

Parts of a whole:  
distributivity as a bridge between  
aspect and measurement\*

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## 1 Introduction

**Main theoretical contribution:** a higher-order property that is general enough to subsume a wide range of semantic oppositions, yet formally precise enough to make testable predictions and to transfer insights across traditional boundaries.

- singular - plural
- count - mass
- bounded - unbounded
- telic - atelic
- collective - distributive
- group - sum

**Main empirical finding:** a large class of nominal and verbal constructions impose a parametrized but otherwise identical *distributivity presupposition* on one of their arguments.

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- This presupposition is parametrized for *dimension*: distributivity occurs in time, in space, or abstractly along a measure function, or a thematic role.
- And it is parametrized for *granularity*: distributivity will reach down to parts but not equally so: to atoms or groups if it can find them, or to a contextually salient level of detail otherwise.

**How the theoretical and the empirical contributions link:** The higher-order property is an adequate characterization of the distributivity presupposition. This means that it is not just an interesting abstraction but linguistically relevant, in the sense that many constructions test for it.

## 2 A unified picture: Distributive constructions

All of the following constructions impose a parametrized distributivity presupposition on one of their constituents. Evidence for this presupposition comes from the entailments they give rise to (not shown here, see Champollion (2009c) and Chapter 1).

- Sensitive to *collective vs. distributive*, in the traditional sense:

– *each* (e.g. Dowty and Brodie, 1984; Link, 1987)

- (1) a. The boys each **read a book**. *distributive*  
 b. \*The boys each **are numerous**. *\*collective*

Dimension parameter: agent

Granularity parameter: singular form of head noun (here: *boy*)

- Sensitive to *group* (e.g. collective action) vs. *sum* (e.g. cardinality check):

– *all* (e.g. Kroch, 1974; Winter, 2001)

- (2) a. All of the soldiers **attacked the fort**. *collective action*  
 b. \*All of the soldiers **were numerous**. *\*cardinality check*

Dimension parameter: agent

Granularity parameter: atom (N.B.: groups are atoms too)

- Sensitive to *telic vs. atelic*:

– *For*-adverbials (e.g. Dowty, 1979; Krifka, 1998)

- (3) a. John **ran** for five minutes. *atelic*

b. #John **ran to the store** for five minutes. *\*telic*

Dimension parameter: time

Granularity parameter: contextually specified very short time

– *Until* (e.g. Karttunen, 1974; Hitzeman, 1991)

- (4) a. John **ate away at his sandwich** until Mary arrived. *atelic*  
 b. #John **finished his sandwich** until Mary arrived. *\*telic*

Parameters as before

- Sensitive to *singular vs. mass/plural*:

– Pseudopartitives (e.g. Krifka, 1998; Schwarzschild, 2006)

- (5) a. five pounds of **books** *plural count*  
 b. three liters of **water** *mass*  
 c. \*five pounds of **book** *\*singular count*

– Comparative determiners (e.g. Hackl, 2001; Schwarzschild, 2006)

- (6) more **books/water/\*book** than **papers/rice/\*shoe**

Dimension parameter: measure function (e.g. weight, volume)

Granularity parameter: contextually specified very small amount

## 2.1 Aligning the elements

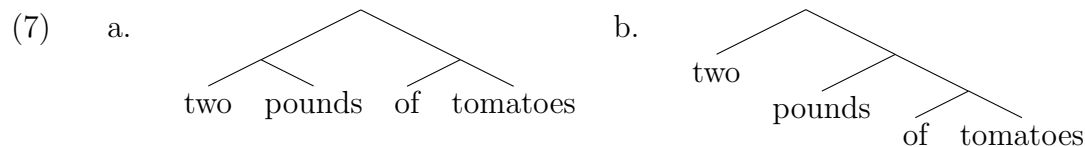
Term	Meaning
Key	the entity about whose parts entailments are licensed
Share	the “thing being distributed” over the parts of the Key
Map	the function (e.g. thematic role, measure function) from Share to Key

“Three boys each laughed.”	<span style="border: 1px solid black; padding: 2px;">three boys</span> <i>Key</i>	... is the <span style="border: 1px solid black; padding: 2px;">agent</span> of ...	<span style="border: 1px solid black; padding: 2px;">laughed</span> <i>Share</i>
“three liters of water”	<span style="border: 1px solid black; padding: 2px;">three liters</span> <i>Key</i>	... is the <span style="border: 1px solid black; padding: 2px;">volume</span> of ...	<span style="border: 1px solid black; padding: 2px;">water</span> <i>Share</i>
“John ran for three hours.”	<span style="border: 1px solid black; padding: 2px;">three hours</span> <i>Key</i>	... is the <span style="border: 1px solid black; padding: 2px;">duration</span> of ...	<span style="border: 1px solid black; padding: 2px;">John ran</span> <i>Share</i>

**Distributivity Constraint, preview:** A distributive construction presupposes that for every part of any Key there is a Share which the Map maps to it.

