

## Event-internal/external quantification and the mereotopology of events

**Introduction.** Depending on a position in a sentence, multiplicatives such as *twice* and *three times* can count either entire events, i.e., occasions, or event-internal acts, i.e., subevents that are relevant parts of a whole. Under the event-external reading (20) means that on three separate occasions Kim knocked on the door (once or more), whereas the event-internal interpretation states that on one occasion they knocked on the door three times (Cusic 1981, Andrews 1983). Furthermore, in (21) *twice* unambiguously counts the number of independent knocking occasions, whereas *three times* quantifies over particular knocks within each of those knocking eventualities (Cinque 1999). An important question concerns the ontological status of occasions and acts (Tovena 2012) and, given that they both seem to be eventualities, the part-whole relationship between the two categories. In this paper, I propose to extend mereotopology to the domain of events. This allows for modeling acts as simplex singular eventualities and occasions as clusters thereof (see also Landman 2006 for a proposal to extend groups to the domain of events and Henderson 2017 for an analysis of pluractionals as swarms of events). Consequently, the meaning of (21) can be informally paraphrased as (22).

**Cross-linguistic data.** While in English the event-internal/external interpretation stems from a syntactic position (with event-external multiplicatives being structurally higher), in some languages the distinction is encoded with overt morphology. In Mandarin, the verbal classifier *cì* triggers only event-external quantification (23), whereas *xià* licenses only event-internal readings (24) (Donazan 2013, Zhang 2017). In Polish, there is an interplay between a type of quantificational adverbial and aspect. When combined with a perfective instantaneous verb, the multiplicative *trzy razy* patterns with *three times* in that it licenses both event-external and event-internal interpretations (25), whereas with an imperfective, it can yield the event-internal reading only on the iterative interpretation. In addition, there is also the construction *po trzykroć*, which triggers only event-internal quantification (26) (note though that it is vanishing and for many speakers it sounds archaic). Finally, frequency adverbs such as *często* ‘often’ require imperfectives and yield only event-external construals. All of this gives us the typology of quantificational adverbials in Table 1.

**Mereotopology.** I assume structured parthood within the relationship between acts and occasions. In order to account for it, I follow Grimm (2012) and adopt mereotopology, a theory of wholes extending standard mereology with topological notions (Casati & Varzi 1999). In mereotopology, CONNECTEDNESS (C) allows for capturing a configuration in which two entities share a boundary. Given C, it is possible to define more complex mereotopological notions to capture subtle distinctions between different spatial configurations. An entity is SELF-CONNECTED (SC) iff any two parts that form the whole of that entity are connected to each other (1) (O stands for overlap). A stronger property of MAXIMALLY STRONGLY SELF-CONNECTED (MSSC) holds if (i) every part of the entity is connected to (overlaps) the whole (strongly self-connected) and (ii) anything else which overlaps it and is strongly self-connected is once again part of it (maximality). The notion of MSSC allows for distinguishing between integrated wholes from other mereological objects such as scattered entities and arbitrary sums. Furthermore, inspired by Grimm (2012), I propose a revised formulation of the property TRANSITIVELY CONNECTED (TC) (3), which determines whether two objects are connected through a series of mediating entities. In addition, TC allows for defining the concept of CLUSTER (CLSTR) (4) (again, a revised definition). An entity  $x$  is a cluster relative to a connection relation  $C$  and a property  $P$  iff  $x$  is a sum of entities falling under the same property which are all transitively connected relative to some subset of a sequence  $Z$  under the same property and connection relation. This allows us to define predicates of MSSC entities (5), clusters (6) and generally objects individuated in mereotopological terms (7) (IND stands for individuation).

