Integrating Montague semantics and event semantics

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Contents

Preface

It is sometimes said that the marriage of (Neo-)Davidsonian event semantics and Montague semantics is an uneasy one. (I use "Montague semantics" as a way to refer to the general kind of work that was inspired by the works of Richard Montague and that pays special attention to aspects in which language is similar to logic: compositionality, scope, quantifiers, negation, coordination, etc.) And indeed, in many implementations of event semantics, standard treatments of scope-taking elements such as quantifiers, negation, conjunctions, modals, etc. need to be complicated as compared to the simple accounts they get in semantics textbooks. A typical graduate Semantics I course will introduce students to the main idea and motivation of event semantics (say, adverbial modification, by reading Davidson (1967)), and will then go on to describe phenomena like quantification and negation in an event-free framework (say, by using the Heim and Kratzer (1998) textbook).

While specialists who wish to combine the two frameworks will know where to look for ideas (e.g. Krifka, 1989; Landman, 2000; Beaver and Condoravdi, 2007), there are currently no easy-to-use, off-the-shelf systems that put the two together, textbook-style. An aspiring semanticist might be discouraged by this situation, particularly when a given language or phenomenon that seems to be well-suited to event semantics also involves scope-taking elements that need to be analyzed in some way. For example, event semantics is a natural choice for a fieldworker who wishes to sketch a semantic analysis of a language without making commitments as to the relative hierarchical order of arguments or the argument-adjunct distinction. Yet the same fieldworker would face significant technical challenges before being able to also use such standard tools as generalized quantifier theory or classical negation when encountering quantifiers and negation.

This course aims to remedy this situation by presenting an implementation of Neo-Davidsonian event semantics that combines with standard treatments of scope-taking elements in a well-behaved way.

Course outline

- **Day 1** Introduction to event semantics, based on Davidson (1967), and of the classical compositional implementation, based on Carlson (1984) and Parsons (1990).

- **Day 2** Review of algebraic semantics and mereology. Compositional event semantics in Landman (2000), which focuses on upward-monotonic quantifiers and scopeless readings.

- **Day 3** A closer look at how quantification interacts with event semantics. Presentation of the system described in Champollion (2011, 2014b), which focuses on scopal interactions of quantifiers.

- **Day 4** Other scope-taking elements in Champollion (2011, 2014b): negation, aspectual adverbials, and coordination.

- **Day 5** A look at the systems in Krifka (1989) (merging GQ theory and event semantics) and Beaver and Condoravdi (2007) (replacing event types by special assignment functions).

Acknowledgments

Many thanks to Cleo Condoravdi, from who has been influential in the development of these notes in several important ways, first and foremost by advising my dissertation, Champollion (2010), on which much of the material in Day 2 is based. Among the many people who helped me write the dissertation, besides my advisor I'd like to specially acknowledge my committee chair, Aravind Joshi, and my committee members, Maribel Romero and Florian Schwarz. Thanks to Cleo and to Hana Filip for teaching a course at the Linguistic Society of America summer institute at Stanford in 2007, *Events: Modification, Aspect and Lexical Meaning*, where I first learned about linking semantics and about many other things my lecture notes cover. The lecture notes of that course have been very helpful as I prepared the lectures of Days 1 and 5 and I thank Cleo for making them available for that purpose. Thanks to Cleo, and to David Beaver, for discussing linking semantics with me on various occasions. Their paper on the topic, (Beaver and Condoravdi, 2007), inspired the framework for compositional event semantics I discuss in Days 3 and 4 and in Champollion (2011, 2014b). For many helpful comments and discussions on that framework, thanks to the audiences of the 6^{th} International Symposium of Cognition, Logic and Communication, and of the 38^{th} Penn Linguistics Colloquium; to Cleo Condoravdi, Chris Potts and to the other Stanford semanticists; to the NYU semanticists, particularly Chris Barker, Simon Charlow, Philippe Schlenker, Anna Szabolcsi, and Linmin Zhang; to Maribel Romero; to Roger Schwarzschild; and to the reviewers of an earlier version of this paper, David Beaver, Michael Glanzberg, Barbara Partee, and Jurgis Skilters.