### 3 A note on the syntax of pseudopartitives

As seen from the alignment above, I claim, contra e.g. Bale (2009), that pseudopartitives have the structure (7a) which makes them parallel with other distributive constructions, rather than (7b). This question is currently open in the literature.



Chapter 4 shows that (7a) is the syntactically less costly assumption overall. The argument rests on coordination facts: *two pounds* can be coordinated, but many people can't coordinate *pounds of tomatoes*.

- (8) John bought two pounds and two ounces of tomatoes.  
(9) \*John bought two pounds of tomatoes and grams of saffron.

### 4 Outline of the talk

- Theoretical part: relativized divisive reference
- Solving empirical puzzles in aspect and measurement
- Refining the theory: relativized granular reference
- Solving empirical puzzles in aspect and distributivity

### 5 The sensitivity of distributive constructions

- (10) \*The boys each **are numerous**.  
(11) \*Three pounds of **book** were visible.  
(12) \*John **ran to the store** for three hours.

**Generalization:** The Shares (in bold) are unacceptable because they fail to apply to certain parts of the entities (individual or event) in their denotation.

- Not every subset of a set that is numerous is itself numerous.
- Not every (in fact, no) part of a book is itself a book.
- Not every part of a running to the store is itself a running to the store.

“Road to nowhere” attempt at formalization: Divisive reference (Cheng, 1973)

- (13)  $\text{DIV}(P) =_{def} \forall x[P(x) \rightarrow \forall y[y < x \rightarrow P(y)]]$  (Krifka, 1998)  
 A predicate  $P$  is **divisive** iff  $P$  holds of every proper part of any entity of which it holds.

**Why divisive reference fails:** it is a binary distinction. But some predicates are acceptable as Shares in some distributive constructions but not others:

- (14) a. Three boys each ran to the store. *run to the store* is distributive  
 b. \*John ran to the store for 5 min. *run to the store* is telic

Divisive reference does not allow us to say: *run to the store* is divisive with respect to agents, but not with respect to time. What we want is a relativized notion of divisive reference.

**Crucial insight:** we need this relativization anyway to model spatial vs. temporal aspect.

## 5.1 *For*-adverbials test for parts relative to a dimension

Atelic predicates have the *subinterval property* (Bennett and Partee, 1972): Whenever they hold at some interval  $i$ , they also hold at every subinterval of  $i$ .

- (15) a. John **ran** for 5 min. *atelic*  
 b. \*John **ran to the store** for 5 min. *telic*

Spatial *for*-adverbials test for spatial atelicity. Following Gawron (2005), we must distinguish between temporal and spatial aspect:

- (16) 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 (Champollion, 2009b) – see Figure 1

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

## 5.2 Relativized divisive reference

A new concept that allows us to say: *run to the store* is divisive relative to the agent dimension but not the time dimension; *run* is divisive relative to both

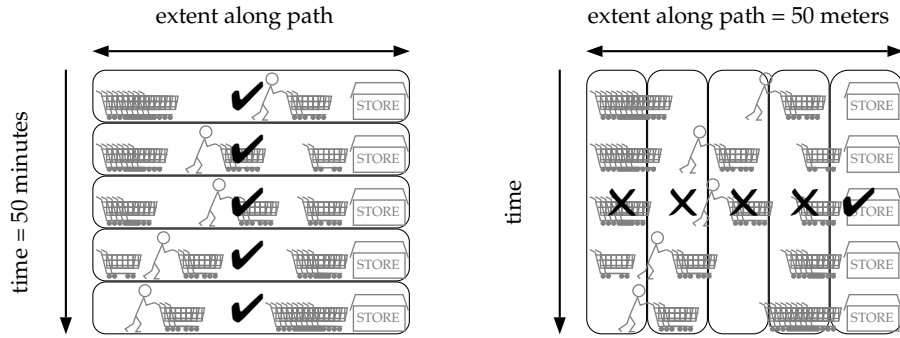


Figure 1: *John pushed carts to the store* has the subinterval property in time but not in space

