A cover-based view on distance distributivity*

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1 Introduction

- There are three uses of 'each' in English:

(1) a. **Adnominal each:** Two men have carried three suitcases *each*.
b. **Adverbial each:** Two men have *each* carried three suitcases.
c. **Determiner each:** *Each* man has carried three suitcases.

- This talk focuses on data and observations by Zimmermann (2002).
- In German, adnominal and adverbial distance-distributive (DD) items are different from the distributive determiner:

(2) a. **Adnominal:** Die Männer haben *jeweils* drei Koffer getragen.
b. **Adverbial:** Die Männer haben *jeweils* drei Koffer getragen.
c. **Determiner:** *Jeder/*Jeweils* Mann hat drei Koffer getragen.

- Though adverbial and adnominal *jeweils* are similar, they can be teased apart syntactically. For more details, see Zimmermann.
- *Each* and *jeweils* generalize to two classes of DD items:
  - *Each*-type DD items can also be used as determiners.
  - *Jeweils*-type DD items cannot double as determiners.
- **Zimmermann's Generalization** (illustrated below): All *each*-type DD items can only distribute over individuals. This contrasts with many *jeweils*-type DD items, which can also distribute over occasions (= salient chunks of time or space).

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1.1 Questions.

– How can we capture the synonymy of the determiner, adnominal and adverbial uses of *each* in English?
– How can we represent the fact that DD items across languages share some part of their meanings?
– How do DD items fit into distributivity theory more generally? How can we formally capture the semantic variation among DD items?
– How can we explain Zimmermann's Generalization?

2 Illustrating Zimmermann's Generalization

2.1 *Jeweils*-type DD Items

Occur in German, Czech, Bulgarian, Japanese, Korean (Zimmermann)

- These languages have adnominal DD items that cannot double as determiners.
- All of these DD items can distribute over individuals, like English *each*.
- Except for Japanese *sorezore*, all of them can also (given supporting context) distribute over temporal/spatial intervals or 'occasions':

(3) Die Kinder haben jeweils zwei Affen gesehen. *German*
The children have EACH two monkeys seen.
a. *Always available:* 'Each of the children has seen two monkeys'
b. *Available, though only with supporting context:* 'The children have seen two monkeys on each occasion'

(4) Hans hat jeweils zwei Affen gesehen. *German*
Hans has EACH two monkeys seen.
'Hans has seen two monkeys on each occasion'

2.2 *Each*-type DD Items

Occur in English, French, Dutch, Norwegian, Icelandic, Italian, Russian (Zimmermann) and Turkish (Tuğba Çolak, p.c.)

- These languages have adnominal DD items that can also be used as distributive determiners.
- All of these DD items can distribute only over individuals, not over occasions:

(5) The children have seen two monkeys each.
a. *Available:* 'Each of the children has seen two monkeys'
b. *Unavailable:* 'The children have seen two monkeys on each occasion'

(6) *John has seen two monkeys each.
Intended: John has seen two monkeys on each occasion.

- French adnominal *chacun* and determiner/adnominal *chaque* are historically related and can be considered formally identical (Zimmermann p. 44 for references).

(7) *Jean a vu chacun deux singes / deux singes chacun. *French*
Jean has seen EACH two monkeys / two monkeys EACH.
Intended: John has seen two monkeys on each occasion.

(8) Les enfants ont vu chacun deux singes / deux singes chacun.
The children have seen EACH two monkeys / two monkeys EACH.
a. *Available:* 'Each of the children has seen two monkeys'
b. *Unavailable:* 'The children have seen two monkeys on each occasion'

