and demonstrate how it allows for deriving the event-internal/external phenomena discussed in §2. Finally, §6 concludes the paper.

2 Acts and occasions

Though the event-internal/external distinction is well described in the syntactic literature (e.g., Cusic 1981; Andrews 1983; Cinque 1999; Landman 2006; Zhang 2017), it has not received much attention from a semantic perspective (but see, e.g., Lasersohn 1995; Landman 2006). The distinction concerns quantification over acts, which are typically assumed to be occasion-internal subevents, and quantification over occasions, i.e., separate events or situations, respectively.

2.1 Data

Depending on a position in a sentence, multiplicatives such as *twice* and *three times* can count either entire situations, i.e., occasions, or occasion-internal acts, i.e.,

subevents that are relevant parts of the whole. Under the event-external reading, (2) means that on three separate occasions Kim knocked on the door (once or more), see (2a), whereas the event-internal interpretation states that on one occasion they knocked on the door three times, see (2b) (Cusic 1981; Andrews 1983; Cinque 1999; Landman 2006; Zhang 2017).

- (2) Kim knocked on the door three times.
- a. On three separate occasions, Kim knocked on the door (once). E-EXT
 - b. On one occasion, Kim knocked on the door three times. E-INT

The event-internal/external ambiguity typically arises with verbs describing instantaneous actions such as semelfactives. What seems to be necessary is a notion of a very brief (punctual) event that ends by returning to its initial state, which in turn creates a possibility of a quick repetition. Otherwise, the ambiguity is very hard to get without coercing the common meaning of the verbal predicate by various pragmatic mechanisms. For instance, out of the blue (3) only has the event-external interpretation. For this reason, in this paper, I will focus only on examples with semelfactive verbs such as (2), as discussed in the previous literature.

- (3) Kim built a house three times.
- a. On three separate occasions, Kim built a house.
 - b. # On one occasion, Kim built a house three times.

Interestingly, when two adverbials modify the VP, one of them targets entire occasions, whereas the other one affects only internal acts. In such cases, the event-internal/external distinction depends on structure. In particular, relative position of different adverbial modifiers results in different scope relations, which determine which adverbial operates event-internally and which one event-externally. Moreover, different syntactic constructions may or may not give rise to scope ambiguities. For instance, Andrews (1983: 696) argues that a sentence such as (4) allows for both scope configurations, i.e., either it involves one intentional instance of knocking on the door twice or two separate occasions of intentional knocking on the door.

- (4) Kim intentionally knocked on the door twice.
- a. intentionally > twice
 - b. twice > intentionally

On the other hand, (5) gives rise only to wide scope of *intentionally* with respect to the multiplicative, and thus the example unambiguously describes one intentional instance of knocking on the door by Kim twice (Andrews 1983: 695). This suggests that the syntactic position of the adverbial impacts the possibility of the event-external/internal interpretation.

- (5) Kim knocked on the door twice intentionally.
 a. intentionally > twice
 b. # twice > intentionally

In this paper, I will limit my focus to constructions with two interacting multiplicative adverbials. Let us, thus, consider the examples in (6)–(10) (see also Cinque 1999: 27–28). In (6), the sentence-initial multiplicative *twice* unambiguously quantifies event-externally, i.e., counts the number of independent knocking occasions, whereas *three times*, which appears lower in the structure, quantifies event-internally, i.e., specifies the number of particular knocks within each of those knocking eventualities.

- (6) Twice, Kim knocked on the door three times.
 a. twice > three times
 b. # three times > twice

The same applies to (7), where *three times* attaches directly to the VP, and thus quantifies over acts, whereas *twice* appears at the right edge of the clause and counts occasions of knocking three times. Again, no ambiguity arises in this case.

- (7) Kim knocked on the door three times twice.
 a. twice > three times
 b. # three times > twice

Nonetheless, for some speakers certain constructions with two multiplicatives seem to give rise to a scope ambiguity. To illustrate, let us consider (8).

- (8) Kim twice knocked on the door three times.
 a. twice > three times
 b. % three times > twice

Though for many English speakers the word order in this sentence appears to be marked, examples of this type have been reported and analyzed in the literature. For instance, Cinque (1999: 27) states that in such cases the only possible interpretation is that the preverbal multiplicative quantifies event-externally, whereas the postverbal multiplicative quantifies event-internally (see also Andrews 1983: 696). However, in addition to this uncontroversial reading some of my informants reported also the possibility of the reversed interpretation of (8) with *three times* counting occasions and *twice* counting acts within those occasions. For this reason, I will assume that for some speakers both scopal relations are available in (8).

Let us now move to configurations with the reversed scope relation between the discussed multiplicatives. For instance, in (9) *twice* arguably appears inside the VP,

and thus is outscoped by the higher *three times*. Hence, the only interpretation of this sentence is that on three occasions Kim gave two knocks on the door.

- (9) Kim knocked twice on the door three times.
- a. # twice > three times
 - b. three times > twice

Finally, we can have an example similar to (7) but with the opposite order of the multiplicatives, as provided in (10). In this case, *twice* unambiguously quantifies even-internally, whereas *three times* counts entire occasions. Consequently, the sentence means that there were three instances of Kim knocking on the door twice, which is the reverse of (7).