### Semantics (by example):

$$(18) \quad \text{DIV}_{ag}(\llbracket \text{run} \rrbracket) \qquad \text{run is distributive} \\ \Leftrightarrow \forall e \in \llbracket \text{run} \rrbracket \forall x < \text{ag}(e) \exists e' \in \llbracket \text{run} \rrbracket . [e' < e \wedge \text{ag}(e') = x]$$

- Every proper part of the (possibly plural) agent of a running event  $e$  is the (possibly plural) agent of a running event that is a proper part of  $e$ .<sup>1</sup>

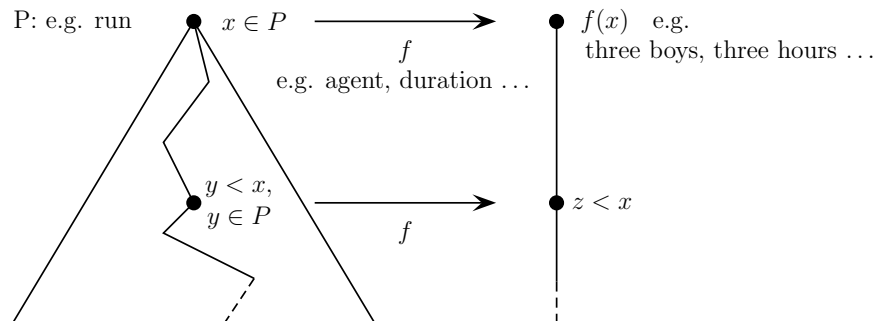
$$(19) \quad \text{DIV}_{duration}(\llbracket \text{run} \rrbracket) \qquad \text{run has the subinterval property} \\ \Leftrightarrow \forall e \in \llbracket \text{run} \rrbracket \forall i < \text{duration}(e) \exists e' \in \llbracket \text{run} \rrbracket . [e' < e \wedge \text{duration}(e') = i]$$

- Every proper part of the temporal trace of a running event  $e$  is the temporal trace of another running event which is a proper part of  $e$ .

### Semantics (formal definition):

$$(20) \quad \text{DIV}_f(P) =_{def} \forall x [P(x) \rightarrow \forall z [z < f(x) \rightarrow \exists y [P(y) \wedge y < x \wedge z = f(y)]]]$$

- A predicate  $P$  has **divisive reference relative to a function  $f$**  iff  $f$  maps every entity  $x$  of which  $P$  holds to a value each of whose proper parts is the value of some proper part of  $x$  of which  $P$  holds.



<sup>1</sup>Background assumptions: events and thematic roles are functions closed under sum (e.g. Landman, 2000; Kratzer, 2007); the part-of relation on degrees corresponds to the less-than relation, e.g.  $4kg < 5kg$

### 5.3 The proposal

- (21) **Distributivity Constraint:**  
Every distributive construction presupposes that  $\text{DIV}_{[\text{Map}]}(\llbracket \text{Share} \rrbracket)$ .  
“For every part of any Key there is a Share which the Map maps to it.”

$\text{DIV}_f$  parametrizes divisive reference to the first parameter (dimension) mentioned in the beginning. To take the second parameter (granularity) into account, we need to refine it further. We’ll do this in a short while – we can already explain a lot without the refinement:

### 5.4 Aspect

- **Question:** Why do *for*-adverbials (and *until*) reject telic predicates?  

(22) \*John ran to the store for three hours.  
(23) \*John finished his sandwich until Mary arrived.
- **Answer:** Temporal *for*-adverbials presuppose  $\text{DIV}_{\text{duration}}(\llbracket \text{Share} \rrbracket)$ , the subinterval property.
- **Explanation:** Temporally telic predicates are ruled out because they lack this property. For example,  $\text{DIV}_{\text{duration}}(\llbracket \text{run to the store} \rrbracket)$  fails, because not every part of the runtime of a running-to-the-store event is the runtime of another running-to-the-store event.
- **Why this matters:** *For*-adverbials are the prime diagnostic of atelicity (Verkuyl, 1989). Understanding their semantics means understanding the nature of atelicity.
- **Comparison with previous work:** unlike e.g. Dowty (1979), the subinterval property presupposition is not stipulated specifically for *for*-adverbials, it is just a special case of a general constraint

### 5.5 Count/mass, singular/plural

- **Question:** Why do pseudopartitives and comparatives reject count nouns?  

