The common core of distributivity, aspect and measurement*

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Universiteit Utrecht — November 25^{th}, 2011

1 Introduction

The primary objective of my research program is to strengthen the empirical and formal connections between domains which are traditionally addressed by separate areas of research within formal semantics.

This talk builds a bridge between aspect, measurement, and distributivity. Its central pillar will be a higher-order property I will call **stratified reference**.

I will show that this concept is general enough to generalize and connect several notions familiar, such as atelicity and distributivity, and formally precise enough to transfer insights across unrelated bodies of literature.

2 The measurement puzzle

Pseudopartitives and comparative determiners reject certain measure functions like *speed* and *temperature* (Krifka, 1998; Schwarzschild, 2006)

(1)	a.	five pounds of rice	*weight*
	b.	five liters of water	*volume*
	c.	five hours of talks	*duration*
	d.	five miles of railroad tracks	*spatial extent*

*This research is part of a dissertation written at Penn, Stanford, and PARC. I am grateful to all three institutions. Special thanks to my advisor, Cleo Condoravdi; my committee members, Aravind Joshi, Maribel Romero, Florian Schwarz; to Sigrid Beck, Danny Bobrow, Beth Levin, Lauri Karttunen, Paul Kiparsky, Tony Kroch, Chris Potts, Annie Zaenen, and many others.

e. *five miles per hour of driving **speed*
f. *five degrees Celsius of water **temperature*

(2) five carats of gold *mass / *purity*

Several other constructions behave analogously, e.g. comparative determiners and true partitives:

(3) more rope *by length / by weight / *by temperature*

(4) *five miles per hour of my driving **speed*

2.1 Questions

1. How can we characterize the class of admissible measure functions in these constructions?
   - Previous answers available but unsatisfying
2. Why are not all measure functions admissible in the first place?
   - No previous answers: We will look at aspect for an answer.

2.2 Previous attempts at characterizing the restriction

Pseudopartitives have been claimed to only accept measure functions that are *monotonic* (Schwarzschild, 2006), see also Krifka (1998).

- A measure function μ is *monotonic* iff for any two entities a and b in the model ($\approx$ physical world), if a is a proper part of b, then $\mu(a) < \mu(b)$.

Examples:

- Volume is monotonic because any proper part of an entity always has a smaller volume than that entity. $\rightsquigarrow$ *thirty liters of water*
- Temperature is not monotonic because a proper part of an entity is not colder than that entity. $\rightsquigarrow$ **thirty degrees Celsius of water*
- What about height? It had better be monotonic: $\rightsquigarrow$ *five feet of snow*

Problem: If height is monotonic, any proper part of an entity has a smaller height than that entity. Last night, five feet of snow fell on Berlin. The snow that fell on West Berlin is a proper part of the snow that fell on Berlin. But, we don't conclude that the height of the snow in West Berlin was less than five feet. So height is **not monotonic**.

Schwarzschild's response: we redefine monotonicity with respect to a pragmatically supplied parthood relation and we assume that the snow in West Berlin is not a pragmatic part of the snow in Berlin.

- This proposal is difficult to evaluate: he does not give clear criteria to decide when something is a pragmatic part of something else.

Conceptual problem: Characterizing the admissible functions is a description, not an explanation.

2.3 Novel observation

Measure functions rejected by pseudopartitives are also rejected by *for*-adverbials.

(5)	a.	five hours of talks	*duration*
	b.	five miles of railroad tracks	*spatial extent*
	c.	*five miles an hour of driving	**speed*
	d.	*five degrees Celsius of water	**temperature*
(6)	a.	John waited for five hours.	*duration*
	b.	The crack widens for five meters.	*spatial extent*
	c.	*John drove for thirty miles an hour.	**speed*
	d.	*The soup boiled for 100 degrees Celsius.	**temperature*

Examples (6c) and (6d) are surprising – after all, it's possible to talk about speed and temperature in other ways:

(7)	a.	John drove (at) thirty miles an hour.	*speed*
	b.	The soup boiled at 100 degrees Celsius.	*temperature*

3 Answer strategy

For-adverbials are most commonly associated with the telic/atelic opposition.