- (10) Kim knocked on the door twice three times.
- a. # twice > three times
 - b. three times > twice

The data indicate that the syntactic position of multiplicatives determines whether they target occasions or acts. Those high in the structure are interpreted event-externally, whereas those that are low get the event-internal reading (Cinque 1999).

2.2 Puzzle

An important question concerns the ontological status of occasions and acts (Tovena 2012). Intuitively, both appear to be eventualities since they both describe actions involving participants and exhibit typical eventive traits such as unfolding in time and being associated with a location. However, the ontological relationship between the two categories is rather unclear and has not been unanimously established in the literature so far. Thus, a question arises on how one should model the event-internal/external distinction.

I will contribute to solving this ontological puzzle by arguing that acts and occasions are in fact both eventualities and that the relationship between the two is that of part-whole. Nonetheless, I do not take occasions to be events and acts some sort of event-internal subparts, but rather I assume that acts are simplex punctual events and occasions are temporally structured series thereof. This idea is inspired by Landman's (2006) proposal to extend groups understood as higher-order units to the domain of events. However, based on recent developments in the research on various types of collective nouns (e.g., Henderson 2017; Zwarts 2020; Wągiel 2021a, 2022a), I argue that these higher-order units have a particular internal structure that makes them temporal clusters. Consequently, there is a semantic parallel between

event-external VPs and certain collective DPs such that the meaning of (7), repeated here as (11a), can be informally paraphrased as (11b).

- (11) a. Kim knocked on the door three times twice.
 b. Kim gave two series of three knocks on the door.

In the next section, I will introduce basic mereotopological notions that will be utilized to capture the intuition spelled out above.

3 Mereotopological framework

In this paper, I adopt a mereotopological framework. Mereotopology is a theory of parts and wholes that combines standard mereology with topological notions that allow for modelling various spatial configurations of entities (Casati & Varzi 1999; see also Grimm 2012; Wagiel 2021b). In this framework, the key topological notion is CONNECTEDNESS (C). This is a reflexive and symmetric relation holding between two individuals. In the version of mereotopology adopted here, C is introduced in such a way that it interacts with the basic mereological notions of PARTHOOD (\sqsubseteq) and OVERLAP (O). This is ensured by the so-called bridging principles (Varzi 2007). Consequently, while a mereological structure is grounded only on \sqsubseteq , a mereotopological structure is based on the interaction between \sqsubseteq and C.

3.1 Integrated objects

The extension of mereology with topology allows for defining various mereotopological notions in order to capture various topological configurations of entities within a given part-whole structure. This in turn allows for modelling different kinds of ontological objects depending on their mereotopological structure. For instance, it is possible to make a formal distinction between discrete objects conceptualized as integrated wholes, arbitrary pluralities thereof and other types of entities, e.g., amorphous solid substances and liquids.

The concept of an integrated object plays an important role in human cognition (for an overview, see Wagiel 2021b: Ch. 5). Intuitively, it is an entity conceptualized as a coherent whole whose parts are joined. Integrated objects are perceived as having natural boundaries and moving across space along continuous paths. In mereotopology, these intuitions can be modelled by utilizing the property of SELF-CONNECTED (SC), which is defined in (12) (Casati & Varzi 1999: 57). In prose, an individual is self-connected if any two parts that form the whole of that individual are connected to each other.

$$(12) \quad SC(x) = \forall y \forall z [\forall w (O(w, x) \leftrightarrow (O(w, y) \vee O(w, z))) \rightarrow C(y, z)]$$

Notice, however, that the property of self-connectedness is not sufficient for modelling integrated wholes because it does not rule out configurations of externally connected entities, i.e., objects merely touching each other, which intuitively do not classify as integrated wholes. This can be ensured by the property of STRONGLY SELF-CONNECTED (SSC), as defined in (13), where INT stands for INTERIOR, i.e., the sum of internal parts of an entity (Casati & Varzi 1999: 58–60). The definition states that an individual is strongly self-connected if it is self-connected and its interior is also self-connected.

$$(13) \quad \text{SSC}(x) = \text{SC}(x) \wedge \text{SC}(\text{INT}(x))$$

Finally, the ultimate definition of an integrated whole should encapsulate two more features. The first one is mereological maximality, i.e., we are interested in the largest SSC part of a thing, and the second one is the fact that integrity should not be regarded in absolute terms but rather in relation to a particular property. In mereotopology, we can capture these two conditions by the property of being MAXIMALLY STRONGLY SELF-CONNECTED (MSSC), as defined in (14) (Casati & Varzi 1999: 60). This formulation models the intuitive concept of an integrated whole as follows: if an entity satisfies MSSC relative to a property P , then it is the largest strongly self-connected entity satisfying P .

$$(14) \quad \text{MSSC}(P)(x) = P(x) \wedge \text{SSC}(x) \wedge \forall y [P(y) \wedge \text{SSC}(y) \wedge \text{O}(y,x) \rightarrow y \sqsubseteq x]$$

With (14) in hand, we can make an ontological distinction between integrated wholes modelled as MSSC entities and other types of entities. Specifically, I will employ entities with a mereotopologically complex internal structure that are called clusters.