(24) three pounds of books/\*book  
(25) more books/\*book

- **Answer:** They presuppose  $\text{DIV}_{\text{Map}}(\text{Share})$ , where *Map* is the covert measure function and *Share* is the noun.
- **Explanation:** Singular count nouns are always quantized. For example, the presupposition  $\text{DIV}_{\text{weight}}(\llbracket \text{book} \rrbracket)$  fails because no book *x* has other books as its parts, in particular, other books with smaller volume.
- **Why this matters:** it shows that the telic/atelic and count/mass distinctions are unified under this model (a basic requirement since at least Bach (1986))

## 5.6 Measurement

- **Question:** Why do pseudopartitives and comparatives reject measure functions like *temperature*?

- (26)
- |    |                                 |   |
|----|---------------------------------|---|
| a. | three liters of water           | ✓ <i>volume</i>                                   |
| b. | *three degrees Celsius of water | * <i>temperature</i>                              |
| c. | more water                      | ✓ <i>volume</i> (“ <i>more water by volume</i> ”) |
| d. | *more water                     | * <i>temperature</i> (“ <i>warmer water</i> ”)    |

- **Answer:** They presuppose  $\text{DIV}_{\text{Map}}(\text{Share})$ , where *Map* is the covert measure function and *Share* is the noun.
- **Explanation:**  $\text{DIV}_{\text{temperature}}(\llbracket \text{water} \rrbracket)$  fails because most amounts of water do not have colder amounts of water among their parts. More generally, any measure function is provably ruled out that returns the same value on all the parts of some substance in the denotation of the noun.
- **Why this matters:** the constraint on measure functions in constructions is an extremely robust and language-independent fact (Schwarzschild, 2006)
- **Comparison with previous work:** Krifka (1989) and Schwarzschild (2006) state a similar constraint (Schwarzschild calls it the “monotonicity constraint”) but do not motivate it in terms of other constructions; also, their constraint makes the wrong empirical predictions, see Champollion (2009c))

## 5.7 Varieties of aspect

- **Question:** there is temporal aspect and spatial aspect, but why is there no “speed aspect”? or other varieties of aspect?

- (27)
- |    |                              |                |
|----|------------------------------|----------------|
| a. | John drove for thirty hours. | ✓ <i>time</i>  |
| b. | John drove for thirty miles. | ✓ <i>space</i> |

c. \*John drove for thirty miles an hour. \*speed

- **Answer:** *For*-adverbials presuppose  $DIV_{\theta}(Share)$ , where *Share* is the VP or IP and  $\theta$  is the dimension (e.g. time or space)
- **Explanation:**  $\theta$  cannot be speed because the presupposition  $DIV_{speed}(\llbracket drive \rrbracket)$ , fails because not every driving event has slower driving events among its parts
- **Why this matters:** this needs to be explained since *for*-adverbials are otherwise productive:

(28) I'm interested in it [=fashion, LC] for five pages, not for 18 pages!<sup>2</sup>

- **Comparison with previous work:** none available (this is a novel observation)

## 5.8 Explaining the Plus Principle

- **The Plus Principle:** A predicate is unbounded (= compatible with *for*-adverbials) if it has either an unbounded head, or an unbounded argument. (Verkuyl (1972), reformulated by Kiparsky (1998))

- (29)
- \*Judith[+B] ate[+B] three sandwiches[+B] for an hour.
  - Judith[+B] wanted[-B] sandwiches[-B] for an hour.
  - Judith[+B] wanted[-B] three sandwiches[+B] for an hour.
  - Judith[+B] ate[+B] sandwiches[-B] for an hour.

(30) Snow[-B] fell[+B] throughout the area[+B] for two straight days.<sup>3</sup>

- (31)
- \*The carafe of wine[+B] flowed[+B] from the jar to the floor[+B] for five minutes.
  - Wine[-B] flowed[+B] from the jar to the floor[+B] for five minutes. (Beavers, 2008)

- **Question:** Why is one [-B] enough to make the whole predicate atelic?
- **Answer:** Temporal *for*-adverbials presuppose  $DIV_{\tau}(Share)$ , not  $DIV(Share)$ . That is, they presuppose the subinterval property, not divisive reference. In many cases, one unbounded predicate is already enough to guarantee the subinterval property.

