A unified account of distributive NPs, *for*-adverbials, and measure constructions

Lucas Champollion

University of Pennsylvania /
Palo Alto Research Center

Sinn und Bedeutung 14 – September 29, 2009

Introduction

Constructions analyzed in this talk

- **Distributively interpreted NPs**
  - Three boys hiccupped.
  - Each man wore a green tie.
- ***for*-adverbials**
  - run for fifty minutes *vs.* *run to the store for fifty minutes
  - run for five miles *vs.* *run to the store for five miles
- **Measure constructions**
  - five pounds of books *vs.* *five pounds of book
  - five inches of snow *vs.* *five degrees Celsius of snow

Goals of this talk

- Analyze all constructions as instances of **distributivity**
- Increase explanatory adequacy by reducing the overall size of the grammar
- Increase descriptive adequacy for each construction by capitalizing on insights gained from the other ones
- Increase empirical testing ground for any theory that explains aspects of one of these phenomena

Outline

1. Upgrade Schwarzschild (1996) for events and sums
   - Use QR as a lingua franca rather than Lasersohn (1998)
   - Clarify the role of contextual covers
2. Show that it extends naturally to *for*-adverbials
   - Intuition: “John ran for three hours” $\approx$ “Always during three hours John ran”

     (cf. Dowty, 1979; Moltmann, 1991)
3. Extend it to measure constructions
   - Intuition: “three liters of water” :: “three hours of running”

     (cf. Krifka, 1998; Schwarzschild, 2006)

for-adverbials as distributive quantifiers

(Vendler, 1957; Verkuyl, 1972; Dowty, 1979; Moltmann, 1991; Krifka, 1998)

Temporal *for*-adverbials are incompatible with telic predicates

Example

John ran for three hours	*atelic*
# John ran a mile for three hours	*telic*

Explanation (Dowty, 1979): *for*-adverbials are like universal quantifers – for Dowty, over the moments of *three hours.*

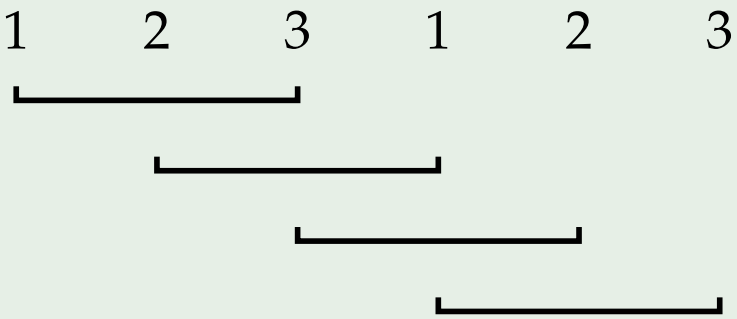
Paraphrase with a quantifier

John ran at each moment of three hours
John ran a mile at each moment of three hours

Quantification over moments is too strong
(Dowty, 1979; Hinrichs, 1985; Moltmann, 1991)

The minimal-parts problem (Dowty, 1979)

The couple waltzed for an hour.



- *waltz* apparently not required by *for an hour* to be true at intervals < 3 steps
- Dowty (1979) already notes the problem. Many ad-hoc solutions since then (e.g. Hinrichs, 1985; Moltmann, 1991).

Quantification over individuals is also too strong

Example (Gillon, 1987)

Rodgers, Hammerstein and Hart wrote musicals.

Distributive: Each one wrote musicals individually.

- Not true

Collective: The three collaborated to write musicals.

- Not true

Intermediate: They paired up to write musicals.

- True:
  - Rodgers and Hammerstein together wrote *Oklahoma*
  - Rodgers and Hart together wrote *On Your Toes*

Claim: Minimal-parts effect = intermediate reading

Minimal-parts problem

The couple waltzed for an hour.

Distributive: At each moment, the couple waltzed.

- Impossible – ruled out by the verb *waltz*

Collective: There was one long waltzing with no waltzing parts

- Ruled out by *for an hour* (and also by the verb semantics)

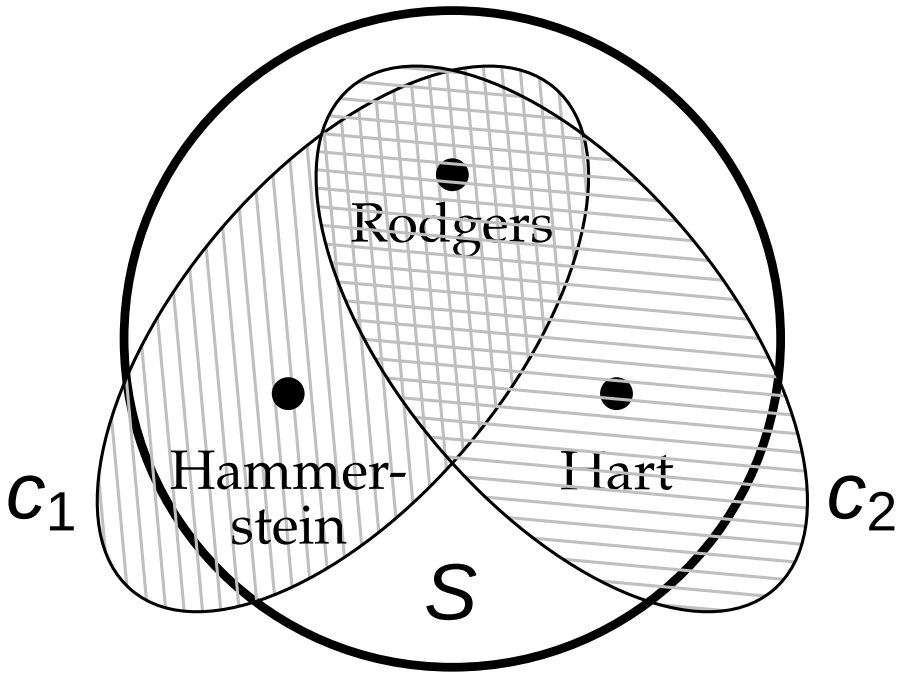
Intermediate: Subintervals of the hour were runtimes of waltzing subevents