- (1)  $SC(x) \stackrel{\text{def}}{=} \forall y \forall z [\forall w (O(w, x) \leftrightarrow (O(w, y) \vee O(w, z))) \rightarrow C(y, z)]$
- (2)  $MSSC(x) \stackrel{\text{def}}{=} SC(x) \wedge \forall y [SC(y) \wedge O(y, x) \rightarrow y \sqsubseteq x]$
- (3) For a finite sequence  $Z = \langle z_1, \dots, z_n \rangle$ ,  $TC(x, y, P, C, Z)$  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  $1 \leq i \leq n$ .
- (4)  $CLSTR_C(P)(x) \stackrel{\text{def}}{=} \exists Z [x = \sqcup Z \wedge \forall z \forall z' \in Z \exists Y \subseteq Z [TC(z, z', P, C, Y)]]$
- (5)  $PMSSC(P) \stackrel{\text{def}}{=} \forall x [P(x) \rightarrow MSSC(P)(x)]$
- (6)  $PCLSTR(P) \stackrel{\text{def}}{=} \forall x [P(x) \rightarrow CLSTR(P)(x)]$
- (7)  $PIND(P) \stackrel{\text{def}}{=} \forall x [P(x) \rightarrow MSSC(P)(x) \vee CLSTR(P)(x)]$

Building on Mazzola's (2019) theory of time, I propose to extend mereotopology to the domain of events. On the assumption that time is linear and gapless, events can be viewed as temporal particulars structured by TEMPORAL CONNECTION (TEMP) on which MSSC and CLSTR can be based.

**Analysis.** I propose that perfective instantaneous verbs denote sets of singular eventualities that are conceptualized as MSSC events (8). Such events can be pluralized and clustered by CLSTR (9). I assume that thematic roles compose with the verb via special heads, e.g., agent is introduced by AG (10), and that existential closure (EC) applies once the verb is combined with all its arguments (11).

- (8)  $\llbracket \text{knocked} \rrbracket = \lambda e_v [MSSC_{TEMP}(\text{KNOCKED})(e)]$
- (9)  $\llbracket \text{CLSTR} \rrbracket = \lambda P_{\langle v, t \rangle} \lambda e_v [CLSTR_{TEMP}(P)(e)]$
- (10)  $\llbracket \text{AG} \rrbracket = \lambda P_{\langle v, t \rangle} \lambda x_e \lambda e_v [P(e) \wedge \text{AG}(e) = x]$       (11)  $\llbracket \text{EC} \rrbracket = \lambda P_{\langle v, t \rangle} \exists e_v [P(e)]$

Counting is performed by the additive measure function  $\#(P)$  (Krifka 1989), which is standardized by the requirement in (12), where  $PIND_{TEMP}(P)$  specifies eventualities that are individuated as units either in terms of  $PMSSC_{TEMP}(P)$  or  $PCLSTR_{TEMP}(P)$ . English *three times* and Polish *trzy razy* have the general semantics in (13). The event-internal/external distinction then reduces to the (non-)occurrence and/or position of CLSTR in a sentence. To illustrate the composition, (14) gives an event-external construal of (20) with 3 separate knocks. Applying CLSTR below the multiplicative yields an event-external reading with 3 series of knocks (15), whereas applying it on top of the modified VP results in the event-internal interpretation (1 series of 3 knocks) (16). The unambiguous structure of (21) is captured as (17). On the other hand, the meaning of Mandarin *sān cì* and *sān xià* is more specific. In particular, *cì* is specified to quantify over clustered eventualities, i.e., occasions (18), whereas *xià* counts MSSC events, i.e., acts (19), similar to Polish *po trzykroć*.