3.2 Clusters

The connectedness relation C can be utilized to derive also other kinds of mereotopologically complex part-whole structures. For instance, one can draw an ontological distinction between unstructured pluralities, i.e., arbitrary sums of entities, and clustered individuals, i.e., topologically structured pluralities with externally connected constituent parts touching each other or parts remaining in close proximity. The key notion for defining clustered individuals is the property of TRANSITIVELY CONNECTED (TC) (see Grimm 2012: 144). In this paper, I will adopt Wągiel's (2021a: 193) revised formulation, as provided in (15). The definition describes structures in which two objects are connected through a series of mediating entities without being directly connected to each other. More specifically, entities x and y are transitively connected relative to a property P , a connection relation C , and a sequence of entities Z , when all members of Z satisfy P and x and y are connected through the sequence of mediating entities z_i s in Z .

- (15) For a finite sequence $Z = \langle z_1, \dots, z_n \rangle$, $\text{TC}(x, y, P, C, Z)$ holds iff
 $z_1 = x, z_n = y, C(z_i, z_{i+1})$ holds for $1 \leq i < n$ and $P(z_i)$ holds for $1 \leq i \leq n$.

An example of a configuration of entities structured topologically by TC would be a chain of individuals a , b and c , such that a touches b but does not touch c , whereas c touches b but does not touch a . In such a configuration the individuals a and c are not directly connected; however, they are transitively connected via the mediating individual b , which is connected to both a and c . Note also that a given configuration always forms a cluster relative to a particular property. For this reason, depending on a property, different kinds of connections may apply. For instance, one can observe clusters structured in terms of their parts touching each other. Formally, this can be described by the notion of EXTERNALLY CONNECTED (EC) (see Grimm 2012: 134), which captures entities sharing (parts of) their boundaries. On the other hand, for other properties, configurations of entities that are simply close to each other without necessarily touching each other can also be conceptualized as clusters. In mereotopology, remaining in stable and predictable proximity can be captured via the property of PROXIMATELY CONNECTED (PC) (see Grimm 2012: 135).

To illustrate, consider the entities in the extension of the nominal expressions *heap of sand* and *flock of birds*. While we perceive the former as collections of grains typically touching each other, we do not necessarily expect the latter to be externally connected. Rather, it is sufficient for individual birds to remain in close, stable and predictable proximity for the whole to be conceptualized as a cluster. This is why in this paper I assume the connection parameter C in (15), which varies across different connection types, and thus allows for accounting for non-uniform conceptualizations of clusters for different predicates, as discussed above.

Crucially, the TC relation introduced in (15) allows for defining the notion of CLUSTER (CLSTR) (see Grimm 2012: 144). Again, in this paper I will adopt Wągiel's (2021a: 193) revised definition in (16). In prose, an individual x is a cluster relative to a connection relation C and a property P iff x is a sum of individuals having the property P , which are all transitively connected relative to a subset of Z under the same property P and connection relation C . For instance, the sum $a \sqcup b \sqcup c$ in the mereotopological configuration discussed above is a cluster since its constituent parts are transitively connected.

- (16) $\text{CLSTR}_C(P)(x) = \exists Z[x = \sqcup Z \wedge \forall z \forall z' \in Z \exists Y \subseteq Z [\text{TC}(z, z', P, C, Y)]]$

With the notion of CLSTR in (16) it is possible to describe various complex spatially structured configurations of individuals as mereotopological objects. Consequently, we can draw an ontological distinction between various types of entities, e.g., integrated wholes, i.e., individuals conceptualized as discrete singular objects whose parts stick to each other, pluralities, i.e., arbitrary sums of entities with no topologi-

cal notions holding between parts, homogenous substances, scattered entities and clusters, which can be modelled as topologically structured pluralities.

With all mereotopological tools in hand, in the next section I will propose how notions such as MSSC and CLSTR could be extended to the domain of events.

4 Extending mereotopology to events

So far, linguistic applications of mereotopology focused mostly on capturing properties of concrete spatial objects (but see [Wągiel 2021a](#) for an attempt to apply mereotopological notions in the abstract domain of social roles). However, the *C* relation and other mereotopological notions should not be viewed as restricted to the domain of spatial physical objects. Rather, they are abstract enough to be applicable also to temporal entities such as events.

4.1 Eventualities

In this paper, I adopt a standard neo-Davidsonian framework, as frequently presumed in natural language semantics (e.g., [Carlson 1984](#); [Dowty 1989](#); [Parsons 1990](#)). Therefore, I assume an ontology extended with events, which are taken to be an independent ontological category of the primitive type v occupying the domain D_v . Since [Davidson \(1967\)](#) events are conceptualized as complex spatiotemporal particulars, i.e., actual entities with a location and time, often with rich internal structure involving participating individuals, i.e., objects of type e , and other components such as the endpoint (*telos*) and a change of state, which all constitute what [Parsons \(1990\)](#) called subatomic semantics. Though both space and time are relevant for how events are conceived of and linguistically relevant, in this paper I will focus exclusively on the temporal dimension.

Events are typically associated with individuals participating in them via thematic roles such as AG (for ‘agent’), TH (for ‘theme’), INSTR (for ‘instrument’) etc. Following [Champollion \(2017\)](#), I assume that thematic roles are functions of type $\langle v, e \rangle$ that take an event and return an individual playing a given participant role in that event. For instance, $AG(a) = b$ states that the individual b is the agent of the event a . On the other hand, individuals typically do not involve an eventive component (but see [Wągiel 2022b](#)).