Other important influences for these lecture notes include the work of Fred Landman, particularly Landman (1996, 2000); Godehard Link, particularly the collected papers in Link (1998); and Manfred Krifka, particularly Krifka (1986, 1989, 1992, 1998).

Thanks to Maribel Romero, Josh Tauberer, and Dylan Bumford for their work on the Lambda Calculator (Champollion, Tauberer, and Romero, 2007), available at `www.lambdacalculator.com`, which I used to check the derivations and generate the LaTeX code for the trees in these notes.

I'm grateful to Vera Zu for carefully proofreading these lecture notes and giving many helpful comments, and to Liz Coppock for her encouragement.

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None of the people I mentioned should be taken to necessarily agree with the content of these lecture notes. All errors are mine, and if you spot any, please drop me a line at `champollion@nyu.edu`.

These lecture notes are subject to change. Comments welcome!

Lucas Champollion, New York, June 18^{th}, 2014

Day 1

Introduction to event semantics

Today: Introduction to event semantics, based on Davidson (1967), and of the classical compositional implementation, based on Carlson (1984) and Parsons (1990).

1.1 Introduction

- Classical work in formal semantics, such as Montague (1974), represents the meaning of a verb with n syntactic arguments as an n-ary relation
- Davidson (1967) argued that verbs denote relations between events and their arguments; syntactic arguments are also arguments of the semantic predicate
- The neo-Davidsonian position (e.g. Castañeda, 1967; Carlson, 1984; Parsons, 1990; Krifka, 1992) relates the relationship between events and their arguments by thematic roles; syntactic arguments as well as modifiers are combined with the event via thematic roles
- There are also intermediate positions. Landman (1996) assumes that the lexical entry of a verb consists of an event predicate conjoined with and one or more thematic roles.Kratzer (2000) argues that verbs denote relations between events and their themes.

Table 1.1: Approaches to verbal denotations

truerule Position	Verbal denotation	Example: Brutus stabbed Caesar
Traditional	$\lambda y \lambda x[\textbf{stab}(x, y)]$	$\textbf{stab}(b, c)$
Classical Davidsonian	$\lambda y \lambda x \lambda e[\textbf{stab}(e, x, y)]$	$\exists e[\textbf{stab}(e, b, c)]$
Neo-Davidsonian	$\lambda e[\textbf{stab}(e)]$	$\exists e[\textbf{stab}(e) \wedge \textbf{ag}(e, b) \wedge \textbf{th}(e, c)]$
Landman (1996)	$\lambda y \lambda x \lambda e[\textbf{stab}(e) \wedge \textbf{ag}(e, x) \wedge \textbf{th}(e, y)]$	$\exists e[\textbf{stab}(e, b, c)]$
Kratzer (2000)	$\lambda y \lambda e[\textbf{stab}(e, y)]$	$\exists e[\textbf{ag}(e, b) \wedge \textbf{stab}(e, c)]$

1.2 Events: Some ontological assumptions

- Events are things like Jones' buttering of the toast, Brutus' stabbing of Caesar.

- Events may be taken to form a mereology, so they include plural events (Bach, 1986; Krifka, 1998). This will be the topic of Day 2.
- An event can have both a temporal extent and a spatial extent, so it can be multi-dimensional, unlike intervals, which by definition are always one-dimensional.
- Events are usually thought to have temporal parts (subevents which occupy less time). It is controversial whether individuals also do (e.g. John doesn't exist at time t, only John's-time-slice-at-t does) or whether they are always wholly present at each moment in time (Markosian, 2009). Most semanticists seem to assume the latter.
- Some authors treat events as built from atoms (Landman, 2000), others distinguish between count and mass events (Mourelatos, 1978). With mereology, we need not decide (Krifka, 1998).
- Some authors also include states (e.g. John's being asleep) as events. Others use *event* more narrowly as opposed to states.
  - Do stative sentences have an underlying event (Parsons, 1990, ch. 10)? Maybe individual-level predicates don't (Kratzer, 1995)?