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<sup>2</sup>Attested example, T. Çolak in conversation with the author, April 25, 2010. Intended interpretation: I'm willing to read five but not 18 pages of articles on fashion.

<sup>3</sup>Attested example (<http://community.lawyers.com/forums/t/17235.aspx>).

- **Explanation:** The reasoning is analogous to spatial vs. temporal aspect – see Figure 2.

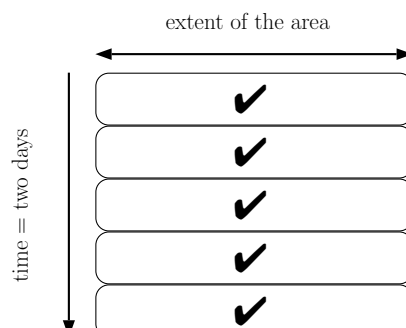


Figure 2: Accepting *Snow fell throughout the area for two straight days*

- **Why this matters:** We have a principled explanation for the effects captured by the Plus Principle, so we can eliminate it from the grammar.
- **Comparison with previous work:** This question puzzles Beavers (2008) a great deal, probably because he assumes a model of telicity based on divisive reference. He postulates a complicated treatment based on tenary  $\theta$  roles. None of this is necessary here.

## 6 Granularity: from *for* to *all* via partitives

- Actually, *for*-adverbials distribute over subintervals of very small but not infinitely small length (the *minimal-parts problem*, Taylor (1977), Dowty (1979) and others)

Background: Waltzing takes at least three steps, so can't be true at instants

- (32) 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

- One could maintain that we don't know what goes on at instants, so *waltz* could be true at instants in a technical sense. Chapter 2 discusses the problems with this position. For example, even generations would have to be able to somehow boil down to instants:

- (33) The Chinese people have created abundant folk arts, such as paper-cuttings, acrobatics, etc., passed on from generation to generation

for thousands of years.<sup>4</sup>

- In order to take the minimal-parts problem into account, we need to loosen relativized divisive reference. There are many ways to do that. Chapter 2 justifies my choice in detail. Here I only give the outcome.

**Technical background** following Link (1987)

- $\forall z(z < A \rightarrow B(z))$  means: every part of A is a B
- $A \in (*\lambda z.\varepsilon(z) \wedge B(z))$  means: there is a way to divide A into  $\varepsilon$ -sized B parts (roughly: every  $\varepsilon$ -sized part of A is a B)

(34) **Relativized divisive reference** (repeated):

$$\text{DIV}_f(P) =_{def} \forall x[P(x) \rightarrow \forall z[z < f(x) \rightarrow \exists y[P(y) \wedge y < x \wedge z = f(y)]]]$$

A predicate  $P$  has **relativized divisive reference** with respect to a function  $f$  iff  $f$  maps every entity  $x$  of which  $P$  holds to a value each of whose proper parts is the value of some proper part of  $x$  that is itself in  $P$ .

(35) **Relativized granular reference:**

$$\text{GRAN}_{f,\varepsilon}(P) =_{def} \forall x[P(x) \rightarrow f(x) \in (*(\lambda z.\varepsilon(z) \wedge \exists y \leq x[z = f(y) \wedge P(y)]))]$$

A predicate  $P$  has relativized granular reference with respect to a function  $f$  and a threshold  $\varepsilon$  iff  $f$  maps every entity  $x$  of which  $P$  holds to a value which can be divided into possibly overlapping parts each of which is within the threshold and is the value of some part  $y$  of  $x$  to which  $P$  applies.

This is motivated by the minimal-parts problem, but it allows us to make progress on completely different problems.

## 6.1 The “paradox of grams” (Bale, 2009)

- **Question:** Why do pseudopartitives that refer to very small quantities accept mass nouns but reject count nouns?

- (36)
- Give me 500 grams of apple/apples.
  - Give me 100 grams of apple/?apples.
  - Give me one gram of apple/??apples.