Finally, following [Bach \(1986\)](#), [Krifka \(1998\)](#) and others I assume that events form a mereological structure, which involves pluralities in a similar way as we obtain pluralities of individuals. Traditionally, such pluralities do not involve structured relations holding between parts within a whole, i.e., they are merely arbitrary sums of events. In contrast, I argue that certain collections of events may involve internal structure that can be captured in mereotopological terms as temporal clusters.

4.2 Temporal connection

Building on [Mazzola's \(2019\)](#) theory of time (see also [Pianesi & Varzi 1996](#)), I propose to extend linguistic application of mereotopology to the domain of events. For one thing, it is intuitive to think of longer time intervals as being composed from shorter time intervals the same way wholes are composed from parts, which motivates a mereological approach. In addition, [Mazzola](#) argues that many standard notions regarding time intervals and relations holding between them such as temporal precedence and overlap actually involve implicit mereotopological assumptions that require time to be conceived of as linear and gapless. In order to spell out these assumptions explicitly, he develops a theory of time, which postulates various mereotopological interval structures based on the notions of \sqsubseteq and C .

Depending on a set of particular mereotopological restrictions one introduces, [Mazzola's](#) system allows for capturing various temporal models based on the absence or existence of loops and/or branches. These restrictions can give rise to a common sense linear model of time, but also to more exotic systems including forking and circular models as well as models admitting several parallel temporal lines. The theory also allows for capturing external connection holding between intervals in a similar vein as discussed in §3.2.

For the purpose of this paper, I assume that the temporal dimension of events is key for defining their mereotopological structure. On the assumption that time is linear, gapless and involves only one temporal line, I posit that eventualities can be viewed as temporal particulars structured by TEMPORAL CONNECTION (TEMP) on which MSSC and CLSTR can be based. Given the assumed linear and gapless nature of time, TEMP holds between intervals that immediately precede or follow each other. For simplicity, I will write $MSSC_{TEMP}$ and $CLSTR_{TEMP}$ in order to refer to properties regarding temporal integrated wholes and temporal clusters, respectively.

5 Proposal

The analysis is inspired by the previous work postulating the relevance of higher-order units in the domain of eventualities. In particular, [Landman \(2006\)](#) proposed to extend the notion of groups to events, whereas [Henderson \(2017\)](#) argued for the relevance of eventive swarms, i.e., structured pluralities of events, for capturing pluractionality. Inspired by these proposals, I intend to capture the relevant intuition in mereotopological terms. The core idea behind my analysis is that acts are simplex discrete eventualities conceived of as temporally integrated wholes, which can be modelled in mereotopological terms as MSSC events, whereas occasions are temporal clusters thereof. As such they correspond to the intuitive notion of series of events, recall the parallel in (11), repeated here as (17).

- (17) a. Kim knocked on the door three times twice.
 b. Kim gave two series of three knocks on the door.

Crucially, on the proposed account the event-internal/external distinction is actually a misnomer since both acts and occasions are eventualities but with different internal part-whole structures.

5.1 Components

Let us begin by distinguishing between two types of event predicates. First, predicates of singular discrete eventualities satisfy the higher-order property $\text{PMSSC}_{\text{TEMP}}$ in (18), which states that a predicate is a predicate of MSSC events if all things in its denotation are eventualities conceptualized as temporally MSSC wholes relative to the relevant property. On the other hand, predicates of clusters of events satisfy the corresponding $\text{PCLSTR}_{\text{TEMP}}$ property in (19). According to the definition, a predicate is a predicate of CLSTR eventualities if its extension consists only of temporal clusters of events. Finally, we can generalize by positing the higher-order property $\text{PIND}_{\text{TEMP}}$ in (20), which covers properties of eventualities that are individuated as units either in terms of $\text{MSSC}_{\text{TEMP}}$ or $\text{CLSTR}_{\text{TEMP}}$.

$$(18) \quad \text{PMSSC}_{\text{TEMP}}(P) = \forall e_v [P(e) \rightarrow \text{MSSC}_{\text{TEMP}}(P)(e)]$$

$$(19) \quad \text{PCLSTR}_{\text{TEMP}}(P) = \forall e_v [P(e) \rightarrow \text{CLSTR}_{\text{TEMP}}(P)(e)]$$

$$(20) \quad \text{PIND}_{\text{TEMP}}(P) = \forall e_v [P(e) \rightarrow \text{MSSC}_{\text{TEMP}}(P)(e) \vee \text{CLSTR}_{\text{TEMP}}(P)(e)]$$

Moreover, I postulate that verbs describing instantaneous actions such as *knock*, *ring* and *sneeze* etc. denote sets of singular eventualities that are conceptualized as discrete integrated wholes, which I capture as MSSC events, recall §3.1 and 4.2. For instance, the postulated semantics for the verb *knock* is provided in (21).¹ Crucially, the events in the extension of the verbs in question can be pluralized and clustered.

$$(21) \quad \llbracket \text{knock} \rrbracket = \lambda e_v [\text{MSSC}_{\text{TEMP}}(\text{KNOCK})(e)]$$