3 Capturing the Semantic Variation

- Strata theory (Champollion, 2010) distills a generalized notion of distributivity from a unified treatment of determiners (*each*, *all*), the distributivity operators (see below), *for*-adverbials, and pseudopartitives.
- In strata theory, distributivity is a parametrized property.
  - The **dimension** parameter indicates the domain of distributivity: e.g. a thematic role in the case of determiner *each*, or time/space in the case of *for*-adverbials (*for an hour*, *for a mile*).
  - The **granularity** parameter indicates the size of the entities over which we distribute: e.g. atoms or amounts of space or time.
- The setting "granularity=atom" blocks "dimension=time" because time is continuous and noncount – there are no atoms to distribute over.
- I propose that adnominal *each* comes prespecified for "granularity=atom". This blocks "dimension=time", so distributivity over occasions is unavailable. *Jeweils* does not come prespecified for anything.
- More concretely, adnominal *each* and *jeweils* include two versions of the distributivity operator (cf. Link (1986) for a similar claim for German *je*, a short form of *jeweils*).
  - *Each* includes the atomic distributivity operator D of Link (1987), which can only distribute over count domains (granularity=atom).
  - *Jeweils* includes the cover-based distributivity operator Part of Schwarzschild (1996), which can also distribute over noncount domains like time (granularity=unspecified).
- This is Link's distributivity operator D in its original formulation:

(9) $[\![\mathrm{D}]\!] = \lambda P_{et} \lambda x \forall y[y \leq x \wedge \mathrm{Atom}(y) \rightarrow P(y)]$ (Link, 1987)

- Applying it to a VP shifts it from a collective to a fully distributive interpretation:

(10) a. The girls built a raft.
$\approx$ The girls built a raft together. *collective*
b. The girls D built a raft.
$\approx$ Each girl built a raft. *fully distributive*

- This is Schwarzschild's distributivity operator Part:

(11) $[\![\text{Part}_C]\!] = \lambda P_{et} \lambda x \forall y [y \leq x \wedge \text{C}(y) \rightarrow P(y)]$ (Schwarzschild, 1996)

- Applying it to a VP shifts it to an "nonatomic distributive" interpretation over sums of a salient size, e.g. pairs:

(12) a. The shoes cost \$50. (Lasersohn, 1995)
$\approx$ The shoes cost \$50 together. *collective*
b. The shoes Part_{pair} cost \$50.
$\approx$ Each pair of shoes costs \$50. *nonatomic distributive*

- Schwarzschild's Part operator contains a free variable C ("cover"). Strata theory reconceptualizes this as a granularity parameter. "Granularity=atomic" is always available as a special case. Then, Schwarzschild's operator behaves like Link's. "Granularity=nonatomic" is only available with supporting context.

(13) John, Mary, Bill, and Sue Part_C were paid \$50.
Available reading: These four people were each paid \$50.
Unavailable out of the blue: John and Mary together were paid \$50; Bill and Sue together were also paid \$50.

- In count domains, distributivity over atoms ("granularity=atomic") is expected to be salient in almost all contexts and to obscure the presence of nonatomic distributive readings (Schwarzschild, 1996).
- So we should look for nonatomic VP-level distributivity in a noncount domain, such as time.
- The readings in question are available given appropriate contextual information or world knowledge.
- Example (14) is based on observations in Moltmann (1991). It is odd out of the blue because pills cannot be taken repeatedly, but it is acceptable in a context where the patient's daily intake is discussed.

(14) This patient took two pills for a month and then went back to one pill.

- Example (15) is from Deo and Piñango (2011), and is acceptable because it is clear that snowmen are typically built in winter.

(15) We built a huge snowman in our front yard for several years.

- The *for*-adverbial is not responsible for these readings because it is not a quantifier (Kratzer, 2007; Champollion, 2010)

(16) a. #John found a flea on his dog for a month. *same flea*

b. John found a flea on his dog every day for a month. *different fleas*

- We can understand the multiple-pills and multiple-snowmen readings as resulting from an application of $\mathrm{D}_{Schwarzschild}$ with setting "dimension=time". This setting is available only with $\mathrm{D}_{Schwarzschild}$, because "granularity=nonatomic" is available.

(17) This patient [Part_{day} took two pills] for a month.
Available reading, though only with supporting context: On every day for a month, the patient took two pills.

- The limitation to supporting context is also present in *jeweils*:

(18) Die Kinder haben jeweils zwei Affen gesehen. *German*
The children have EACH two monkeys seen.

a. *Always available:* 'Each of the children has seen two monkeys'
b. *Available reading, though only with supporting context:* 'The children have seen two monkeys on each occasion'

4 Explaining Zimmermann's Generalization

- What follows is similar to Zimmermann's own account, but reconceptualized in the context of strata theory.
- I propose that in English, adnominal, adverbial and *each* have identical meanings up to type-shifting.
- Determiner *each* is only compatible with count domains ("granularity=atomic") – **each mud, *each water* etc.
- Adnominal *each* is formally identical, so it inherits this property.
- The count domain restriction of adnominal *each* is incompatible with time because they do not contain atoms: "granularity=atom" blocks "dimension=time".
- *Jeweils*-type DD items are formally different from determiners. So it is unsurprising that they do not inherit "granularity=atom".