(8)	a.	John **talked** for five minutes.	*atelic*
	b.	*John **finished talking** for five minutes.	*telic*
(9)	a.	John **ate apples** for an hour.	*atelic*
	b.	*John **ate ten apples** for an hour.	*telic*

There is no previous work on *for*-adverbials and measurement. But the empirical connection between pseudopartitives and *for*-adverbials allows us to tap into the literature on aspect.

To do this, I will:

- Present a formal view of the fact that *for*-adverbials reject telic predicates.
- Motivate a constraint which generalizes the telic-atelic opposition and relate it to pseudopartitives.
- Derive the restriction on measure functions from this constraint.

4 The aspect puzzle: What does it mean to be atelic?

The same event can be described by the predicates *run* (atelic) and *run to the store* (telic). So telicity is a property of predicates (Krifka, 1998), a higher-order property. But which one?

Classical answer To be atelic means to have the *subinterval property* (e.g. Bennett and Partee, 1972; Dowty, 1979). Here's an event-based version of it:

(10) SUBINT(P) $=_{def}$
$\forall e[P(e) \rightarrow \forall i[i < \tau(e) \rightarrow \exists e'[P(e') \wedge e' < e \wedge i = \tau(e')]]]$
(Whenever P holds of an event e, then at every subinterval of the runtime of e, there is a subevent of which P also holds.)

On a Dowty-style account, *for*-adverbials presuppose the subinterval property. Telic predicates are ruled out because they lack this property.

(11) *eat ten apples for three hours
Failing presupposition: SUBINT($[\![$eat ten apples$]\!]$), i.e. every part of the runtime of an eating-ten-apples event e is the runtime of another eating-ten-apples event that is a part of e.

4.1 Problems with the subinterval property

First problem The "minimal-parts problem" (Taylor, 1977; Dowty, 1979): The subinterval property distributes P literally over all subintervals. This is too strong.

(12) John and Mary waltzed for an hour
$\not\Rightarrow$ #John and Mary waltzed within every single moment of the hour
$\Rightarrow$ John and Mary waltzed within every short subinterval of the hour

The length interval that counts as very small for the purpose of the *for*-adverbial varies relative to the length of the bigger interval:

(13) The Chinese people have created abundant folk arts ... passed on from generation to generation for thousands of years.[1]

Second problem The subinterval property contains a hard-coded reference to time. But this is not sufficiently general: Spatial *for*-adverbials test for spatial atelicity but work analogously to temporal ones otherwise. (Gawron, 2005)

(14) a. The crack **widens** for 5 meters. *spatially atelic*
b. *The crack **widens 2cm** for 5 meters. *spatially telic (but stative!)*

Spatial and temporal *for*-adverbials do not have the same distribution, so they impose different constraints – see Figure 1.

(15) a. John pushed carts to the store for fifty minutes. *temporally atelic*
b. #John pushed carts to the store for fifty meters. *spatially telic*

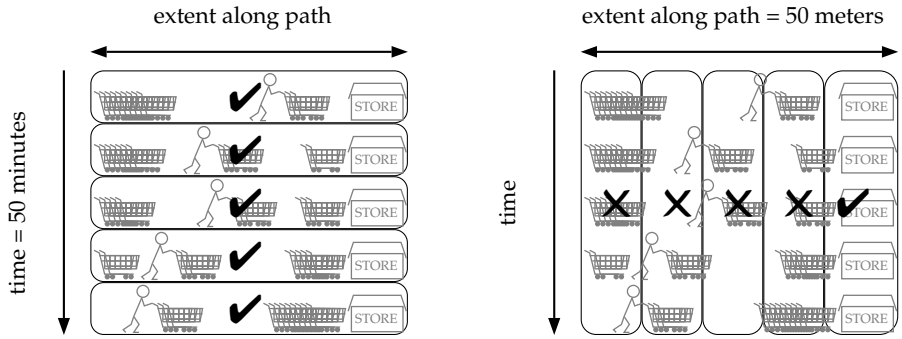


Figure 1: *John pushed carts to the store* is temporally atelic but spatially telic

4.2 Generalizing the subinterval property

What the subinterval property says: An atelic predicate P distributes along the *time* dimension down to intervals of *infinitely short length*.

What it should say: An atelic predicate P distributes along the ___ dimension down to intervals of ___ length.

That is, we want to *parametrize* the subinterval property.

We start with applying the subinterval property to *waltz*:

[1] Attested example (`http://www.twinbridge.com/detail.aspx?ID=315`). Nov 15, 2010.