- Possible

Implementation

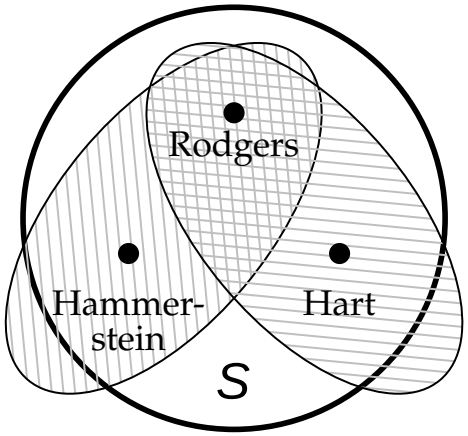
Covers: a tool to capture intermediate readings

Gillon (1987); Schwarzschild (1996)

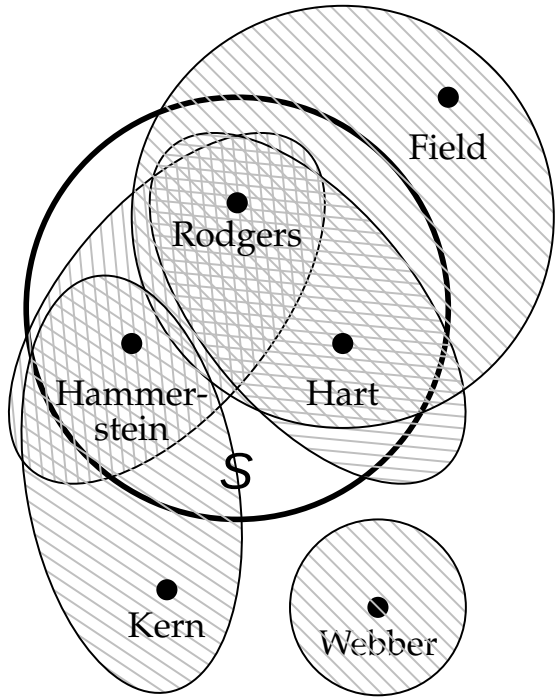


A set *Cov* **covers** a set *S* iff *Cov* is a set of (possibly overlapping) subsets of S such that each member of *S* is also contained in at least one of the subsets.

We can also – and will – use extended covers



A cover of S
(also an extended cover of S)



An extended cover of S

I call a set P an **extended cover** of S to say that a subset of P covers S. This includes the case that P itself covers S.

Intermediate distributivity with contextual covers

Schwarzschild (1991, 1996)

Example

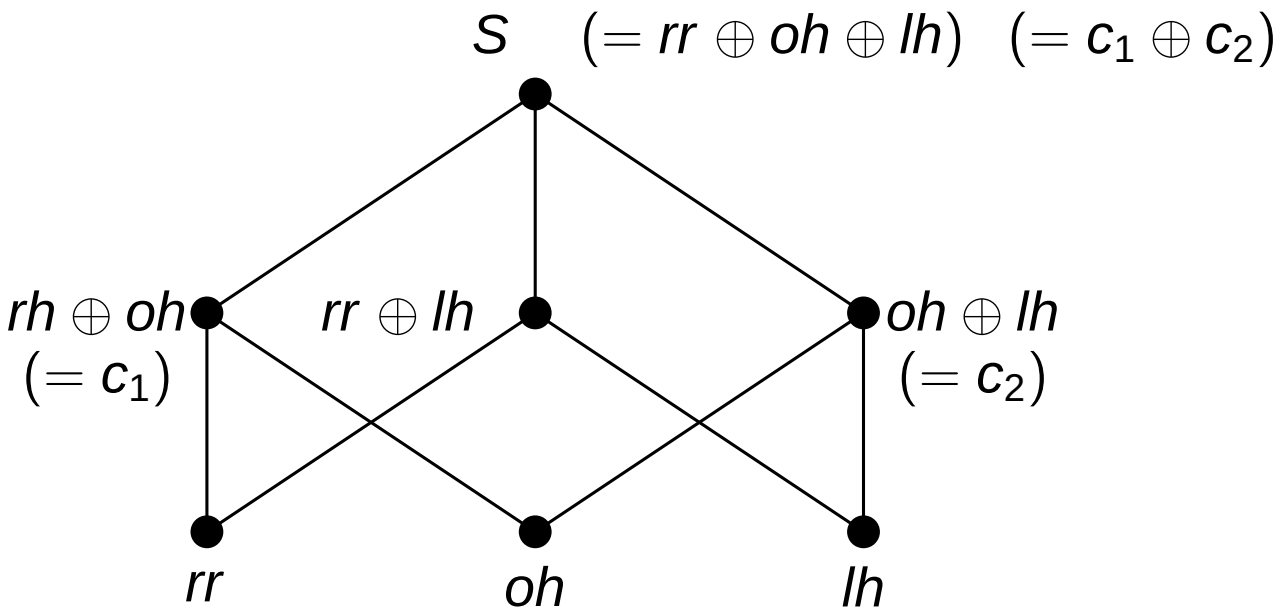
Rodgers, Hammerstein and Hart wrote musicals.

$\forall y[(y \in [\![Cov]\!] \wedge y \subseteq \{rr, oh, lh\}) \rightarrow y \in [\![\text{write musicals}]\!]]$

which is true in the real world if *Cov* is as in the previous picture.