5 Reformulating the D Operator

- Link's formulation of the D operator needs to be adjusted for several reasons:
  - To modal occasion readings, I will assume event semantics. VPs are of type $\langle vt \rangle$ instead of $\langle et \rangle$, which leads to a type mismatch.
  - We need to be able to coindex D with different thematic roles (Lasersohn, 1995).

(19) a. <u>The first-year students</u> D(took an exam). *Target: agent*
b. John D(gave a pumpkin pie) to <u>two girls</u>. *Target: recipient*
c. John D(summarized) <u>the articles</u>. *Target: theme*

- The D operator can be understood as shifting arbitrary predicates to a distributive interpretation with granularity *Atom* (i.e. singular individual):

(20) **Definition: Atomic event-based D operator**
$[\![\mathrm{D}_\theta]\!] \stackrel{\text{def}}{=} \lambda P_{\langle vt\rangle}\lambda e[e \in {}^*\lambda e' \begin{pmatrix} P(e') \wedge \\ \mathrm{Atom}(\theta(e')) \end{pmatrix}]$
(Takes an event predicate P and returns a predicate that holds of any event e which consists entirely of events that are in P and whose thematic roles θ are atoms.)

- Example:

(21) The girls are wearing a dress.
$\exists e[{}^*\mathrm{ag}(e) = \bigoplus \mathrm{girl} \;\wedge\; {}^*\mathrm{wear}(e) \;\wedge\; \mathrm{dress}(\mathrm{th}(e))]$
(There is a potentially plural wearing event whose agents sum up to the girls, and whose theme is a dress.)

(22) The girls D(are wearing a dress.)
$\exists e[{}^*\mathrm{ag}(e) = \bigoplus \mathrm{girl} \wedge$
$e \in {}^*\lambda e'({}^*\mathrm{wear}(e') \;\wedge\; \mathrm{dress}(\mathrm{th}(e')) \;\wedge\; \mathrm{Atom}(\mathrm{ag}(e')))]$
(There is an event whose agents sum up to the girls, and this event consists of wearing events for each of which the agent is a atom and the theme is a dress.)

- The star operator ${}^*\lambda e'$ is introduced through the D operator and takes scope over the predicate *dress* introduced by the theme.
- Algebraic semantics supplies background assumptions that ensure that (22) entails that each girl wears a dress.

5.1 The Leakage Problem

- There are various other proposals for doing distributivity in event semantics.
- Lasersohn (1998) proposes the following entry (among others):

(23) **Distributivity operator over events (Lasersohn)**
$[\![\mathrm{D}_{Lasersohn}]\!] = \lambda P_{\langle e,vt\rangle}\lambda x\lambda e\forall y[y \leq_{Atom} x \rightarrow \exists e'[e' \leq e \;\wedge\; P(y)(e')]]$

- This applies to a predicate of type $\langle e, vt\rangle$, e.g. $[\![\mathrm{smile}]\!] = \lambda x\lambda e[\mathrm{smile}(e) \;\wedge\; \mathrm{ag}(e) = x]$.
- Inserting a D operator into *The girls smiled* before existential closure applies:

(24) a. Lasersohn's representation:
$\lambda e\forall y[y \leq_{Atom} \bigoplus \mathrm{girl} \wedge \;\rightarrow \exists e'[e' \leq e \;\wedge\; \mathrm{smile}(e') \;\wedge\; \mathrm{ag}(e') = y]$
b. My representation:
$\lambda e[{}^*\mathrm{ag}(e) = \bigoplus \mathrm{girl} \;\wedge\; e \in {}^*\lambda e'[\mathrm{smile}(e') \;\wedge\; \mathrm{Atom}(\mathrm{ag}(e'))]]$

- Lasersohn's representation suffers from what Bayer (1997) calls leakage. Whenever (24a) applies to an event e, it also applies to any event of which e is a part.
- My representation applies to all events that contain a smiling subevent for each girl and nothing else.