(16) $\forall e[\text{waltz}(e) \rightarrow \forall i[i < \tau(e) \rightarrow \exists e'[\text{waltz}(e') \wedge e' < e \wedge i = \tau(e')]]]$
(Whenever *waltz* holds of an event e, then at every subinterval of the runtime of e, there is a subevent of which *waltz* also holds.)

We want to distribute over "very small" events. I assume that ε is a function that tells us what counts as very small. For example, $\varepsilon(\lambda t[\text{hours}(t) = 1])(t')$ is true just in case t' is very small with respect to one hour.

We want to be able to say:

(17) Whenever *waltz* holds of an event, there is a way of dividing this event into subevents with very small runtimes such that *waltz* also holds of each of these subevents.

To express this formally, we use the star operator from Link (1987)'s work on plurality and distributivity.

- $x \in {}^*(\lambda y.B(y))$ means: x consists of one or more parts of which B holds
  Technical background: $A \in {}^*P$ is defined as $\exists C[A = \bigoplus C \ \wedge \ C \subseteq P]$
  (A is the sum of all the elements of a subset C of P)

With the star operator, we can express (17) as follows:

(18) $$\forall e[\text{waltz}(e) \rightarrow e \in {}^*\lambda e' \left(\begin{array}{l} \text{waltz}(e') \wedge \\ \varepsilon(\lambda t[\text{hours}(t) = 1])(\tau(e')) \end{array} \right)]$$

Let us say that *waltz* has **stratified reference** (SR) with respect to the dimension τ ("runtime") and the granularity $\varepsilon(\lambda t[\text{hours}(t) = 1])$ ("very short time interval") just in case (18) above is true.

(19) **Stratified reference (Example)**
$\text{SR}_{\tau,\ \varepsilon(\lambda t[\textit{hours}(t) = 1])}(\lambda e[\text{waltz}(e)]) \Leftrightarrow$ (18)

By abstracting from this example, we arrive at the following definition (the predicates and variables are meant to be untyped, e.g. x ranges over both individuals/substances and events):

(20) **Stratified reference (Definition)**
$$\text{SR}_{f,\varepsilon(K)}(P) \stackrel{\text{def}}{=} \forall x[P(x) \rightarrow x \in {}^*\lambda y \left(\begin{array}{l} P(y) \wedge \\ \varepsilon(K)(f(y)) \end{array} \right)]$$

The answer to the aspect puzzle.
We can now say: Being atelic means having stratified reference with respect to time and a suitably instantiated granularity parameter.

For-adverbials presuppose stratified reference, not the subinterval property:

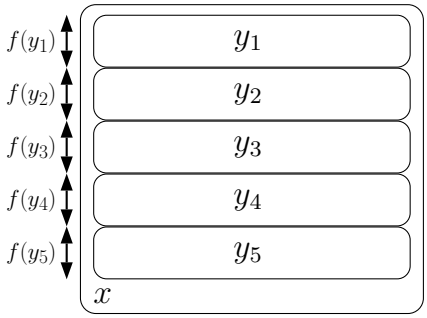


Figure 2: Illustration of stratified reference

(21) waltz for an hour
Satisfied presupposition:
$\forall e[\text{waltz}(e) \rightarrow e \in {}^*\lambda e' \left(\begin{array}{l} \text{waltz}(e') \wedge \\ \varepsilon(\lambda t[\text{hours}(t) = 1])(\tau(e')) \end{array} \right)]$
(Every waltzing event consists of waltzing subevents whose runtimes are very small compared to an hour.)

(22) push carts for three hours
Satisfied presupposition:
$\forall e[[\![\text{push carts}]\!](e) \rightarrow e \in {}^*\lambda e' \left(\begin{array}{l} [\![\text{push carts}]\!](e') \wedge \\ \varepsilon(\lambda t[\text{hours}(t) = 3])(\tau(e')) \end{array} \right)]$
(Every event in which one or more carts are pushed consists of subevents in which one or more carts are pushed and whose runtimes are very small compared to three hours.)