<sup>4</sup><http://www.twinbridge.com/detail.aspx?ID=315>

- **Answer:** Pseudopartitives presuppose  $GRAN_{Map,\varepsilon}(Share)$ , where *Map* is the covert measure function, *Share* is the noun, and  $\varepsilon$  is very small compared to the Key.
- **Explanation:** the weight of the smallest apples is not very small compared to 100 grams, let alone compared to one gram. But the weight of stuff that qualifies as *apple* in the mass sense (i.e. of applesauce) can be very small down to milligrams.
- **Why this matters:** it shows that a standard semantics of number can account for the “paradox of grams”, contra Bale (2009).
- **Comparison with previous work:** Bale (2009) assumes that *grams of apples* is a constituent and notes that standard assumptions about its semantics leads to a conflict: either *500 grams of apples* has an empty denotation of *100 grams of apples* has a nonempty denotation. This problem doesn’t even arise on this analysis because I assume that *grams of apples* is not a constituent.

## 7 Distributivity: *all* vs. *each*

We can make progress on the behavior of *all* and *each*, two items that appear as determiners and adverbials and that have challenged semanticists since Kroch (1974).

Claim: *All* imposes granular reference down to atoms:

$$(37) \quad \llbracket \text{all the girls}_{ag} \rrbracket = \lambda P_{\langle v,t \rangle} \lambda e : GRAN_{ag,atom}(P).[P(e) \wedge \theta(e) = \llbracket \text{the girls} \rrbracket]$$

Definite plurals are ambiguous between sum and group interpretation: (Landman, 1989)

- $\llbracket \text{the girls} \rrbracket =$  the sum of the girls
- $\llbracket \text{the girls} \rrbracket =$  the group consisting of the girls

*Each* imposes granular reference down to members of the denotation of the Key noun (e.g. *boy* in *The boys<sub>i</sub> have each<sub>i</sub> spoken up*).

$$(38) \quad \llbracket \text{each}_i \rrbracket = \lambda P_{\langle v,t \rangle} \lambda e : GRAN_{ag,i}(P).P(e)$$

### 7.1 Sums vs. groups

- **Question:** why is *all* not compatible with all collective predicates?

- (39) a. All of the soldiers attacked the fort. *collective action*  
 b. \*All of the soldiers were numerous. *\*cardinality check*

- **Answer:** *All* presupposes  $\text{GRAN}_{\theta,atom}(Share)$ , where *Share* is the VP predicate and  $\theta$  is the thematic role (e.g. agent).
- **Explanation:** This means that *all* presupposes that the agent of every VPing event consists of one or more atomic parts that are agents of VPing events. Background assumptions:
  - *attack the fort* applies to groups because it requires collective action. Groups only have themselves as atomic parts (Landman, 1989). This means the presupposition is vacuously true.
  - *be numerous* applies to sums because it does not require collective action. Sums that are numerous may have nontrivial atomic parts that do not themselves qualify as being numerous
- **Why this matters:** this shows that a compositional model-theoretic treatment of *all* is possible, contra Brisson (2003)
- **Comparison with previous work:**
  - the intuition that the argument of a coordinated-action predicate like *attack the fort* is more than the sum of its members is already present in Kroch (1974), but it has not entered the literature. Relativized granular reference is a way to explain why this intuition should matter.
  - Winter (2001) models the problem by giving *be numerous* and *attack the fort* different types (“atom” and “set” type respectively), but he has no independent criterion for his classification.
  - Taub (1989) and Brisson (2003) claim that states and achievements are unacceptable with *all*. On this account we expect “collective-action achievements” to be acceptable. This is the case:
 

(40) a. All the parties involved reached an agreement. ✓ *collective*

Not sure if collective-action states exist, though.

## 7.2 Distributivity and *all*

- **Question:** we have said that *all* rejects sum predicates, so why is it compatible with any distributively interpreted predicate?

Group predicates have collective and distributive interpretations:<sup>5</sup>

- (41) a. All the boys lifted the piano. ✓ *collective* ✓ *distributive*

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<sup>5</sup>Examples (41a), (41b), (42b) from Taub (1989); Nakanishi and Romero (2004); (42a) from Winter (2001). Characterization mine.