- Leakage causes problems in connection with predicates such as *surprisingly*, *unharmoniously* or *in slow procession* which hold of an event even if they do not hold of its parts (Schein, 1993).

(25) Unharmoniously, every organ student sustained a note on the Wurlitzer.

- This says that the ensemble event was unharmonious and not any one student's note.
- Let *Lasersohn* stand for Lasersohn's (24a) and let *Mine* stand for my (24b).
- Imagine an event G-SMILE that satisfies both *Lasersohn* and *Mine*, that is, the girls smiled in it.
- Let B-CRY be an event in which the boys cry.
- Now G-SMILE $\oplus$ B-CRY does not satisfy *Mine*, but it does satisfy *Lasersohn.*
- Suppose that G-SMILE is not surprising by itself, but that G-SMILE $\oplus$ B-CRY is surprising. Then we have these judgments:

(26)
a. The girls smiled. *true*
b. The girls smiled and the boys cried. *true*
c. Surprisingly, the girls smiled. ***false***
d. Surprisingly, the girls smiled and the boys cried. *true*

- If one of the D operators is applied to *smile*, then (27) is translated as (27a) or (27b).

(27) Surprisingly, the girls smiled.
a. $\exists e[\text{surprising}(e) \wedge Lasersohn(e)]$
b. $\exists e[\text{surprising}(e) \wedge Mine(e)]$

- The problem is that G-SMILE $\oplus$ B-CRY satisfies both *Lasersohn* (by leakage) and the predicate *surprising* (by assumption). So Lasersohn's D operator wrongly predicts that (27) is judged true.
- The above implementation avoids this kind of leakage.

6 Distributivity in Algebraic Event Semantics

- The thematic role parameter allows us to capture the fact that DD items can also target different thematic roles (Zimmermann, 2002):

(28) The boys told the girls two stories each. *Target: agent*
(two stories per boy)

(29) The boys told the girls two stories each. *Target: recipient*
(two stories per girl)

- When we instantiate C with *Atom*, we get Link's VP-level D operator.
- Schwarzschild's Part operator is a generalization: instead of specifying the granularity parameter to be atomic, we leave it free:

(30) $[\![\mathrm{D}_{\theta,\mathbf{C}}]\!] \stackrel{\text{def}}{=} \lambda P_{\langle vt\rangle}\lambda e[e \in {}^*\lambda e' \begin{pmatrix} P(e') \wedge \\ \mathbf{C}(\theta(e')) \end{pmatrix}]$

(Takes an event predicate P and returns a predicate that holds of any event e which consists entirely of events that are in P and whose θs **satisfy the contextually salient 'cover predicate' C**.)

- Examples:

(31) The shoes cost \$50. *collective*

a. $\exists e.{}^*\text{theme}(e) = [\![\text{the shoes}]\!] \wedge [\![\text{cost \$50}]\!](e)$
(There is a costing-fifty-dollar event whose theme is the shoes.)

(32) The shoes $\mathrm{D}_{\text{theme,pair}}$ cost \$50. *distributive*

a. $\exists e.{}^*\text{theme}(e) = [\![\text{the shoes}]\!] \wedge [\![D_{\text{theme,pair}}]\!]([\![\text{cost \$50}]\!])(e)$
b. $\exists e.{}^*\text{theme}(e) = [\![\text{the shoes}]\!] \ \wedge\ e \in {}^*\lambda e'\ [e' \in [\![\text{cost \$50}]\!] \ \wedge\ \text{pair}(\text{theme}(e'))]$
(There is a plural event whose themes sum up to the shoes and which consists of costing-fifty-dollars events with pairs as themes.)

- In the following, I assume a Neo-Davidsonian algebraic semantic system loosely based on Krifka (1989) and Champollion (2010). Events, verbs and thematic roles are each closed under sum formation. Verbs and their projections are all of type vt (event predicates).

- Here is a sample entry of a verb:

(33) $[\![\text{see}]\!] = \lambda e\ [{}^*\text{see}(e)]$

- The star operator maps a set P to the predicate that applies to any sum of things each of which is in P (Link, 1983).