1.3 Event semantics and verbal modifiers

- Verbs have an implicit event argument

(1) $[\![\text{stab}]\!] = \lambda y \lambda x \lambda e[\textbf{stab}(e, x, y)]$

- Verbal modifiers apply to the same event variable

(2) a. $[\![\text{at noon}]\!] = \lambda e[\textbf{time}(e, \textbf{noon})]$
b. $[\![\text{in the forum}]\!] = \lambda e[\textbf{loc}(e, \iota x.\textbf{forum}(x))]$

- The event argument is bound by existential closure

(3) $[\![\text{Brutus stabbed Caesar}]\!] = \exists e[\textbf{stab}(e, \textbf{brutus}, \textbf{caesar})]$

- (Arguments and) modifiers are additional conjuncts

(4) $[\![\text{Brutus stabbed Caesar at noon}]\!] = \exists e[\textbf{stab}(e, \textbf{brutus}, \textbf{caesar}) \wedge \textbf{time}(e, \textbf{noon})]$

1.4 Thematic roles

- Thematic roles represent ways entities take part in events (Parsons, 1990; Dowty, 1991)

- Two common views:
  - Traditional view: thematic roles encapsulate generalizations over shared entailments of argument positions in different predicates (e.g. Gruber, 1965)
    - *agent* (initiates the event, or is responsible for the event)
    - *theme* (undergoes the event)
    - *instrument* (used to perform an event)
    - sometimes also *location* and *time*
  - Alternative view: thematic roles as verb-specific relations: Brutus is not the agent of the stabbing event but the stabber (Marantz, 1984).
- No consensus on the inventory of thematic roles, but see Levin (1993) and Kipper-Schuler (2005) for a wide-coverage role lists of English verbs

Questions:

- Do thematic roles have syntactic counterparts, the theta roles (something like silent prepositions)? Generative syntax says yes at least for the external argument: the "little v" head (Chomsky, 1995). See also the applicative heads of Pylkkänen (2008).
- Does each verbal argument correspond to exactly one role (Chomsky, 1981) or is the subject of a verb like *fall* both its agent and its theme (Parsons, 1990)?
- Thematic uniqueness / Unique Role Requirement: Does each event have at most one agent, at most one theme etc. (widely accepted in semantics, see Carlson (1984, 1998), Parsons (1990), and Landman (2000)) or no (Krifka (1992): one can touch both a man and his shoulder in the same event)?

1.5 Advantages of the Neo-Davidsonian approach

Davidson (1967), Castañeda (1967), Carlson (1984), Parsons (1990), and Landman (2000)

- Makes it easier to state generalizations across the categories of nouns and verbs, and to place constraints on thematic roles
- Good for formulating analyses without committing to an argument/adjunct distinction
- Lends itself to a natural compositional process in terms of intersection with an existential quantifier at the end (Carlson, 1984). Similarly in Parsons (1990, 1995).

(5) a. $[\![\text{[agent]}]\!] = \lambda x \lambda e[\mathbf{ag}(e) = x]$
b. $[\![\text{[theme]}]\!] = \lambda x \lambda e[\mathbf{th}(e) = x]$
c. $[\![\text{stab}]\!] = \lambda e[\mathbf{stab}(e)]$

d. ⟦[ag] Brutus⟧ = $\lambda e[\mathbf{ag}(e) = \mathbf{brutus}]$
e. ⟦[th] Caesar⟧ = $\lambda e[\mathbf{ag}(e) = \mathbf{caesar}]$
f. ⟦Brutus stab Caesar⟧ = (5c) ∩ (5d) ∩ (5e) (sentence radical)
g. ⟦Brutus stabbed Caesar⟧ = $\exists e.e \in$ (5c) ∩ (5d) ∩ (5e) (full sentence)

- This has been elevated to a principle, *conjunctivism*, in Pietroski (2005, 2006).