Furthermore, I assume that thematic roles compose with the verbal predicate via silent syntactic heads that attach to the spine of the clause. For instance, the agent is introduced by the AG head with the semantics in (22).

$$(22) \quad \llbracket \text{AG} \rrbracket = \lambda P_{\langle v,t \rangle} \lambda x_e \lambda e_v [P(e) \wedge \text{AG}(e) = x]$$

¹ Note that I am not suggesting that all verbs should be analyzed this way. Many authors assume an inherently plural semantics for verbs, i.e., whenever two events are in the denotation of a verb, so is their sum (e.g., Krifka 1989; Landman 2000; Kratzer 2008). However, for the purpose of this paper I assume that the subclass of verbs in question does not have such a plural meaning.

Once the verb is combined with all its arguments, another head, which I will call the EC, applies existential closure, as specified in (23). As a result, the event variable is existentially bound and a complete proposition is obtained.

$$(23) \quad \llbracket \text{EC} \rrbracket = \lambda P_{\langle v,t \rangle} \exists e_v [P(e)]$$

In addition, drawing on the mereotopological notion of a cluster that can be applied both in the domain of individuals and the domain of events, recall §3.2 and 4.2, I propose a special syntactic head, which I will call CLSTR. This head introduces the clustering operation, see (24). It is a predicate modifier that takes a property of events and returns a property of clusters of events construed in temporal terms.

$$(24) \quad \llbracket \text{CLSTR} \rrbracket = \lambda P_{\langle v,t \rangle} \lambda e_v [\text{CLSTR}_{\text{TEMP}}(P)(e)]$$

Finally, let us discuss multiplicatives. Unlike cardinal numerals, somewhat surprisingly this type of numerical expressions has not received much attention in the semantic literature (but see, e.g., Doetjes 1997; Moltmann 1997; Landman 2006 for some notable exceptions). Following Krifka (1989), I assume that counting is performed by additive measure functions. In particular, I propose that numeric quantification over events is ensured by the $\#_{\text{PIND}}$ operation, which takes a property and yields a measure function standardized by the requirement in (25), where $\text{PIND}_{\text{TEMP}}(P)$ covers properties of eventualities that are individuated as units either in terms of $\text{PMSSC}_{\text{TEMP}}(P)$ or $\text{PCLSTR}_{\text{TEMP}}(P)$, recall (20).

$$(25) \quad \forall P_{\langle v,t \rangle} \forall e_v [\#_{\text{PIND}}(P)(e) = 1 \text{ iff } \text{PIND}_{\text{TEMP}}(P)(e)]$$

For the purpose of this paper, I assume that number words such as *three* in multiplicatives are simply names of numbers, i.e., expressions of type n , as in (26).

$$(26) \quad \llbracket \text{three} \rrbracket = 3$$

On the other hand, I postulate that the morpheme *times* denotes a function that shifts a number to a multiplicative counting device. The semantics in (27) yields a predicate modifier that selects for a predicate of events individuated either in terms of MSSC events or clusters of events (this is encoded as a presupposition) and returns a set of pluralities of n -many such events that have the relevant property.

$$(27) \quad \llbracket \text{times} \rrbracket = \lambda n_n \lambda P_{\langle v,t \rangle} : \text{PIND}_{\text{TEMP}}(P) \lambda e_v [P(e) \wedge \#_{\text{PIND}}(P)(e) = n]$$

Thus, after putting the two pieces together, the English multiplicative adverbial *three times* has the semantics in (28). In a similar vein, *twice* receives the meaning in (29). Both are eventive predicate modifiers that ultimately yield predicates denoting sets of pluralities consisting of three or two eventualities, respectively. When they combine with a predicate that satisfies $\text{PMSSC}_{\text{TEMP}}$, these pluralities consist of MSSC events. If on the other hand, the input is a $\text{PCLSTR}_{\text{TEMP}}$ predicate, the multiplicative counts clusters of events.

$$(28) \quad \llbracket \text{three times} \rrbracket = \llbracket \text{times} \rrbracket (\llbracket \text{three} \rrbracket) = \\ \lambda P_{\langle v,t \rangle} : \text{PIND}_{\text{TEMP}}(P) \lambda e_v [P(e) \wedge \#_{\text{PIND}}(P)(e) = 3]$$

$$(29) \quad \llbracket \text{twice} \rrbracket = \lambda P_{\langle v,t \rangle} : \text{PIND}_{\text{TEMP}}(P) \lambda e_v [P(e) \wedge \#_{\text{PIND}}(P)(e) = 2]$$

With all the tools in place, let us now demonstrate how the proposed components allow for capturing the event-internal/external distinction discussed in §2.