Note: I assume following Zweig (2008) and others that $[\![\text{push carts}]\!]$ = "push one or more carts", not "push two or more carts" (the "two or more" is an implicature)

(23) *eat ten apples for three hours
Failing presupposition:
$\forall e[[\![\text{eat ten apples}]\!](e) \rightarrow e \in {}^*\lambda e' \left(\begin{array}{l} [\![\text{eat ten apples}]\!](e') \wedge \\ \varepsilon(\lambda t[\text{hours}(t) = 3])(\tau(e')) \end{array} \right)]$
(Every eating-ten-apples event consists of eating-ten-apples subevents whose runtimes are very small compared to three hours.)

5 Back to the measurement puzzle

Why can you not say **thirty degrees of water*?

We have seen that *for*-adverbials are incompatible with measure functions like *speed* and *temperature*:

(24) a. *John drove for thirty miles an hour. **speed*
b. *The soup boiled for 100 degrees Celsius. **temperature*

Null assumption These sentences have the same presuppositions as sentences with temporal and spatial *for*-adverbials, except that time/space has been replaced by speed/temperature. This assumption predicts presupposition failures for (24):

(25) *drive for thirty miles per hour
Failing presupposition: $\mathrm{SR}_{\mathrm{speed},\varepsilon(\llbracket \text{thirty mph} \rrbracket)}(\llbracket \text{drive} \rrbracket)$
(Every driving event consists of driving subevents whose speeds are very small compared to thirty mph.)

(26) *boil for 100 degrees Celsius
Failing presupposition: $\mathrm{SR}_{\mathrm{temperature},\varepsilon(\llbracket 100 \text{ degrees} \rrbracket)}(\llbracket \text{boil} \rrbracket)$
(Every boiling event consists of boiling subevents whose temperatures are very small compared to 100 degrees.)

To transfer this idea to pseudopartitives, we make use of a parallel between distinctions in the nominal and in the verbal domain (e.g. Bach, 1986; Krifka, 1998):

atelic : *telic*
::
mass/plural : *singular count*

Pseudopartitives reject singular count nouns:

(27) a. five pounds of **books** *plural*
b. thirty liters of **water** *mass*
c. *five pounds of **book** **singular*

Intuition: *run for three hours* ≈ *three hours of running*

5.1 Crossing the bridge again

Assumption: The same presupposition that is found in *for*-adverbials is also found in pseudopartitives, just with other parameters.

5.2 Baseline examples

Event-denoting pseudopartitives work just like *for*-adverbials:

(28) run for three hours / three hours of running
Satisfied presupposition: $\mathrm{SR}_{\tau,\varepsilon(\llbracket\text{three hours}\rrbracket)}(\llbracket\text{run}\rrbracket)$
(Every running event consists of running subevents whose runtimes are very small compared to three hours.)

In substance-denoting pseudopartitives, we assume that the dimension parameter is the appropriate measure function. Mass nouns like *water* are acceptable because they have divisive reference (Krifka, 1998): whenever they apply to an entity, they also apply to all of its parts.

(29) thirty liters of water
Satisfied presupposition: $\mathrm{SR}_{\text{volume},\varepsilon(\llbracket\text{thirty liters}\rrbracket)}(\llbracket\text{water}\rrbracket)$
(Every water amount consists of water parts whose volumes are very small compared to thirty liters.)

5.3 Ruling out singular count nouns

Singular count nouns are ruled out because they are quantized.

(30) *five pounds of book
Failing presupposition: $\mathrm{SR}_{\text{weight},\varepsilon(\llbracket\text{five pounds}\rrbracket)}(\llbracket\text{book}\rrbracket)$
(Every book consists of parts which are themselves books (!) and whose weights are very small compared to five pounds.)

5.4 Temperature in pseudopartitives

A nonmonotonic measure function like *temperature* is ruled out because smaller values are not guaranteed as you go from bigger to smaller amounts of substance.

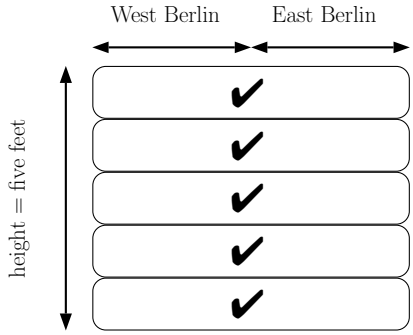
(31) *thirty degrees Celsius of water
Failing presupposition: $\mathrm{SR}_{\text{temperature},\varepsilon(\llbracket\text{thirty degrees Celsius}\rrbracket)}(\llbracket\text{water}\rrbracket)$
(Every water amount consists of water parts whose temperatures are very small compared to thirty degrees Celsius.)