Translating covers into a mereological framework

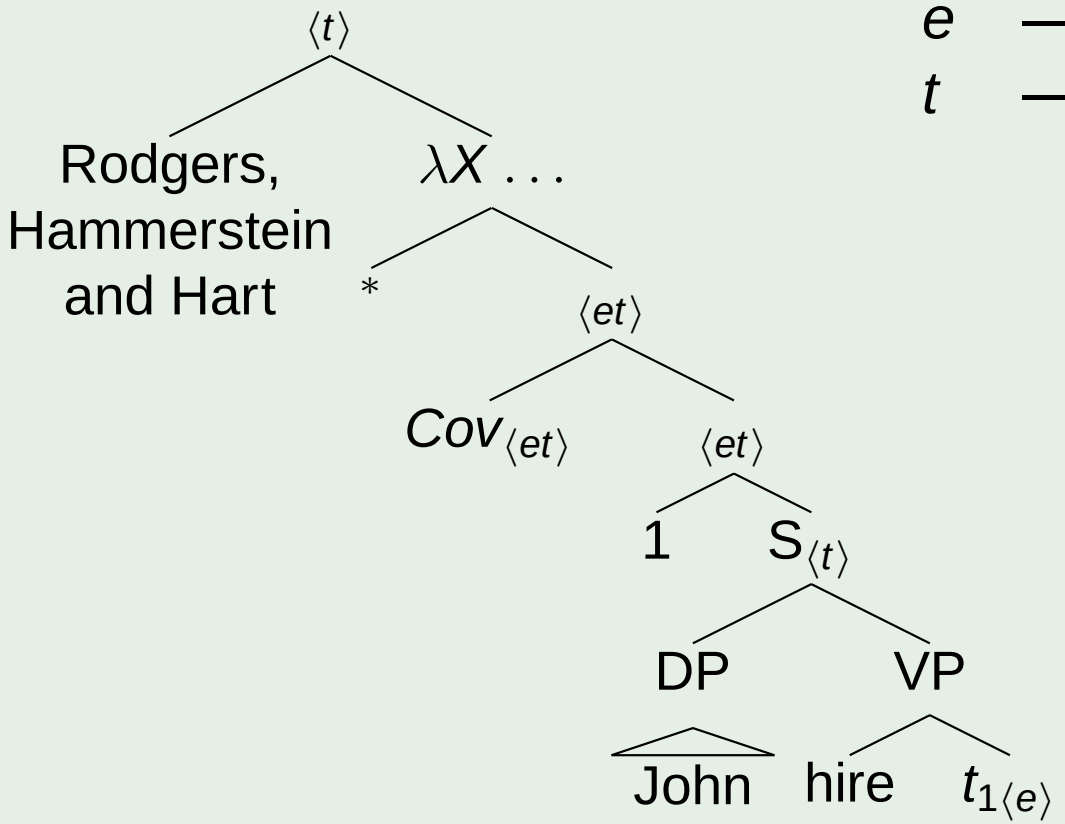
Heim (1994); Link (1997); Lasersohn (1998)



- A set *Cov* **covers** *S* iff *S* is the sum of the entities in *Cov*.
- *P* is an extended cover of *S* iff $S \in {}^{*}P$. (see Vaillette, 2001)

Implementation using Link's star operator
(Heim, 1994)

John hired Rodgers, Hammerstein and Hart.



e — individual
t — truth value

Combining covers with a Neo-Davidsonian framework

Proposed amendment: Switch to the cumulativity operator **

- $\langle X, E \rangle \in {}^{**}R$ holds just in case X is a sum of individuals that stand in relation R to a set of events whose sum is E

** is motivated from cumulative readings:

Example: 600 firms own 5000 computers

$\exists X$ 600-*firms*$(X) \wedge \exists Y$ 5000-*computers*$(Y) \wedge \langle X, Y \rangle \in {}^{**}$*own*

(Gillon, 1987; Heim, 1994; Sternefeld, 1998; Beck and Sauerland, 2000; Beck, 2001)

Almost anything under the stars is a cover

Theorem: Reasoning under the stars

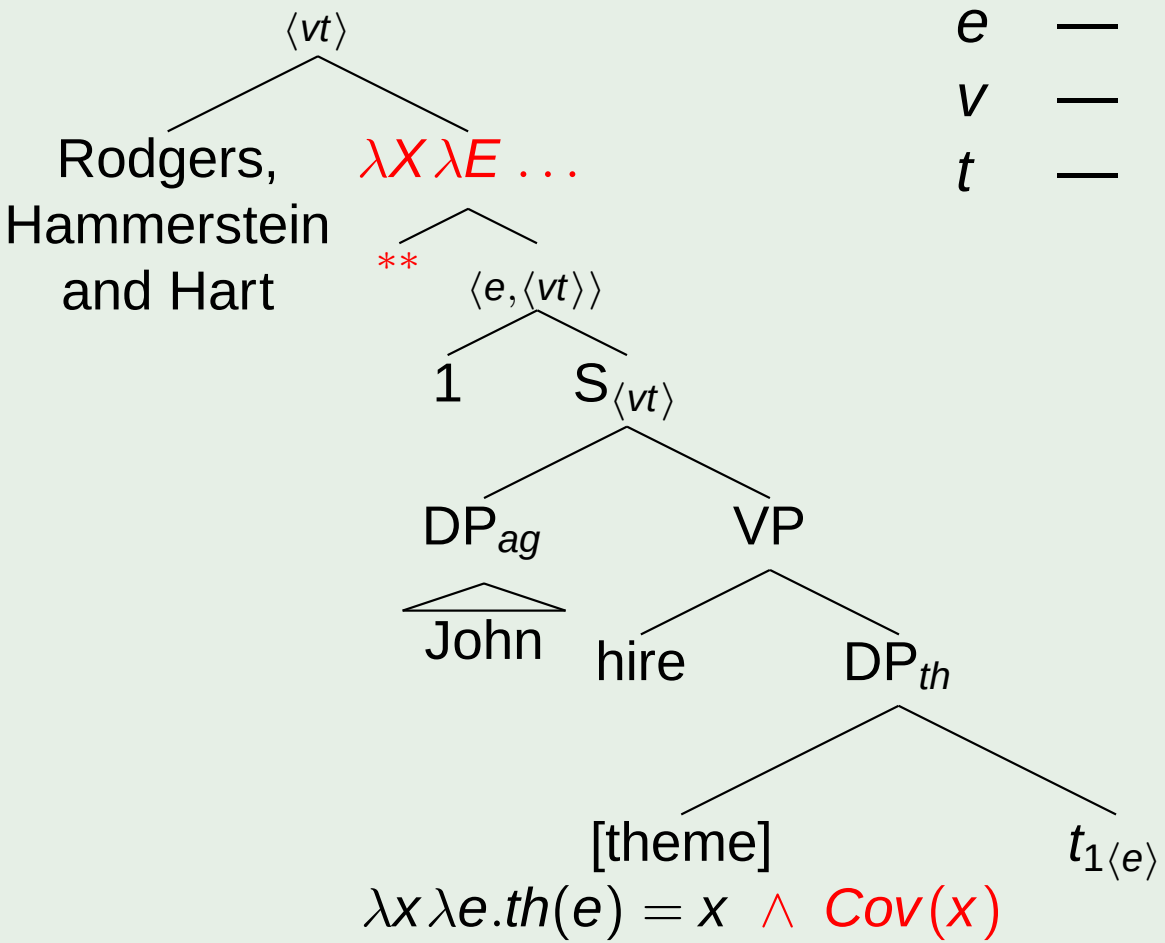
Suppose that for any choice of $x_1 \ldots x_k \ldots x_n$, it holds that $R(x_1 \ldots x_k \ldots x_n) \rightarrow C(x_k)$.
Then ${}^{*n}R(X_1 \ldots X_k \ldots X_n) \rightarrow {}^{*}C(X_k)$.