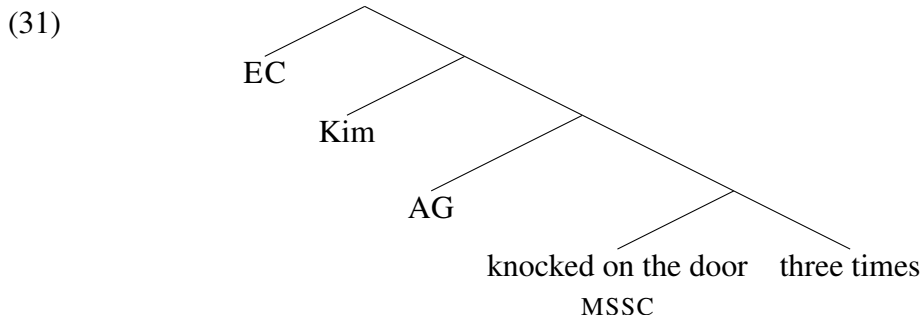
5.2 Derivations

The core idea is that we can capture the event-internal/external distinction by inserting the CLSTR head in different positions in the structure. Specifically, applying it below the multiplicative yields an event-external reading of that multiplier, whereas applying it on top of the modified VP results in the event-internal interpretation.

Let us begin with explaining how the event-internal/external ambiguity of sentences such as (2), repeated here as (30), can be captured under the proposed account.

(30) Kim knocked on the door three times.

First, let us consider the event-external construal on which the sentence in (30) describes three separate occasions of Kim giving one knock on the door. The derivation of this meaning is provided in the structure in (31).²

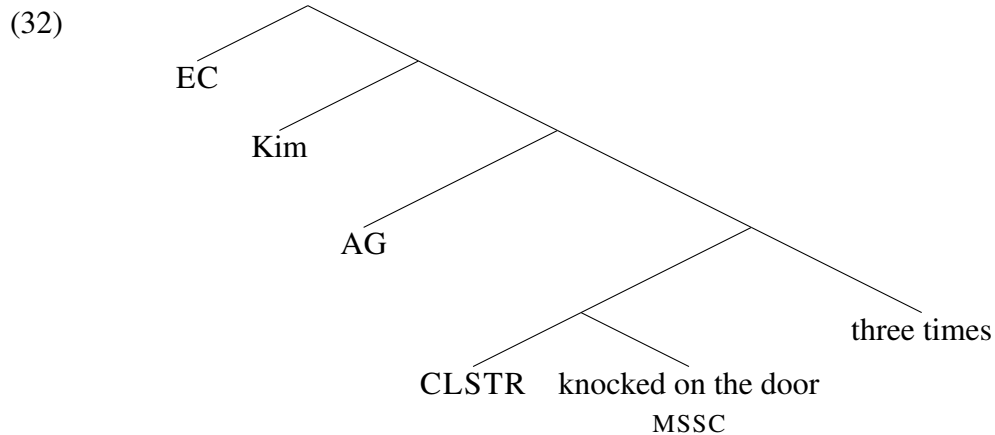


The VP *knocked on the door* denotes a set of discrete eventualities conceptualized as temporally integrated wholes, which I model as MSSC events, recall (21). The multiplicative *three times* is a predicate modifier that functions as an eventive counting device, recall (28). When it combines with the VP, the definedness condition is met because the VP satisfies the $\text{PIND}_{\text{TEMP}}$ presupposition. The outcome is an expression denoting a set of unstructured pluralities involving three separate MSSC events each. Next, the AG head introduces the individual variable corresponding to the agent of these events, recall (22), which is subsequently saturated by the entity denoted by

² For the sake of simplicity, I will not discuss the composition of the VP and the multiplicative, but it is easy to see how it comes about. For the same reason, I will also ignore tense, aspect etc.

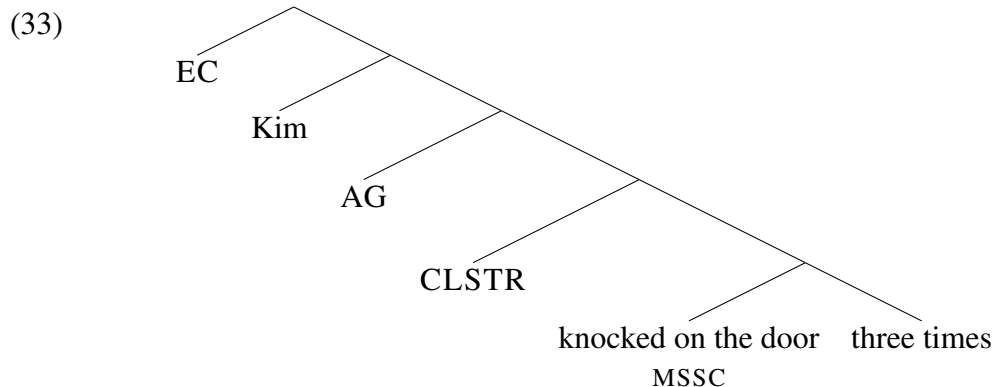
the subject *Kim* and finally the EC head triggers existential closure binding the event variable, recall (23). As a result, we get the proposition describing Kim giving three separate knocks on the door, which corresponds to three knocking occasions.

In addition, we can also derive the event-external construal on which the sentence in (30) describes three series of knocks by Kim. This is demonstrated in (32).



The difference between the structures in (32) and (31) is that (32) involves the CLSTR head attached to *knocked on the door*. The CLSTR applies clustering, recall (24), and turns a set of MSSC knocking events into a set of clusters thereof. The resulting expression is a valid input for *three times* since predicates that satisfy PCLSTR_{TEMP} also satisfy PIND_{TEMP}, recall (20), and thus meet the selectional requirement of the multiplicative. Hence, *three times* in (32) does not count individual knocks but rather series of an unspecified number of knocks. After the VP combines with the AG, subject and EC, we obtain the truth conditions describing Kim giving three series of knocks on the door with each series conceived of as a separate occasion.