5.5 The problematic snow example

Unlike Schwarzschild's, this account does not require the measure function in the pseudopartitive to be monotonic.

(32) five feet of snow
Satisfied presupposition: $\mathrm{SR}_{\text{volume},\varepsilon(\llbracket\text{five feet}\rrbracket)}(\llbracket\text{snow}\rrbracket)$
(Every snow amount consists of snow parts whose heights are very small compared to five feet.)

Figure 3: Accepting *five feet of snow*



The answers to the measurement puzzle.

1. How can we characterize the class of admissible measure functions?

   - A measure function μ in a pseudopartitive of the form *Num N1 of N2* has to be such that $\mathrm{SR}_{\mu,\,\varepsilon([\![Num\ N1]\!])}([\![N2]\!])$ is true.

2. Why are not all measure functions admissible in the first place?

   - The constraint on measure functions is independently attested in *for*-adverbials, and it also rejects telic predicates in *for*-adverbials and singular count nouns in pseudopartitives.

6 Distributivity and collectivity

Stratified reference can also be used to gain new insights into the *distributivity-collectivity* opposition. Here are three relevant puzzles and a unified solution.

6.1 The *numerous/gather* puzzle

On many collective predicates, *all* forces a distributive interpretation, which is usually nonsensical (Kroch, 1974; Dowty, 1987; Winter, 2001)

(33) a. The students who came to the rally are numerous.
b. The men who run this country are politically homogeneous.
c. The people on this boat are a motley crew.

(34) a. *All the students who came to the rally are numerous.

b. *All the men who run this country are politically homogeneous.
c. *All the people on this boat are a motley crew.

(35) a. *Each of the students who came to the rally is numerous.
b. *Each man who run this country is politically homogeneous.
c. *Each person on this boat is a motley crew.

Other examples: *suffice to defeat the army* (Kroch, 1974), *be a large group, be a group of four, be few in number, be a couple* (Dowty, 1987), *be denser in the middle of the forest* (Barbara Partee p.c. via Dowty 1987), *pass the pay raise, elect Bush* (Taub, 1989), *be too heavy to carry* (Brisson, 1998), *be a good team, form a pyramid* (Winter, 2001).

But *all* is compatible with many other collective predicates:

(36) a. The students gathered in the hallway.
b. The professors met in the garden.
c. The soldiers dispersed.

(37) a. All the students gathered in the hallway.
b. All the professors met in the garden.
c. All the soldiers dispersed.

This is not a syntactic but a semantic phenomenon (Winter, 2001):

(38) a. The committees were numerous. ✓*distributive,* ✓*collective*
b. All the committees were numerous. ✓*distributive,* **collective*

(39) a. The committees gathered. ✓*distributive,* ✓*collective*
b. All the committees gathered. ✓*distributive,* ✓*collective*

Other examples: *be similar, fit together* (Vendler, 1957), *scatter, be alike, disagree, surround the fort* (Dowty, 1987), *form a big group* (Manfred Krifka p.c. via Brisson 2003).

Question: What is the semantic distinction between *numerous*-type and *gather*-type collective predicates? And why is *all* sensitive to it?

6.2 The *each/all* puzzle

For *numerous*-type collective predicates, *each* (and *every*) behaves exactly as *all* does.

(40) *Each ant in the colony was numerous. **distributive,* **collective*

But for *gather*-type predicates, they don't:

(41) *Each ant in the colony gathered. **distributive, *collective*

The collective interpretation of *gather*-type collective predicates is also blocked by *every/each*, but it is not blocked by *all* (Vendler, 1962; Dowty, 1987; Taub, 1989; Brisson, 2003; Winter, 2001):

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

Question: Why does *each* block collective interpretation where *all* doesn't?

6.3 Zweig's puzzle

Zweig (2008) notes that the quantifier *all* normally cannot give rise to scopeless (cumulative) readings, in contrast to nondistributive quantifiers like *three*:

(43) a. Three safari participants saw thirty zebras.
Available scopeless reading: Three safari participants saw at least one zebra each, and thirty zebras were seen overall.
b. All the safari participants saw thirty zebras.
Unavailable scopeless reading: Each safari participant saw at least one zebra, and thirty zebras were seen overall.