A few consequences:

- If $X \in {}^{*}P$ and $P \rightarrow Q$ then $X \in {}^{*}Q$.
- If $\langle E, [\![NP]\!] \rangle \in {}^{**}\lambda e \lambda x (x \in [\![Cov]\!] \wedge \ldots$, then $[\![Cov]\!]$ is an extended cover of [[NP]]. This is true no matter what [[Cov]] denotes!

Covers as restrictions on thematic roles

John hired Rodgers, Hammerstein and Hart.



e — individual
v — event
t — truth value

The resulting reading is as expected

Example: John hired Rodgers, Hammerstein and Hart.

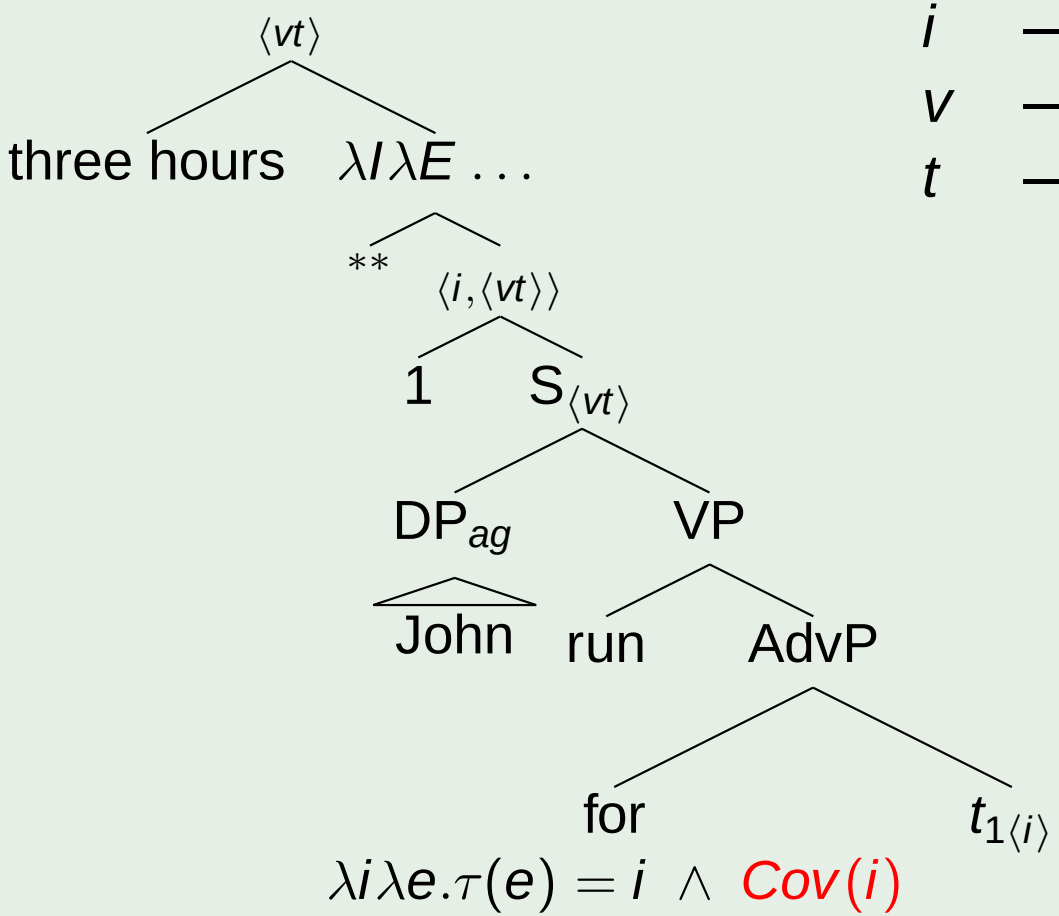
$$\exists E\ \langle E, rr \oplus os \oplus lh \rangle \in {}^{**}\lambda e \lambda y (hiring(e) \wedge ag(e) = j \wedge th(e) = y \wedge y \in [\![Cov]\!])$$

- John hired every part of the sum $rr \oplus os \oplus lh$ that is also a member of [[Cov]]
- [[Cov]] is an extended cover of $rr \oplus os \oplus lh$, i.e. each of them is in at least one cell of [[Cov]]

We don't need to give contextual covers special status in the grammar. They are just contextual restrictions on thematic roles, or on copies that have been left stranded under **.

Adverbial distributivity is just like the nominal one . . .