Next, let us demonstrate how the event-internal construal is derived in the proposed system. The tree in (33) shows the composition of the meaning of (30) on which on one occasion Kim gives a series of three knocks on the door.

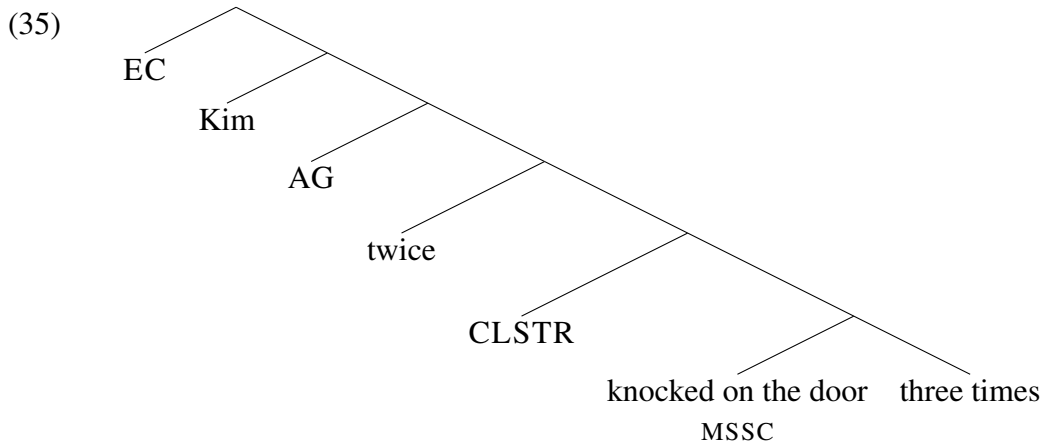


Similar to (32), the structure in (33) also involves the CLSTR head. However, the difference is that in (32) it attaches higher, i.e., above the multiplicative adverbial. Therefore, first *three times* counts separate MSSC knocking events and then clustering applies to a set containing triples of events. As a result, we obtain a predicate true of eventive clusters each of which consists of three temporally connected knocks. Consequently, at the end of the derivation we get a proposition corresponding to the interpretation that involves event-internal quantification, i.e., one occasion of Kim giving a series of three knocks.

Having demonstrated how different event-internal/external readings of sentences such as (30) can be derived within the proposed system, let us now turn to examples with two multiplicatives. In order to show how a possible scope ambiguity or the lack thereof can be captured on my analysis, I will discuss two such examples. I will begin with the sentence in (8), repeated here as (34).

(34) Kim twice knocked on the door three times.

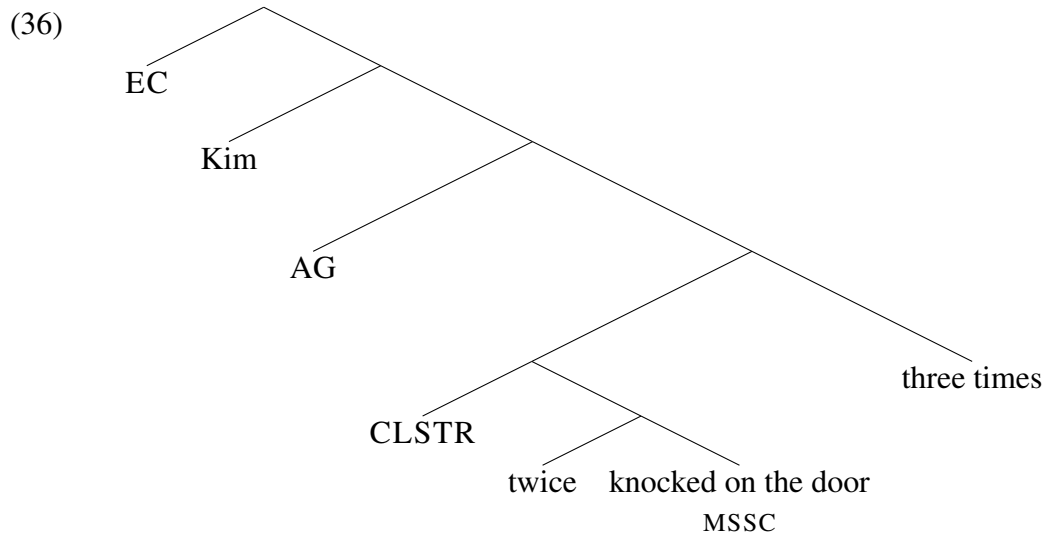
As already discussed in §2.1, for some speakers (34) can give rise to an ambiguity. The uncontroversial reading is the one on which *twice* outscopes *three times* or, in other words, *twice* quantifies event-externally, whereas *three times* quantifies event-internally. This interpretation describes two occasions of Kim knocking three times and the way it is derived in the proposed system is given in (35).