- (12)  $\forall P_{\langle v, t \rangle} \forall e_v [\#_{PIND}(P)(e) = 1 \text{ iff } PIND_{TEMP}(P)(e)]$
- (13)  $\llbracket \text{three times} \rrbracket = \llbracket \text{trzy razy} \rrbracket = \lambda P_{\langle v, t \rangle} : PIND_{TEMP}(P) \lambda e_v [P(e) \wedge \#_{IND}(P)(e) = 3]$
- (14)  $[ \text{EC} [ \text{Kim} [ \text{AG} [ \text{knocked on the door three times} ] ] ] ]$
- (15)  $[ \text{EC} [ \text{Kim} [ \text{AG} [ [ \text{CLSTR} [ \text{knocked on the door} ] \text{ three times} ] ] ] ] ]$
- (16)  $[ \text{EC} [ \text{Kim} [ \text{AG} [ [ \text{CLSTR} [ \text{knocked on the door three times} ] ] ] ] ]$
- (17)  $[ \text{EC} [ \text{Kim} [ \text{AG} [ [ \text{CLSTR} [ \text{knocked on the door three times} ] ] \text{ twice} ] ] ] ]$
- (18)  $\llbracket \text{sān cì} \rrbracket = \lambda P_{\langle v, t \rangle} : PCLSTR_{TEMP}(P) \lambda e_v [P(e) \wedge \#_{PCLSTR}(P)(e) = 3]$
- (19)  $\llbracket \text{sān xià} \rrbracket = \llbracket \text{po trzykroć} \rrbracket = \lambda P_{\langle v, t \rangle} : PMSSC_{TEMP}(P) \lambda e_v [P(e) \wedge \#_{PMSSC}(P)(e) = 3]$

**Conclusion.** The paper offers an explanation to the event-internal/external puzzle and sheds new light on the ontological status and part-whole structure of acts and occasions. There are three significant consequences of the proposal that mereotopology can be effectively applied to the domain of events: (i) abstract entities involve structured part-whole relations, (ii) there is a unified mechanism of individuation and counting across ontological categories and (iii) typological variation can be reduced to slight differences in the meaning of quantificational adverbials across languages.

- (20) Kim knocked on the door three times.  
(21) Kim knocked on the door three times twice.  
(22) Kim performed two series of three knocks on the door.  
(23) Dàlín zài mén-shàng qiāo-le sān cì.  
Dalin at door-on knock-PFV three CLF<sub>ext</sub>  
‘On three separate occasions, Dalin knocked on the door.’ (Mandarin)  
(24) Dàlín zài mén-shàng qiāo-le sān xià.  
Dalin at door-on knock-PFV three CLF<sub>int</sub>  
‘On one occasion, Dalin knocked on the door three times.’ (Mandarin)  
(25) Jacek za-pukał do drzwi trzy razy.  
Jacek PFV-knocked to door three times  
‘Jacek knocked on the door three times.’ (Polish)  
(26) %Jacek za-pukał do drzwi po trzykroć.  
Jacek PFV-knocked to door DISTR thrice  
‘On one occasion, Jacek knocked on the door three times.’ (Polish)  
(27) Jacek (#za-)pukał do drzwi często.  
Jacek PFV-knocked to door often  
‘Jacek often knocked on the door.’ ≈  
≈ ‘On many occasions, Jacek knocked on the door.’ (Polish)

Table 1: Typology of quantificational adverbials

LANGUAGE	EXPRESSION	EVENT-EXTERNAL	EVENT-INTERNAL
English	<i>three times</i>	✓	✓
Polish	<i>trzy razy</i>	✓	✓
Mandarin	<i>sān-cì</i>	✓	×
Polish	<i>często</i>	✓	×
Mandarin	<i>sān-xià</i>	×	✓
Polish	<i>po trzykroć</i>	×	%

**References.** Andrews (1983) *A note on the constituent structure of modifiers* • Bach (1986) *The algebra of events* • Casati & Varzi (1999) *Parts and places: The structures of spatial representation* • Cinque (1999) *Adverbs and functional heads: A cross-linguistic perspective* • Cusic (1981) *Verbal plurality and aspect* • Donazzan (2013) *On counting and measuring events* • Grimm (2012) *Number and individuation* • Henderson (2017) *Swarms: Spatiotemporal grouping across domains* • Krifka (1989) *Nominal reference, temporal constitution and quantification in event semantics* • Landman (2006) *Indefinite time-phrases, in situ-scope, and dual-perspective intensionality* • Mazzola (2019) *The mereotopology of time* • Tovenà (2012) *Elements for a linguistic ontology* • Zhang (2017) *The syntax of event-internal and event-external verbal classifiers*