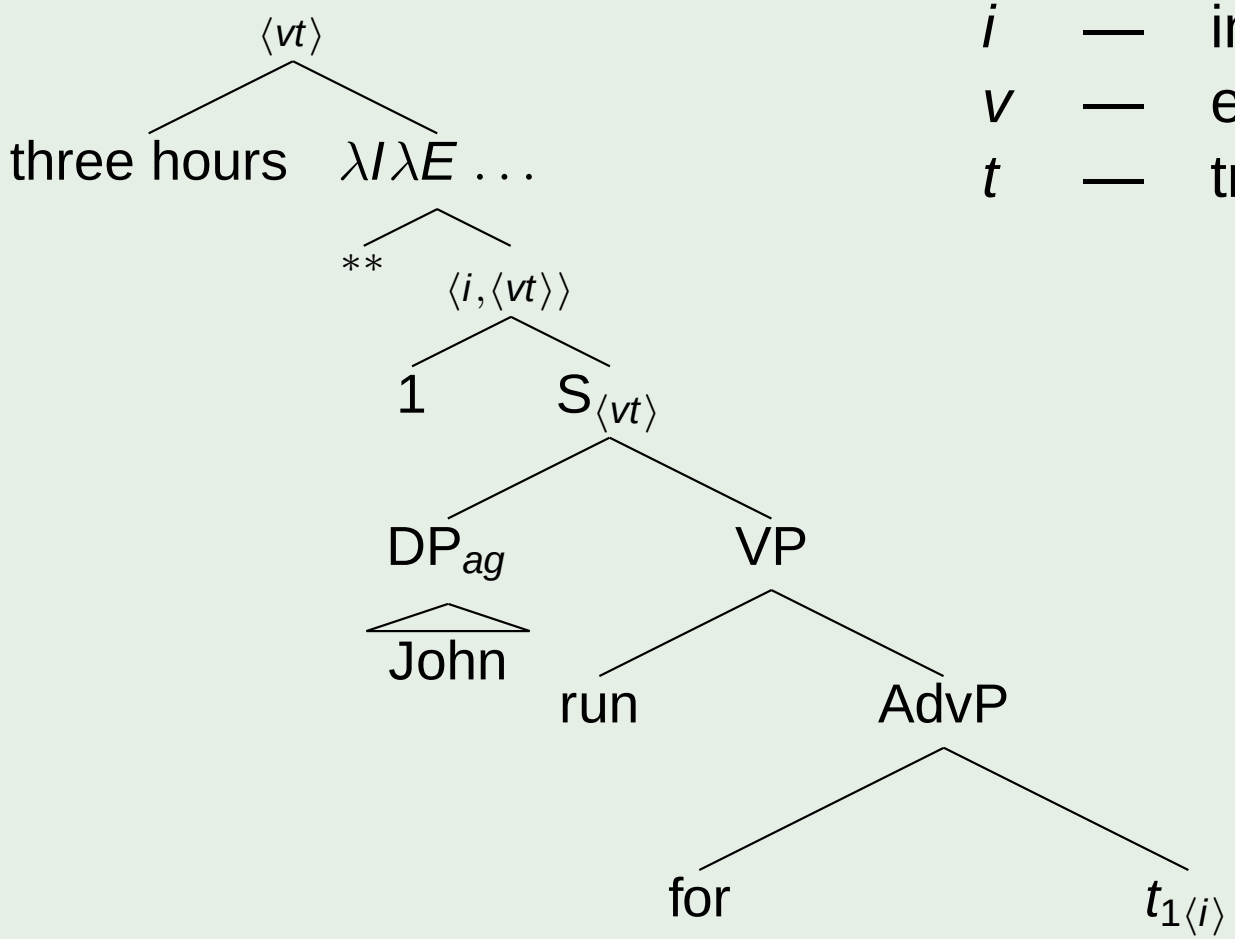
John ran for three hours.



i — interval
v — event
t — truth value

. . . except that the cover on *for* is lexicalized.

John ran for three hours.



$\lambda i \lambda e.\tau(e) = i \ \wedge$ *very-short*$_C(i)$

i — interval
v — event
t — truth value

The resulting reading

Claim

for has a vague meaning component that denotes very short intervals. What counts as very short is context dependent.

John ran for three hours.

$\exists E\ \exists I$ three-hours$(I) \wedge \langle E, I \rangle \in$
$^{**}\lambda e \lambda i(\textit{very-short}_C(i) \wedge \textit{run}(e) \wedge \textit{ag}(e) = \textit{john} \wedge \tau(e) = i)$

- There is a three-hour long interval *I*
- Every very short subinterval of *I* is the runtime of a running event *e* by John
- The sum of all these subintervals is equal to *I*

Remember that covers have no special status in the system. "very short" is just a part of the meaning of *for*.

Harvesting

Problem: *for*-adverbials allow for gaps

Frequentative readings of *for* (Partee, p.c. in Vlach (1993))

Mary slept for a week. *(almost continuously)*
Mary slept in the attic for a week. *(allows for breaks)*

- Problem: Interruptions are allowed, unexpected if quantification is really over all subintervals.
- Ad-hoc solutions:
  - Hinrichs (1985) essentially implements covers
  - Vlach (1993) posits a silent frequency adverbial

Solution: Domain of *for* is pragmatically restricted

Pragmatic restriction (von Fintel, 1994)

Mary always slept. *(almost continuously)*
Mary always slept in the attic. *(allows for breaks)*

- Solution: restrictor of quantifiers is anaphoric on the discourse context (e.g. von Fintel, 1994)

Problem: *for*-adverbials are focus sensitive

MacDonald and Ürögdi (2009)

Focus restricts *for*

For a week, Mary took John to the MOVIES.

For a week, Mary took JOHN to the movies.

Solution: *for*-adverbials are like adverbial quantifiers

for-adverbials behave exactly as expected:

Focus restricts *for*

Last week, Mary always took John to the MOVIES.
Last week, Mary always took JOHN to the movies.

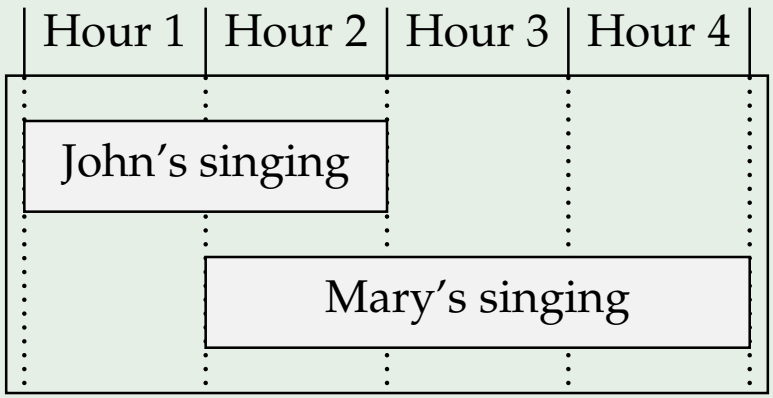
- Solution: von Fintel (1994) has a general solution that derives focus sensitivity and pragmatic sensitivity from discourse-context anaphoricity