Dependent-plural readings, which Zweig shows are scopeless, are an exception. Here *all* patters with *three*:

(44) a. Three safari participants saw zebras.
Available scopeless reading: Three safari participants saw at least one zebra each, and at least two zebras were seen overall.
b. All the safari participants saw zebras.
Available *scopeless reading:* Each safari participant saw at least one zebra, and at least two zebras were seen overall.

Aside: The phenomenon is sensitive to c-command and also occurs with *every*:

(45) a. All the students read thirty papers. *distributive, *cumulative*
b. Every student read thirty papers. *distributive, *cumulative*

(46) a. Thirty students read all the papers. *distributive, ✓cumulative*
b. Thirty students read every paper. *distributive, ✓cumulative*

See Schein (1993) Kratzer (2000), Champollion (2010a) for cumulative readings of *every*.

Question: What is the relevant semantic distinction between *see zebras* and *see thirty zebras*? Why is *all* sensitive to it?

7 Stratified reference as distributivity

Claim: *Each* and *all* impose a constraint which is analogous to the presupposition of *for*-adverbials, except that the "dimension" involved is not runtime but the thematic role of the *all*-phrase, usually *agent*. The "granularity" involves various flavors of atoms rather than very short intervals.

(47) **Presupp. of *for 1h*:** $\forall e[\mathrm{VP}(e) \rightarrow e \in {}^*\lambda e' \begin{pmatrix} \mathrm{VP}(e') \wedge \\ \varepsilon(\lambda t[\mathrm{hours}(t) = 1])(\tau(e')) \end{pmatrix}]$

(Every VPing event consists of one or more VPing events whose runtimes are very short compared to an hour.)

(48) **Presupposition of *each*:** $\forall e[\mathrm{VP}(e) \rightarrow e \in {}^*\lambda e' \begin{pmatrix} \mathrm{VP}(e') \wedge \\ \mathrm{PureAtom}(\mathrm{ag}(e')) \end{pmatrix}]$

(Every VPing event consists of one or more VPing events whose agents are pure atoms.)

(49) **Presupposition of *all*:** $\forall e[\mathrm{VP}(e) \rightarrow e \in {}^*\lambda e' \begin{pmatrix} \mathrm{VP}(e') \wedge \\ \mathrm{Atom}(\mathrm{ag}(e')) \end{pmatrix}]$

(Every VPing event consists of one or more VPing events whose agents are atoms.)

The "pure atom" terminology will be explained in a moment. Singular individuals are pure atoms. Here are some baseline examples:

(50) The children each smiled. / Each of the children smiled.

Presupposition: $\forall e[\mathrm{smile}(e) \rightarrow e \in {}^*\lambda e' \begin{pmatrix} \mathrm{smile}(e') \wedge \\ \mathrm{PureAtom}(\mathrm{ag}(e')) \end{pmatrix}]$

(Every smiling event consists of one or more smiling events whose agents are pure atoms.)

(51) The children all smiled. / All the children smiled.

Presupposition: $\forall e[\mathrm{smile}(e) \rightarrow e \in {}^*\lambda e' \begin{pmatrix} \mathrm{smile}(e') \wedge \\ \mathrm{Atom}(\mathrm{ag}(e')) \end{pmatrix}]$

(Every smiling event consists of one or more smiling events whose agents are atoms.)

7.1 The *numerous* vs. *gather* puzzle

Question: What is the semantic distinction between *numerous*-type and *gather*-type collective predicates? And why is *all* sensitive to it?

Auxiliary idea:

(52) a. Numerous-type predicates = Nonthematic collectivity
b. Gather-type predicates = Thematic collectivity

Terminology from Verkuyl (1994).

7.1.1 Nonthematic collectivity

Defined negatively: a predicate that does not distribute down to singular individuals. A plurality of people may be numerous (that is, if it has many members), but it does not even make sense to apply the predicate *numerous* to a single person. Similar to the *kolkhoz collectivity* of Verkuyl (1994).

(53) The boys were numerous.

(54) The people on this boat are a motley crew.

Nonthematic collective predicates have sum agents:

(55) The boys are numerous.
$\exists e[{}^*\text{numerous}(e) \wedge {}^*\text{ag}(e) = \bigoplus(\text{boy})]$
The sum of all boys is numerous, i.e. is large in number.