1.6 Diamond entailments

- Diamond entailments are perhaps the strongest argument for event semantics.

(6) a. Brutus stabbed Caesar on the forum at noon.
b. Brutus stabbed Caesar on the forum.
c. Brutus stabbed Caesar at noon.
d. Brutus stabbed Caesar.

Exercise 1.1 What are the entailment relations between these sentences? Why do you think this is called a diamond entailment? □

- Capturing diamond entailments, classical Davidsonian style:

(8) Brutus stabbed Caesar on the forum at noon
$\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{loc}(e) = \mathbf{forum} \wedge \mathbf{time}(e) = \mathbf{noon}]$

(9) Brutus stabbed Caesar on the forum
$\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{loc}(e) = \mathbf{forum}]$

(10) Brutus stabbed Caesar at noon
$\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{time}(e) = \mathbf{noon}]$

(11) Brutus stabbed Caesar
$\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar})]$

- Capturing the same entailments, Neo-Davidsonian style:

(12) Brutus stabbed Caesar on the forum at noon
$\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar} \wedge \mathbf{loc}(e) = \mathbf{forum} \wedge \mathbf{time}(e) = \mathbf{noon}]$

(13) Brutus stabbed Caesar on the forum
$\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar} \wedge \mathbf{loc}(e) = \mathbf{forum}]$

(14) Brutus stabbed Caesar at noon
$\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar} \wedge \mathbf{time}(e) = \mathbf{noon}]$

(15) Brutus stabbed Caesar
$\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar}]$

- Diamond entailments in downward entailing environments:

(16) a. Nobody stabbed Caesar on the forum at noon.
b. Nobody stabbed Caesar on the forum.
c. Nobody stabbed Caesar at noon.
d. Nobody stabbed Caesar.

(17) a. Brutus did not stab Caesar on the forum at noon.
b. Brutus did not stab Caesar on the forum.
c. Brutus did not stab Caesar at noon.
d. Brutus did not stab Caesar.

Exercise 1.2 What are the entailment relations between the sentences in (16)? What are the entailment relations between the sentences in (17)? How can they be represented using logical formulas like the ones above? □

1.7 Other applications of event semantics

- Antecedents for anaphoric expressions like pronouns, and referents for definite descriptions and the like:

(22) a. Jones did it slowly, deliberately, in the bathroom, with a knife, at midnight. What he did was butter a piece of toast. (Davidson, 1967)
b. After the singing of the Marseillaise they saluted the flag. (Parsons, 1990)

- Explicit quantification over events (Parsons, 1990):

(23) a. In every burning, oxygen is consumed.
b. Agatha burned the wood.
c. Therefore, oxygen was consumed.

- Perceptual reports (Higginbotham, 1983), as an alternative to situation semantics:

(24) John saw Mary leave.

- The semantic relation between adjectives (*violent*) and adverbs (*violently*) (Parsons, 1990):

(25) a. Brutus stabbed Caesar violently.
b. There was something violent.

- The semantic relation between gerunds and verbs (Parsons, 1990)

(26) a. They sang the song.
b. the singing of the song

- Various semantic relations between causatives and their intransitive counterparts (Parsons, 1990)

(27) a. Mary felled the tree.
b. The tree fell.

(28) a. Mary opened the door.
b. The door opened.

- Aspectual phenomena and measurement (Krifka, 1998; Champollion, 2010)

(29) a. three liters of water
b. three hours of running
c. run for three hours

1.8 Recommended background reading

- Davidson (1967), Parsons (1990), Carlson (1984), and Landman (2000, lecture 1)
- For the next lecture: Landman (1996)

Exploring the derivations interactively

From Day 2 on, all derivations will be available for interactive viewing in the Lambda Calculator (Champollion, Tauberer, and Romero, 2007), a pedagogical software application that allows step-by-step viewing and computing of semantic derivations in the typed λ calculus in a user-friendly, graphics-based environment that provides interactive feedback. All derivations in this document have been checked for correctness with the help of this program, and the figures have been generated with it. A file that implements the semantic fragment described in this proposal is available at `http://www.nyu.edu/projects/champollion/events-calculatorfile.txt`. Readers who would like to experiment with the fragment can easily edit this file with a regular text editor. Instructors who would like to view the fragment are recommended to use the "teacher edition" of the calculator, which allows the user to step through derivations automatically. Please send requests to `champollion@nyu.edu`.