Problem: Overlapping events lead to ambiguity

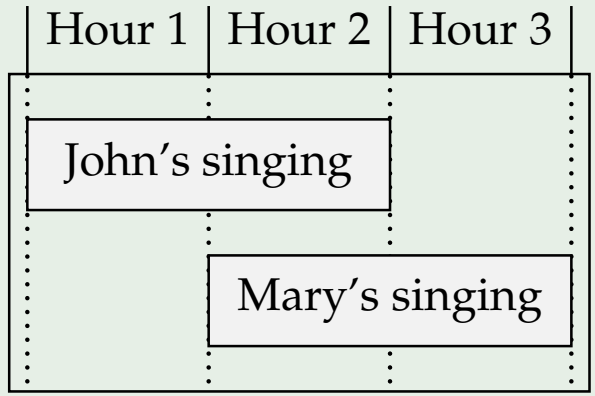
Krifka (1998)

- *John and Mary sang for four hours* is true in these two scenarios:

Occupy-the-room scenario



Paid-by-the-hour scenario



- Ad-hoc solution (Krifka, 1998): the function that maps events to their duration in hours is underdefined when it comes to sums of events.

The related phenomenon goes by two names

Event/object related readings (Krifka, 1992)

Last year, 4000 ships passed through the lock.

- If some ship passed through the lock twice . . .
  - **Reading 1**: it is counted only once.
  - **Reading 2** : it is counted twice.

Proportion ambiguity (e.g. Partee, 1984; Kadmon, 1987)

Usually, if a farmer owns a donkey, he beats it.

- If some farmer has two donkeys . . .
  - **Reading 1**: he is counted only once.
  - **Reading 2** : he is counted twice.

Solution: Any account that works for mass nouns

Example

John and Mary sang for four hours.

- If, during some time interval, John sang and Mary sang . . .
  - **Reading 1 (occupy the room)**: it is counted only once.
  - **Reading 2 (paid by the hour)** : it is counted twice.

- Solution: Any account general enough to deal with mass quantification, e.g. Doetjes and Honcoop (1997).

Problem: Mixed bounded/unbounded predicates

Example

John pushed carts to the store for fifty minutes.
John pushed carts to the store for fifty meters.

- Problem: *for an hour* and *for a mile* have different distributions. Unexpected if they only test for homogeneity as in (Krifka, 1998; Kratzer, 2007)

Solution: Distributivity is relativized to one dimension

Example

John pushed carts to the store for fifty minutes.
John pushed carts to the store for fifty meters.

Parallel example

Each of the farmers rounded up donkeys.
Farmers rounded up each of the donkeys.

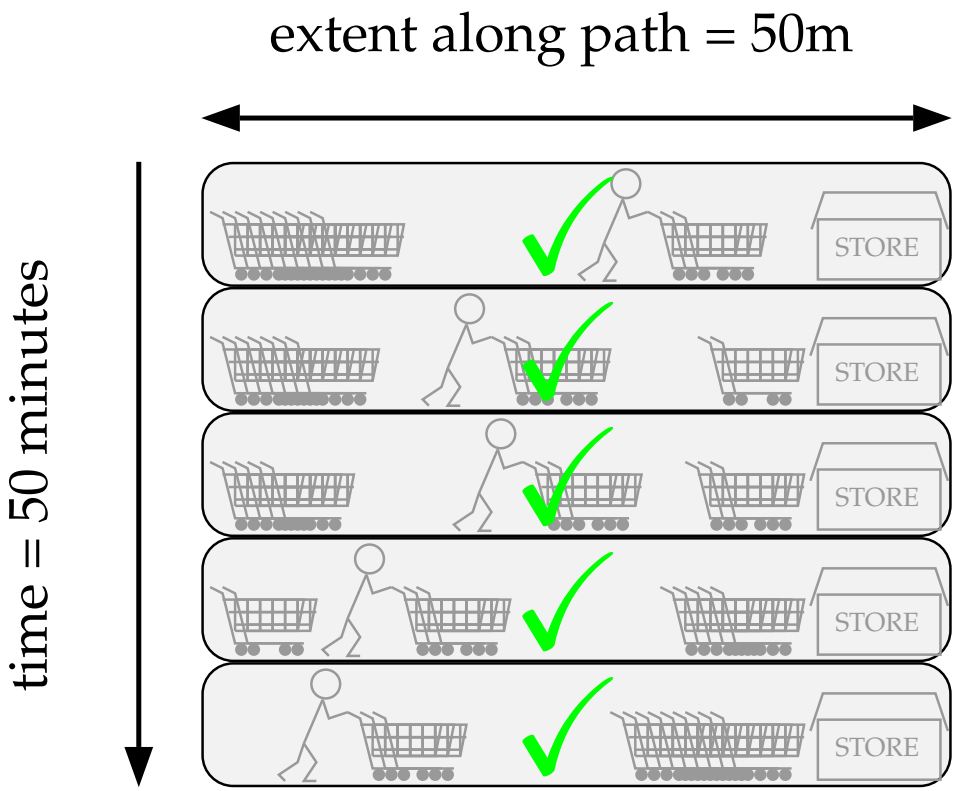
- Solution (Champollion, 2009): They distribute only along time vs. space, just as *each of the N* does (agent vs. theme).
- This falls out of the mechanism described without any changes.

How the minimal pair is explained

Judgment to be predicted

John pushed carts to the store for fifty minutes.