7.1.2 Thematic collectivity

Defined positively by the presence of noninductive entailments, e.g. collective responsibility or collective action (Landman, 2000)

(56) The Marines invaded Grenada. (Roberts, 1987, p. 147)

(57) The boys touch the ceiling. (Landman, 2000)

(58) The boys carried the piano upstairs. (Landman, 2000)

Sentence (56) is about the Marines as an institution. Following Landman (1989), I model thematic collectivity by using groups ("impure" atoms). For any set of individuals there is also a group that corresponds to this set.

Thematic collective predicates have group agents:

(59) The boys gathered.
$\exists e[{}^*\text{gather}(e) \wedge {}^*\text{ag}(e) = \uparrow(\bigoplus(\text{boy}))]$
The group of all boys gathered. – with Landman's $\uparrow$ (group formation)

7.1.3 Application

(60) a. *All the boys were numerous. *nonthematic collectivity*
b. **Failing presupposition:** $\text{SR}_{\text{agent, Atom}}([\![\text{be numerous}]\!])$
(Every event in the denotation of *be numerous* can be divided into one or more parts each of which is in the denotation of *be numerous* and has an atomic agent.)

This fails because *be numerous* is nonthematic collective (has sum agents).

(61) a. All the boys gathered. *thematic collectivity*
b. **Satisfied presupposition**: $\mathrm{SR}_{\text{agent, Atom}}(\llbracket\text{gather}\rrbracket)$
(Every gathering event can be divided into one or more parts each of which is a gathering event and has an atomic agent.)

This presupposition is vacuously satisfied: Since *gather* is thematic collective, (61a) involves a group agent. So any gathering event can be divided into one gathering event which has an atomic agent.

7.2 *Gather* distinguishes between *each* and *all*

Question: Why does *each* block collective interpretation where *all* doesn't?

(62) a. *Each of the boys gathered.
b. **Failing presupposition**: $\mathrm{SR}_{\text{agent, PureAtom}}(\llbracket\text{gather}\rrbracket)$
(Every gathering event can be divided into one or more parts each of which is a gathering event and has an agent which is a pure atom.)

This fails because apart from cases like *The committee gathered*, gathering events have impure atoms as agents (e.g. the one in (61a)).

7.3 Zweig's puzzle

Question: What is the relevant semantic distinction between *see zebras* and *see thirty zebras*? Why is *all* sensitive to it?

(63) a. All the safari participants saw thirty zebras. **cumulative*
b. All the safari participants saw zebras. ✓*cumulative*

We can rule out the scopeless reading of (63a) as a presupposition failure:

(64) **Failing presupposition:** $\mathrm{SR}_{\text{agent, Atom}}(\llbracket\text{see thirty zebras}\rrbracket)$
(Every see-thirty-zebras event consists of subevents with atomic agents and in each of which thirty zebras are seen.)

The scopeless reading of (63b) is available, though (cf. atelic/telic distinction):

(65) **Satisfied presupposition:** $\mathrm{SR}_{\text{agent, Atom}}(\llbracket\text{see zebras}\rrbracket)$
(Every event in which at least one zebra is seen consists of subevents with atomic agents and in each of which at least one zebra is seen.)

Answers.
What is the semantic distinction between *numerous*-type and *gather*-type collective predicates? And why is *all* sensitive to it?

- Only the agents of gather-type collective predicates may be impure atoms. *All* has a presupposition which is vacuous in that case.

Why does *each* block collective interpretation where *all* doesn't?

- *Each* distributes down to pure atoms; *all* distributes down to pure and impure atoms.

What is the relevant semantic distinction between *see zebras* and *see thirty zebras*? Why is *all* sensitive to it?

- Only *see zebras* has stratified reference with respect to agents.

8 Summary

We have used a parametrized higher-order property, stratified reference, to

- improve on a notion developed for aspect (the subinterval property)
- solve a problem in the study of measurement
- and to get a new perspective on distributivity and collectivity.

Emerging bigger picture: Distributivity as a higher-order property with two parameters:

- dimension: runtime, spatial extent, measure functions, thematic roles ...
- granularity: atomic (*all*), nonatomic contextual (*for*, pseudopartitives)

Further applications: Distance distributivity and reformulation of the D operator (AC 2011 coming up); spatial aspect; aspectual composition; generics; vagueness of granularity in *for*-adverbials

Further reading: Champollion (2010b) Penn Ph.D. thesis

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