Day 2

Algebraic semantics and mereology

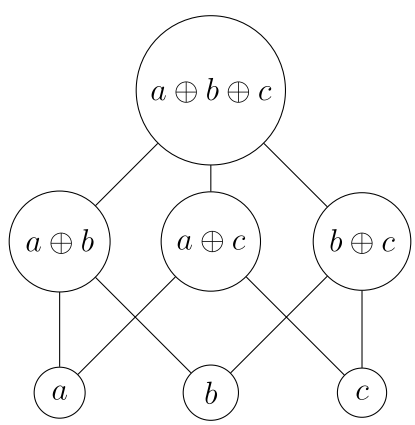
Today: Review of algebraic semantics and mereology. Compositional event semantics in Landman (2000), which focuses on upward-monotonic quantifiers and scopeless readings.

2.1 Algebraic structures for semantics

- **Mereology:** the study of parthood in philosophy and mathematical logic

- Mereology can be axiomatized in a way that gives rise to **algebraic structures** (sets with binary operations defined on them)

Figure 2.1: An algebraic structure



- **Algebraic semantics:** the branch of formal semantics that uses algebraic structures and parthood relations to model various phenomena

2.2 Basic motivation of mereology

- Basic motivation (Link, 1998): entailment relation between collections and their members

(1) a. John and Mary sleep. $\Rightarrow$
John sleeps and Mary sleeps.
b. The water in my cup evaporated. $\Rightarrow$
The water at the bottom of my cup evaporated.

- Basic relation $\leq$ (parthood) – written $\leq$; a partial order
- Sums (also called fusions) are that which you get when you put several parts together
- Fundamental assumption in algebraic semantics: any nonempty set of things of the same sort (e.g. individuals, substances, events) has a sum.
- Two applications of sum in linguistics are conjoined terms and definite descriptions. We will see more of them below.
  - For Sharvy (1980), ⟦the water⟧ = $\bigoplus$ water
  - For Link (1983), ⟦John and Mary⟧ = $j \oplus m$.
- Link (1983) proposes algebraic closure as underlying the meaning of the plural.

(2) a. John is a boy.
b. Bill is a boy.
c. $\Rightarrow$ John and Bill are boys.

- Algebraic closure closes any predicate (or set) P under sum formation:

(3) **Definition: Algebraic closure (Link, 1983)**
The algebraic closure $^*P$ of a set P is defined as $\{x \mid \exists P' \subseteq P[x = \bigoplus P']\}$.
(This is the set that contains any sum of things taken from P.)

- Link translates the argument in (2) as follows:

(4) boy(j) $\wedge$ boy(b) $\Rightarrow$ *boy($j \oplus b$)

- This argument can be proven valid given the axioms of classical extensional mereology.
- Are thematic roles their own algebraic closures (Krifka, 1986, 1998; Landman, 2000)?

(5) **Cumulativity assumption for thematic roles**
For any thematic role θ it holds that θ = $^*\theta$. This entails that
$\forall e, e', x, y[\theta(e) = x \ \wedge \ \theta(e') = y \ \rightarrow \ \theta(e \oplus e') = x \oplus y]$

- Example: If John is walking (event e_1) and Mary is walking (event e_2), then John is the agent of e_1 and Mary is the agent of e_2. The sum of e_1 and e_2, intuitively the event of John and Mary walking, is an event – call it e_3. Cumulativity of thematic roles says that the agent of e_3 is (the sum of the individuals) John and Mary.
  - Many people assume the answer is yes (makes things easier to formalize)
  - To symbolize this, instead of writing th, I will write *th.
- As a consequence of (5), thematic roles are homomorphisms with respect to the $\oplus$ operation:

(6) **Fact: Thematic roles are sum homomorphisms**
For any thematic role θ, it holds that $\theta(e \oplus e') = \theta(e) \oplus \theta(e')$.
(The θ of the sum of two events is the sum of their θs.)