- Noun phrases are interpreted in situ

- Silent theta role heads of type ve are located between noun phrases and verbal projections

- Type shifters are used for composition:

(34) a. Type shifter for indefinites: $\lambda\theta_{ve}\lambda P_{et}\lambda V_{vt}\lambda e[V(e) \wedge P(\theta(e))]$
b. Type shifter for definites: $\lambda\theta_{ve}\lambda x\lambda V_{vt}\lambda e[V(e) \wedge \theta(e) = x]$

- Each of these type shifters combines a noun phrase with its theta role head to build an event predicate modifier of type $\langle vt, vt\rangle$.

- Example:

(35) $[\![\text{[agent [the boys]]}]\!] = \lambda V\lambda e[V(e) \wedge {}^*\text{ag}(e) = \bigoplus \text{boy}]$

(36) $[\![\text{[theme [two monkeys]]}]\!] = \lambda V\lambda e[V(e) \wedge |{}^*\text{th}(e)| = 2 \wedge {}^*\text{monkey}({}^*\text{th}(e))]$

- The event variable is existentially bound if the sentence is uttered out of the blue (see Figure 1).

- If the sentence is understood as referring to a specific event, the event variable is instead resolved to that event.

7 *Each* and *Jeweils* as Distributivity Operators

- Adverbial *each* is a VP modifier, and is synonymous to Link's D operator:

(37) $[\![\text{each}_\theta]\!]_{adverbial} = [\![D_{\theta,Atom}]\!] = (20)$

- Adnominal and determiner *each* need to be type-shifted, but both are defined in terms of D:

(38) $[\![\text{each}_\theta]\!]_{adnominal} = \lambda P_{et}\lambda\Theta_{ve}\lambda V_{vt}\lambda e\ [[\![D_{\theta,Atom}]\!](\lambda e'[V(e') \wedge P(\Theta(e'))])(e)]$

- Adnominal *each* combines with an indefinite NP and then with a theta head:

(39) $[\![[[[\text{two monkeys}]\ \text{each}_{ag}]\ \text{theme}]]\!]$
$= \lambda V_{vt}\lambda e[[\![D_{ag,\ Atom}]\!](\lambda e'[V(e')\ \wedge\ |^*\text{th}(e')| = 2 \wedge {}^*\text{monkey}({}^*\text{th}(e'))])(e)]$
$= \lambda V_{vt}\lambda e[e \in {}^*\lambda e'[{}^*\text{see}(e')\ \wedge\ |^*\text{th}(e')| = 2 \wedge {}^*\text{monkey}({}^*\text{th}(e'))\ \wedge\ \text{Atom}(\text{ag}(e'))]]$

(40) $[\![\text{each}]\!]_{determiner} = \lambda P_{et}\lambda\theta_{ve}\lambda V_{vt}\lambda e\ [\theta(e) = \bigoplus P \wedge [\![D_{\theta,Atom}]\!](V)(e)]$

Determiner *each* combines first with a nominal and then with a theta head:

(41) $[\![[[\text{Each child}]\ \text{agent}]]\!]$
$= \lambda V_{vt}\lambda e[{}^*\text{ag}(e) = \bigoplus \text{child} \wedge [\![D_{ag,Atom}]\!](V)(e)]$
$= \lambda V_{vt}\lambda e[{}^*\text{ag}(e) = \bigoplus \text{child} \wedge e \in {}^*\lambda e'[V(e') \wedge \text{Atom}(\text{ag}(e'))]]$

The result of these derivations is always the same, which reflects their synonymy:

(42) $[\![\text{The children each}_{ag}\ \text{saw two monkeys}]\!]$
$= [\![\text{The children saw two monkeys each}_{ag}]\!]$
$= [\![\text{Each child saw two monkeys}]\!]$
$[\![\text{The children D}_{ag,\ Atom}\ \text{saw two monkeys}]\!]$

- The same type shift as in (38) brings us from Schwarzschild's Part operator to adnominal *jeweils*:

(43) $[\![\text{jeweils}_{\theta,C}]\!]_{adverbial} = [\![\text{D}_{\theta,C}]\!] = (30)$

(44) $[\![\text{jeweils}_{\theta,C}]\!]_{adnominal} = \lambda P\lambda\Theta\lambda V\lambda e[[\![\text{D}_{\theta,C}]\!](\lambda e'[V(e') \wedge P(\Theta(e'))])(e)]$

- Setting C to *Atom* and θ to *agent* leads to distribution over individuals:

(45) Die Kinder haben jeweils$_{ag,Atom}$ zwei Affen gesehen.
The children have DIST two monkeys seen.
"The children have each seen two monkeys."