- Cover contains very short time intervals
- For each of them there is an event of pushing carts to the store

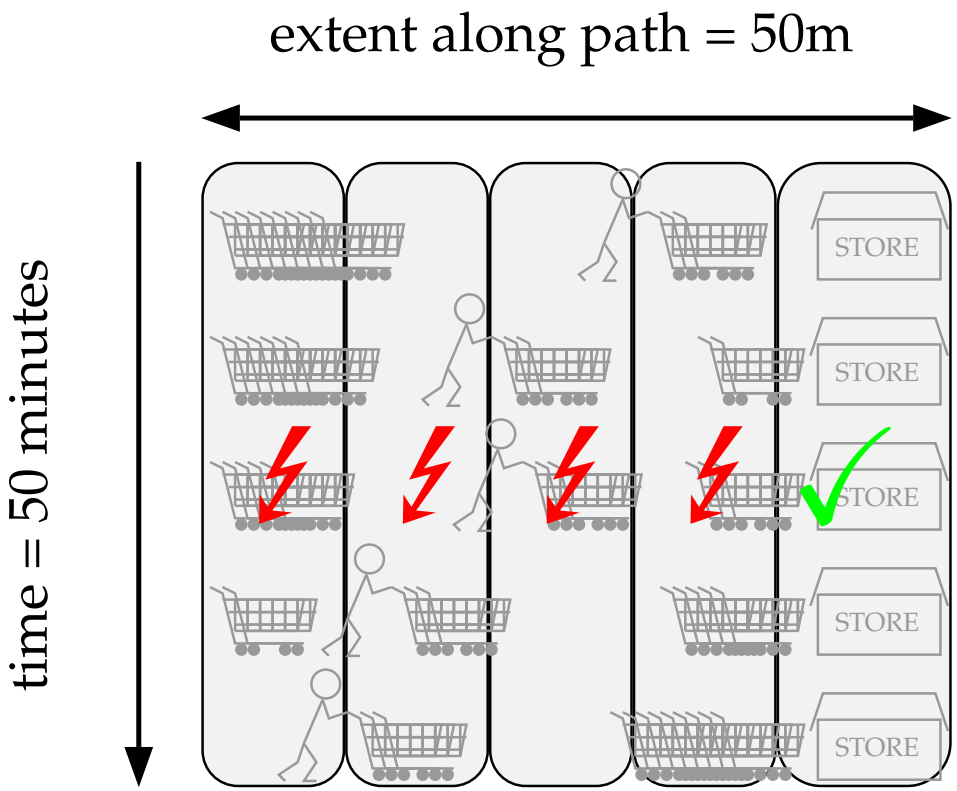


How the minimal pair is explained

Judgment to be predicted

John pushed carts to the store for fifty meters.

- Cover contains very short extents along the path
- For most of them there is no event of pushing carts to the store



Measure constructions

Measure constructions

Krifka (1998); Schwarzschild (2006)

Require mass nouns or plurals

three liters of water
three pounds of grapes

*three liters of (a) bottle of water
*three pounds of baby

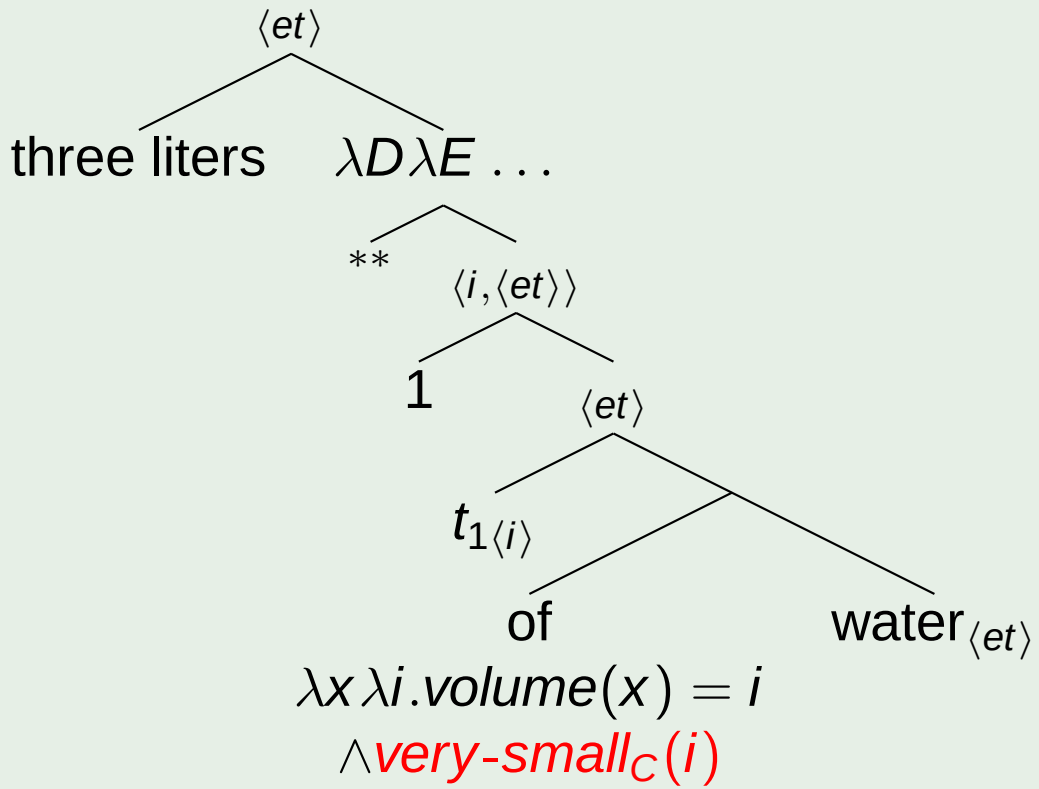
Minimal-parts problem : *300 pounds of furniture*

Idea:

- Mass : Count :: Atelic : Telic (Mourelatos, 1978)
- three hours of running $\approx$ three liters of water

Plugging measure constructions into the framework

three liters of water



The resulting reading

three liters of water

$$\lambda X \exists I\ [\textit{three-liters}(I) \wedge\ \langle I, X \rangle \in$$
$$^{**}\lambda I' \lambda X' [\textit{very-small}_C(I') \wedge \textit{water}(X')$$
$$\wedge\ \text{volume}(X') = I']]$$

True of any X such that . . .

- There is a three-liter interval I
- which can be divided into very small parts
- Each part is the volume of some quantity of water
- All of these quantities form X

Problem: Monotonicity requirement

Krifka (1998); Schwarzschild (2006)

Some measure functions are unacceptable:

Example

three liters of water	*volume*
*thirty degrees Celsius of water	*temperature*
*three miles per hour of water	*speed*

Same constraint as in *for*-adverbials:

Example

drive for three hours	*duration*
drive for three miles	*distance*
*drive for three miles per hour	*speed*

Previous work

Previous insight (Krifka, 1998; Schwarzschild, 2006): Every proper part of a given quantity of X has a smaller volume, but not a smaller temperature than the whole.