In the tree in (35), the CLSTR head adjoins above the VP *knocked on the door* modified by the lower multiplicative adverbial *three times*, but below the higher multiplicative *twice*. In such a configuration, clustering applies to a set consisting of triples of events, compare (33). The resulting predicate denotes a property of eventive clusters and as such it is again compatible with the multiplicative. The PIND_{TEMP} presupposition encoded in the meaning of *twice* is satisfied, and thus the entire expression serves as the input for the multiplicative predicate modifier.

This time, however, *twice* does not count MSSC events, but rather temporal clusters consisting of three such events each. Consequently, after the attachment of the AG, subject and EC, we end up with truth conditions corresponding to Kim giving two independent series of three knocks on the door each, which captures the intuition behind the widely available reading of (34) discussed above.

However, for some speakers a parse of (34) with *three times* having wider scope relative to *twice* is also possible. In such a case, *three times* quantifies over occasions, whereas *twice* counts acts, which yields a reading on which on three occasions Kim knocked on the door twice. I propose that for those speakers the structure in (36) is also accessible.

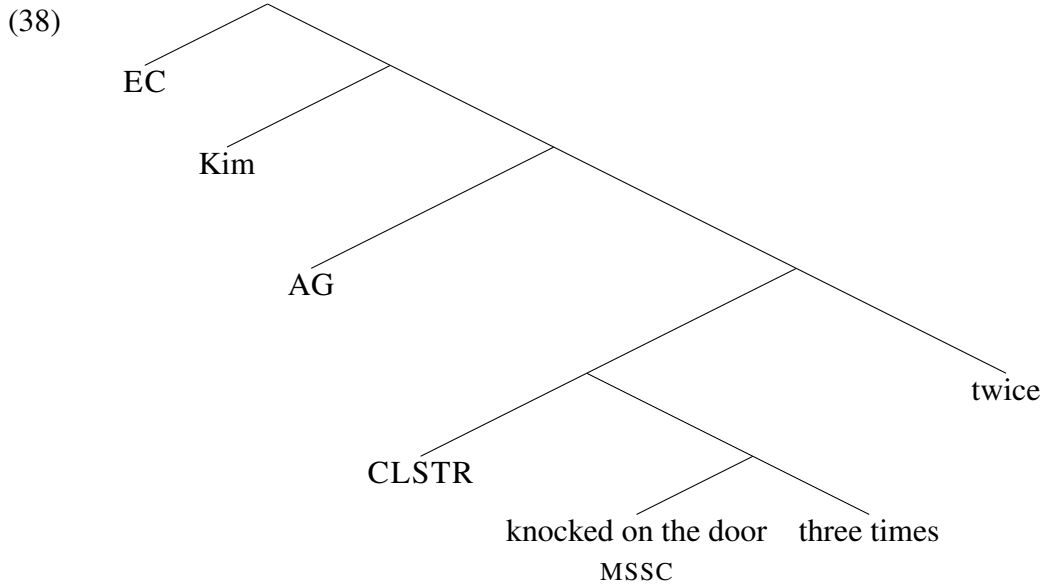


The differences between the structures in (36) and (35) regard the order of the composition of the VP with the multiplicatives and the position of the CLSTR head. In (36), *knocked on the door* combines first with *twice*, which quantifies over MSSC knocking events, and then the CLSTR triggers the clustering of the obtained pairs of knocks. Finally, the resulting predicate serves the input for *three times*, which in this configuration counts clusters and not MSSC events. Therefore, at the end of the derivation, we obtain a proposition describing three occasions of Kim knocking on the door twice, which captures the uncommon, but possible reading of (34).

Finally, let us discuss the derivation of the unambiguous sentence in (7), repeated here as (37).

(37) Kim knocked on the door three times twice.

The only possible reading of this example is with the multiplicative *twice* having wide scope with respect to *three times*. This results in the interpretation on which on two occasions Kim knocked on the door three times. The structure deriving this reading under the proposed approach is provided in (38).



Similar to the tree in (35), in (38) the CLSTR head appears above the VP modified by *three times* but below *twice*. Thus, the lower multiplicative counts MSSC knocking events, i.e., acts, whereas the higher one quantifies over clusters thereof, i.e., occasions, just like in (35). Notice, however, that in the configuration in (38) there is no straightforward possibility to compose *knocked on the door* with *twice* first, so that it could serve as the input for the CLSTR, and consequently the multiplier *three times*. I argue that this fact explains the unavailability of the interpretation of (37) with *three times* outscoping *twice*, which is a desired result.

6 Conclusion

The paper offers a solution to the well-known event-internal/external puzzle and sheds new light on the ontological status of acts and occasions. Inspired by recent developments in nominal semantics, I proposed to extend linguistic applications of mereotopology to the domain of events. I argued that both acts and occasions are eventualities and the relationship between the two categories can be viewed in terms of part-whole structure. In particular, acts are simplex punctual events, whereas occasions are conceived of as temporal clusters thereof. Based on English data, I demonstrated that the (un)availability of event-internal/external interpretations of a given multiplicative adverbial reduces to the (un)available positions for the clustering operation in the structure. A significant consequence of the proposed approach is that mereotopology can be effectively applied in the domain of events, which indicates that abstract entities may involve structured part-whole relations. This in turn invites research on structured parthood in other abstract domains.

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Acts, occasions and multiplicatives

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