- With supporting context, the anaphoric predicate C can be set to a salient antecedent other than *Atom*. Then θ is free to adopt values like τ (runtime).
- Example: the children have been to the zoo to see animals last Monday, last Wednesday and last Friday. (46) is uttered with reference to that sum event:

(46) $[\![$Die Kinder haben jeweils$_{\tau,\text{zoovisit}}$ zwei Affen gesehen.$]\!]$ =
$^*\text{ag}(e_0) = \bigoplus \text{child} \;\wedge\; e_0 \in {}^*\lambda e'[{}^*\text{see}(e') \;\wedge\; |{}^*\text{th}(e')| = 2 \wedge {}^*\text{monkey}({}^*\text{th}(e')) \;\wedge\; \text{zoovisit}(\tau(e'))]$
"The children have seen two monkeys on each occasion."

- This sentence refers specifically to the sum e_0 of the three events in question
- The salient predicate *zoovisit* is an antecedent for C. Then θ can be set to τ.
- (46) asserts that e_0 has the children as its agents; that it can be divided into subevents, each of whose runtimes is the time of a zoo visit; and that each of these subevents is a seeing-two-monkeys event.
- Dividing e_0 results in parts whose runtimes sum up to $\tau(e_0)$ (Krifka, 1989)
- Assuming that $\tau(e_0)$ is the (discontinuous) sum of the times of the three zoo visits in question, this entails that each of these zoo visits is the runtime of one of the seeing-two-monkeys events.

8 Summary

How can we capture the synonymy of the determiner, adnominal and adverbial uses of *each* in English?

- They are all derived from Link's D operator.

How can we represent the fact that DD items across languages share some part of their meanings?

- They are derived from related distributivity operators (Link's or Schwarzschild's) which differ only in their parameter settings.

How do DD items fit into distributivity theory more generally? How can we formally capture the semantic variation among DD items?

- They display the same parametric variation as other flavors of distributivity do.

How can we explain Zimmermann's generalization?

- *Each*-type DD items are formally identical to determiners and therefore inherit their "granularity=atomic" value. *Jeweils*-type DD items may have any setting for the granularity parameter.