- Modeled by an ad-hoc “monotonicity requirement” on *of*.
- This is too strong:
  - *three inches of snow covered the fields*
    $\not\models$ *less than three inches of snow covered field 1*

A new perspective: Monotonicity as distributivity

***thirty degrees Celsius of water**

$$\lambda X \exists I\ [\textit{thirty-degrees-Celsius}(I) \wedge\ \langle I, X \rangle \in {}^{**}\lambda I' \lambda X' [\textit{very-small}_C(I') \wedge \textit{water}(X') \wedge \text{temperature}(X') = I']]$$

- Entails that each part of the three-degree-Celsius interval I is the temperature of some quantity of water
- Could rule out by world knowledge: if X is water, then any parts of X always have (more or less) the same temperature as X.
- Could also claim that temperature intervals don't have parts

Distributivity is relativized to one dimension

three inches of snow

$$\lambda X \exists I\ [\mathit{three\text{-}inches}(I) \wedge\ \langle I, X\rangle \in {}^{**}\lambda I' \lambda X' [\mathit{very\text{-}small}_C(I') \wedge \mathit{snow}(X') \wedge \mathrm{height}(X') = I']]$$

- Entails that each part of the three-inch interval I is the height of some quantity of snow. All the snow together forms X.
- Does *not* entail that each part of X has a smaller height than X itself.
- Same solution as for *push carts to the store for fifty minutes*

Summary: Overall results

Distributivity explains:

- the atelicity requirement of *for*-adverbials
- the monotonicity constraint on measure constructions
- the fact that they are checked along only one dimension

Covers (= intermediate distributivity) explain:

- the minimal parts problems for verbs like *waltz*
- and in measure constructions for nouns like *furniture*

Previous theories carry over to explain:

- focus sensitivity and frequentative readings of *for*
- the proportion ambiguity in *for*

The End

Thank you!

Lucas Champollion
Penn / PARC
lucas@web.de

For help and comments, thanks to Danny Bobrow, Aravind Joshi, Lauri Karttunen, Tony Kroch, Beth Levin, Maribel Romero, Annie Zaenen, audiences at Penn and Stanford, and most of all Cleo Condoravdi. For hospitality and support, thanks to Penn/SAS, PARC, and Stanford.

Beck, S. (2001). Reciprocals are definites. *Natural Language Semantics*, 9:69–138.

Beck, S. and Sauerland, U. (2000). Cumulation is needed: A reply to Winter 2000. *Natural Language Semantics*, 8(4):349–371.

Champollion, L. (2009). *for*-adverbials quantify over subintervals, not subevents. In *9th International Conference on Tense, Aspect and Modality (CHRONOS 9)*, Paris.

Doetjes, J. and Honcoop, M. (1997). The semantics of event-related readings: a case for pair-quantification. In Szabolcsi, A., editor, *Ways of scope taking*, chapter 8, pages 263–310. Springer.

Dowty, D. (1979). *Word meaning and Montague grammar*. Dordrecht: Reidel, Germany.

von Fintel, K. (1994). *Restrictions on quantifier domains*. PhD thesis, University of Massachusetts, Amherst.

Gillon, B. (1987). The readings of plural noun phrases in English. *Linguistics and Philosophy*, 10:199–219.

Heim, I. (1994). Plurals. Lecture notes, MIT.

Hinrichs, E. (1985). *A Compositional Semantics for Aktionsarten and NP Reference in English*. PhD thesis, The Ohio State University.

Kadmon, N. (1987). *On unique and non-unique reference and asymmetric quantification*. PhD thesis, University of Massachusetts, Amherst.

Kratzer, A. (2007). On the plurality of verbs. In Dölling, J., Heyde-Zybatow, T., and Schäfer, M., editors, *Event structures in linguistic form and interpretation*. Walter de Gruyter, Berlin.

Krifka, M. (1992). Thematic relations as links between nominal reference and temporal constitution. In Sag, I. A. and Szabolcsi, A., editors, *Lexical Matters*, pages 29–53. CSLI, Stanford.

Krifka, M. (1998). The origins of telicity. In Rothstein, S., editor, *Events and grammar*, pages 197–235. Kluwer Academic Publishers, Dordrecht/Boston/London.

Lasersohn, P. (1998). Generalized distributivity operators. *Linguistics and Philosophy*, 21(1):83–93.

Link, G. (1997). Ten years of research on plurals — where do we stand? In Hamm, F. and Hinrichs, E., editors, *Plurality and quantification*, pages 19–54. Kluwer.

MacDonald, J. E. and Ürögdi, B. (2009). Duratives, negation and reference time identification. In *9th International Conference on Tense, Aspect and Modality (CHRONOS 9)*, Paris.

Moltmann, F. (1991). Measure adverbials. *Linguistics and Philosophy*, 14:629–660.

Mourelatos, A. P. D. (1978). Events, processes, and states. *Linguistics and Philosophy*, 2:415–434.

Partee, B. H. (1984). Nominal and temporal anaphora. *Linguistics and Philosophy*, 12:243–286.

Schwarzschild, R. (1991). *On the meaning of definite plural noun phrases*. PhD thesis, University of Massachusetts, Amherst.

Schwarzschild, R. (1996). *Pluralities*. Kluwer, Dordrecht.

Schwarzschild, R. (2006). The role of dimensions in the syntax of noun phrases. *Syntax*, 9(1):67–110.

Sternefeld, W. (1998). Reciprocity and cumulative predication. *Natural Language Semantics*, 6:303–337.

Vaillette, N. (2001). A type-logical approach to plural semantics. In *OSU Working Papers in Linguistics 56*, pages 135–157. Ohio State University.

Vendler, Z. (1957). Verbs and times. *The philosophical review*, 66:143–160.

Verkuyl, H. (1972). *On the compositional nature of the aspects*. Dordrecht: Reidel.

Vlach, F. (1993). Temporal adverbials, tenses and the Perfect. *Linguistics and Philosophy*, 16:231–283.