- b. All the girls built the raft. ✓ *collective* ✓ *distributive*

Sum predicates only have distributive interpretations:

- (42) a. All the committees are numerous. \*collective ✓ *distributive*  
 b. All the bottles are too heavy to carry. \*collective ✓ *distributive*

- **Answer:** *All* presupposes  $\text{GRAN}_{\theta,atom}(Share)$ , where *Share* is the VP predicate and  $\theta$  is the thematic role (usually agent); in an eventless framework,  $\theta$  is the identity function. Distributive readings of VPs can be created by a VP-level distributive operator D (Link, 1987). D is defined standardly as in Link (1983). **Fact:** D always returns a predicate that satisfies  $\text{GRAN}_{\theta,atom}(Share)$ .

- $\llbracket \text{be numerous} \rrbracket = \lambda x.x \text{ is numerous}$
- $\llbracket D \text{ be numerous} \rrbracket = \lambda x.\text{each of } x\text{'s parts is numerous}$   
 (can be true e.g. if each of them is a committee)

- **Why this matters:** it responds to Winter (2001)'s challenge of modeling the fact that \**all the boys are numerous* is out but *all the committees are numerous* is OK
- **Comparison with previous work:** This is similar to Brisson (2003)'s claim that *all* requires a D operator in its scope. But here, this requirement, to the extent that it holds, is explained rather than stipulated.

### 7.3 Cumulative readings

- **Question:** why does *all* not license cumulative readings? (Zweig, 2008, 2009)

- (43) a. Three students read thirty papers.  
*Can mean:* Three students each read at least one paper and a total of 30 papers were read overall. (*cumulative reading*)
- b. All the students read thirty papers.  
*Cannot mean:* Each student read at least one paper and a total of 30 papers were read overall. (*cumulative reading*)

- **Answer:** *All* presupposes  $\text{GRAN}_{\theta,atom}(Share)$ , where *Share* is the VP predicate and  $\theta$  is the thematic role (e.g. agent).
- **Explanation:** This means that *all* presupposes that the agent of every VPing event consists of one or more atomic parts that are agents of VPing

events. For example, the (plural) agent of a (plural) event of reading thirty papers would have to consist of one or more atomic parts that each read thirty papers. This is not the case since some of them will read less papers.

- **Why this matters:** This result has important consequences for the study of dependent plurals. The state-of-the-art theory of dependent plurals is Zweig (2008, 2009), who analyses dependent plurals in structurally the same way as cumulative readings. Zweig’s account predicts that dependent plurals should be available in exactly the same cases as cumulative readings. In other words, there should be no minimal pairs such as the following:

- (44) a. All the students read papers. (*cumulative reading possible*)  
 b. All the students read thirty papers. (*c.r. impossible*)

The present account saves Zweig’s account by providing an independent factor that rules out the cumulative reading of (44b) without ruling out (44a). (The predicate *read papers* satisfies the presupposition of *all*.)

- **Comparison with previous work:** Zweig (2008)’s own (very brief) account of the contrast in (43) is ad hoc and technically flawed (see Champollion (2010)) but his intuition seems to be accurate.

## 8 Solving a scope puzzle for *for*-adverbials

### 8.1 The scope constraint

- **Question:** Why must indefinites in the scope of *for*-adverbials take wide scope, except with supporting context? (Zucchi and White, 2001; van Geenhoven, 2004; Kratzer, 2007; Champollion, 2010)

- (45) #John found a flea on his dog for a month.  
 a. There is a flea that John found on his dog repeatedly for a month.  
 b. \*On every day during a month, John found another flea on his dog.  
 ⇒ *a flea* cannot have narrow scope

- **Answer:** *find a flea* only has sum events in its denotation in which the same flea is found. So it does not satisfy the Distributivity Constraint  $\text{GRAN}_{\tau,\varepsilon}$  except if the same flea is found over and over again.
- **Explanation:** the Distributivity Constraint requires *a flea* to take “double scope” (both over and under the star operator of *for an hour*):

- (46)  $\llbracket \text{John found a flea for an hour} \rrbracket$   
 Presupposition:  $GRAN_{\tau,\varepsilon}(\text{John find a flea})$  with  $\varepsilon$  very small compared to an hour  
 $= \forall e[e \in \llbracket \text{John find a flea} \rrbracket \rightarrow \tau(e) \in *(\lambda t.\varepsilon(t) \wedge \exists e' \leq e[t = \tau(e') \wedge e' \in \llbracket \text{John find a flea} \rrbracket])]$   
 The runtime of every event  $e$  in  $\llbracket \text{John find a flea} \rrbracket$  can be divided into one or more very small parts (compared with one hour) each of which is the runtime of a part of  $e$  that is in  $\llbracket \text{John find a flea} \rrbracket$ .