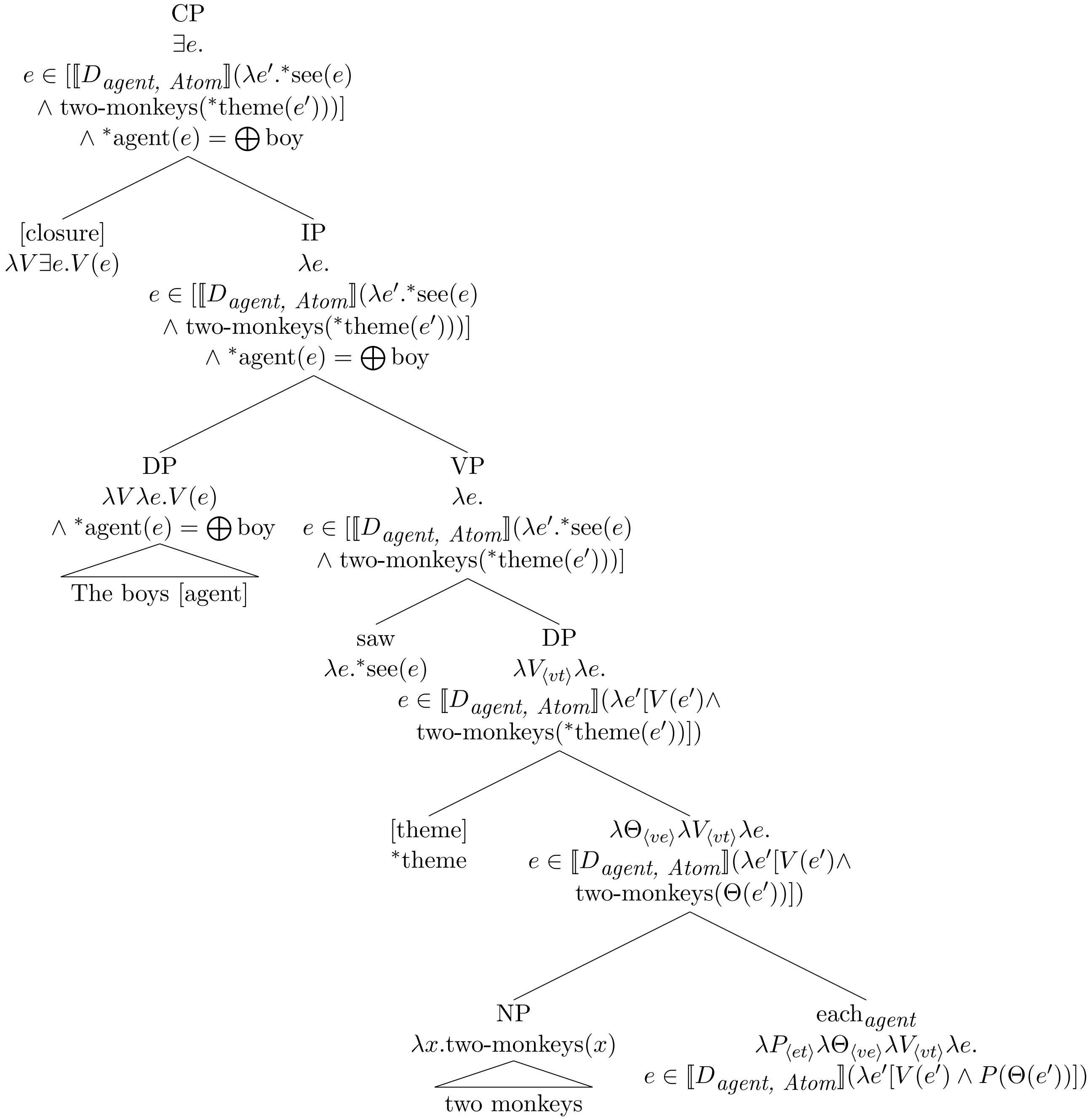

Figure 1: Deriving *The boys saw two monkeys each.*

References

Bayer, S. L. (1997). *Confessions of a Lapsed Neo-Davidsonian: Events and Arguments in Compositional Semantics*. Garland, New York, NY.

Champollion, L. (2010). *Parts of a whole: Distributivity as a bridge between aspect and measurement*. PhD thesis, University of Pennsylvania, Philadelphia, PA.

Deo, A. and Piñango, M. M. (2011). Quantification and context in measure adverbs. In Ashton, N., Chereches, A., and Lutz, D., editors, *Proceedings of SALT 21*, pages 295–312.

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*, pages 269–300. de Gruyter, Berlin, Germany.

Krifka, M. (1989). Nominal reference, temporal constitution and quantification in event semantics. In Bartsch, R., van Benthem, J., and van Emde Boas, P., editors, *Semantics and contextual expression*, pages 75–115. Foris, Dordrecht, Netherlands.

Lasersohn, P. (1995). *Plurality, conjunction and events*. Kluwer, Dordrecht, Netherlands.

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

Link, G. (1983). The logical analysis of plurals and mass terms: A lattice-theoretical approach. In Bäuerle, R., Schwarze, C., and von Stechow, A., editors, *Meaning, use and interpretation of language*, pages 303–323. de Gruyter, Berlin, Germany.

Link, G. (1986). Je drei Äpfel - three apples each: Quantification and the German 'je'. In *Link (1998)*, pages 117–132.

Link, G. (1987). Generalized quantifiers and plurals. In Gärdenfors, P., editor, *Generalized Quantifiers: Linguistic and Logical Approaches*, pages 151–180. Reidel, Dordrecht, Netherlands. Reprinted in Link (1998), Chapter 4.

Link, G. (1998). *Algebraic semantics in language and philosophy*. CSLI Publications, Stanford, CA.

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

Schein, B. (1993). *Plurals and events*. MIT Press, Cambridge, MA.

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

Zimmermann, M. (2002). *Boys buying two sausages each: On the syntax and semantics of distance-distributivity*. PhD thesis, University of Amsterdam, Amsterdam, Netherlands.