- Potential challenge to this assumption: the rosebush story (Kratzer, 2003). Suppose there are three events e_1, e_2, e_3 in which Al dug a hole, Bill inserted a rosebush in it, and Carl covered the rosebush with soil. Then there is also an event e_4 in which Al, Bill, and Carl planted a rosebush. Let e_4 be this event. If e_4 = $e_1 \oplus e_2 \oplus e_3$, we have a counterexample to lexical cumulativity.

Exercise 2.1 Why is this a counterexample? How could one respond to this challenge? □

2.3 Lexical cumulativity

- Many authors assume *lexical cumulativity*: whenever two events are in the denotation of a verb, so is their sum (Scha, 1981; Schein, 1986, 1993; Lasersohn, 1989; Krifka, 1989, 1992; Landman, 1996, 2000; Kratzer, 2007).

(7) a. John walked.
b. Mary walked.
c. $\Rightarrow$ John and Mary walked.

(8) a. John saw Bill.
b. Mary saw Sue.
c. $\Rightarrow$ John and Mary saw Bill and Sue.

- Verbs have plural denotations: they obey the same equation as plural count nouns on the inclusive view

(9) $[\![V]\!] = {}^*[\![V]\!]$

(10) $[\![\mathrm{N}_{pl}]\!] = {}^*[\![\mathrm{N}_{sg}]\!]$

- It is customary to indicate lexical cumulativity by writing $\lambda e[^*\text{see}(e)]$ for the meaning of the verb *see* instead of $\lambda e[\text{see}(e)]$.

  This entailment is parallel to the entailment from singular to plural nouns:

(11) a. John is a boy.
 b. Bill is a boy.
 c. $\Rightarrow$ John and Bill are boys.

2.4 Cumulative readings

- Cumulative readings were first discussed independently by Kroch (1974) and Scha (1981) and are discussed in detail by Krifka (1992) and Landman (1996, 2000).

- Cumulative readings involve a "cross-product" interpretation:

(12) a. 600 Dutch firms use 5000 American computers. (Scha, 1981)
 b. 600 Dutch firms each use at least one American computer and 5000 American computers are each used by at least one Dutch firm.

- Scha assumed that the *exactly* component of sentence (12a) (that is, the fact that it is exactly 600 firms and not more than that, etc.) is part of its literal meaning. Most authors assume that the *exactly* component is a scalar implicature and needs to be separated from the phenomenon of cumulative quantification. The paraphrase does not reflect this scalar implicature, nor do the logical representations I will use in the following. This is a side issue, and I will ignore it in the following.

- Cumulative readings also occur with definite plurals:

(13) The men in the room are married to the girls across the hall. (Kroch, 1974)

- Cumulative readings can be represented compactly given certain background assumptions we will learn about in later lectures (lexical cumulativity):

(14) $\exists e[^*\textbf{use}(e) \;\wedge\; ^*\textbf{dutch.firm}(^*\textbf{ag}(e)) \;\wedge\; |^*\textbf{ag}(e)| = 600 \;\wedge$
 $^*\textbf{american.computer}(^*\textbf{th}(e)) \;\wedge\; |^*\textbf{th}(e)| = 5000]$

- This type of representation is easy to derive compositionally because the arguments are kept apart (Krifka, 1986, 1999; Landman, 2000).