## 8.2 Why context overrides the scope constraint

- **Question:** Why is the scope constraint overridden when there is supporting context?

- (47) [In a report discussing the daily intake of medications by a certain patient:] The patient took two pills for a month and then went back to one pill.  
 $\Rightarrow$  *two pills* can have narrow scope

- **Answer:** I assume with Schwarzschild (1996) that distributivity over sums requires supporting context or a salient level of granularity:

- (48) a. These shoes cost fifty dollars. *per pair reading ok*  
 b. These men weigh 250 lbs. *per pair reading not available*

I implement this assumption by assuming that the temporal equivalent of the D operator is sensitive to a contextually supplied threshold, representing the level of granularity (cf. Schwarzschild's cover variable):

$$(49) \quad D_C^{\tau} = \lambda P \lambda e. \tau(e) \in *(\lambda t. \mathbf{C}(\mathbf{t}) \wedge \exists e' \leq e P(e') \wedge \tau(e') \leq t)$$

In (45), there is no supporting context, so  $D_C^{\tau}$  is not available. In (47), there is, so it is available. **Fact:** Any predicate to which  $D_C^{\tau}$  applies has granular reference with respect to time and  $C$ .

An overt counterpart of  $D_C^{\tau}$  is *every day* (see Champollion (2009a) for a related argument that *every* is not the universal quantifier):

$$(50) \quad \llbracket \text{every day} \rrbracket = \lambda P \lambda e. \tau(e) \in *(\lambda t. \text{day}(t) \wedge \exists e' \leq e P(e') \wedge \tau(e') \leq t)$$

The entry for *every day* does not contain a deictic variable. This models the fact that *every day* lexically specifies the level of granularity and allows any predicate to apply distributively.

- (51) John found a flea on his dog every day for a month.
- a. There is a flea that John found on his dog every day for a month.
  - b. On every day during a month, John found a (different) flea on his dog.

- **Why this matters:** it shows that the idea of Schwarzschild (1996) (intermediate-level distributivity exists but requires context) can be extended to *for*-adverbials.
- **Comparison with previous work:** Kratzer (2007) solves the scope puzzle by banning the D operator from applying in the scope of *for*-adverbials. This is too strict. Intermediate-level distributivity is possible, as in (47).

## 9 Conclusion: Beyond explanatory adequacy for semantics?

What is (or should be) an explanation in formal semantics?

- von Stechow (1984) on comparing semantic theories: “If a number of highly complex and apparently unrelated facts are reducible to a few simple principles, then these principles explain these facts.” ( $\approx$  Chomsky’s explanatory adequacy)
- Chomsky (2001) on going beyond explanatory adequacy: “One can plausibly trace interest in [external constraints on evolutionary diversity] back to the Galilean intuition that ‘nature is perfect’ from the tides to the flight of birds and that it is the task of the scientist to discover in just what sense this is true. However obscure it may be, that intuition about what Haeckel called nature’s ‘Sinn für das Schöne’ has been a guiding theme of modern science ever since, perhaps its defining characteristic. In principle, then, we can seek a level of explanation deeper than explanatory adequacy, asking not only *what* the properties of language are but also *why* they are that way.”
- The distributivity constraint qualifies as an explanation in the sense of explanatory adequacy, but not beyond: it is beautiful (at least in my eyes). But why does it exist?
- Trying a Minimalist answer: the constraint satisfies an interface condition: these distributivity presuppositions must be present so that the sentences can be interpreted. But then why are there (near) paraphrases that are acceptable?

- (52) a. John drove / \*drove to the store for three hours.

- b. John drove from noon to 3pm.
  - c. John drove to the store from noon to 3pm.
- (53)
- a. three liters of water / \*three degrees Celsius of water
  - b. water with a volume of three liters
  - c. water with a temperature of three degrees Celsius
- (54)
- a. All the soldiers attacked the fort / \*were numerous.
  - b. The soldiers attacked the fort.
  - c. The soldiers were numerous.

- I can't make sense of "why" such a thing as the Distributivity Constraint should exist. The more widespread I found it was, the more this mystery grew. Worse, I don't even have the tools to find an answer. Two years of research have certainly left me in awe of language.

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