- To derive the "cross-product" inference, one needs an additional meaning postulate that says that *use* is *distributive* on both its arguments

(15) **Meaning postulates: *use* is distributive with respect to agents and themes**

a. $\forall e[{}^*\mathbf{use}(e) \rightarrow e \in {}^*\lambda e'({}^*\mathbf{use}(e') \ \wedge$ $\mathbf{Atom}(\mathbf{ag}(e')))]$
(Every event in the denotation of *use* consists of one or more events in the denotation of *use* whose agents are atoms.)

b. $\forall e[{}^*\mathbf{use}(e) \rightarrow e \in {}^*\lambda e'({}^*\mathbf{use}(e') \ \wedge \ \mathbf{Atom}(\mathbf{th}(e')))]$
(Every event in the denotation of *use* consists of one or more events in the denotation of *use* whose themes are atoms.)

2.5 Collective readings

- In collective readings, some group bears collective responsibility for an event. There is no "cross product" style interpretation.

- Sometimes only the collective reading is available:

(16) a. The cowboys sent an emissary to the Indians.
(i) *Does **not** mean:* Each of the cowboys sent an emissary to one of the Indians, and each of the Indians was sent an emissary by one of the cowboys.
(ii) *Means:* The cowboys as a group sent an emissary to the Indians as a group.

- Some authors do not consider cumulative and collective readings distinct from each other (Roberts, 1987; Link, 1998)

- But sometimes both readings are available (Landman, 1996):

(17) Three boys invited four girls.
a. *Cumulative reading:* Three boys each invited a girl, and four girls each were invited by a boy.
b. *Collective reading:* A group of three boys invited a group of four girls.

- Landman (1989, 1996) assumes that collective readings involve separate model-theoretic entities called groups, which are assumed to be related to their "underlying sums" via a group formation operator.

- The group formation operator $\uparrow$ introduces a distinction between the sum $a \oplus b$ whose proper parts are the individuals a and b, and the impure atom $\uparrow(a \oplus b)$, which has no proper parts.

- Groups, understood as the output of a group formation operator, may or may not be involved in the denotations of group nouns – that is a separate question. Barker (1992) argues that they are not.

- Here we only assume that they are involved in the denotations of collective readings, more specifically in the arguments that occur in these readings.

(18) a. The cowboys sent an emissary to the Indians.
b. $\exists e[{}^*\mathbf{send}(e) \ \wedge \ {}^*\mathbf{ag}(e) = \uparrow (\bigoplus \mathbf{cowboy}) \wedge \mathbf{emissary}({}^*\mathbf{th}(e)) \ \wedge \ {}^*\mathbf{recipient}(e) = \uparrow (\bigoplus \mathbf{Indian})]$

- Atoms which are not generated through the group formation operator are called *pure atoms* and the other ones are called *impure*. I assume that only pure atoms occur in the denotations of singular count nouns.

(19) $\mathbf{ImpureAtom}(x) \stackrel{\text{def}}{=} \exists y[y \neq x \ \wedge \ x = \uparrow (y)]$
(An impure atom is an atom that is derived from a distinct entity through the group formation operation $\uparrow$.)

(20) $\mathbf{PureAtom}(x) \stackrel{\text{def}}{=} \mathbf{Atom}(x) \ \wedge \ \neg\mathbf{ImpureAtom}(x)$
(A pure atom is an atom which is not impure.)

- By contrast, example (13) (repeated here) only has a cumulative reading, not a collective reading, because a group cannot be married to another group. (The boundaries between the readings are sometimes fuzzy. For suggested criteria on how to distinguish the two readings, see Landman (1996). Essentially, he suggests that the presence of certain entailments like collective action, collective body formation and collective responsibility is a necessary condition for a collective reading to obtain.)

(21) a. The men in the room are married to the girls across the hall. (Kroch, 1974)
b. $\exists e[{}^*\mathbf{married}(e) \ \wedge \ {}^*\mathbf{ag}(e) = \bigoplus \mathbf{man.in.the.room} \wedge {}^*\mathbf{th}(e) = \bigoplus \mathbf{girl.across.the.hall}]$

- Collective readings can also occur when only one noun phrase in the sentence is interpreted as a group:

(22) a. Three boys (as a group) carried a piano upstairs.
b. $\exists e[{}^*\mathbf{carry.upstairs}(e) \wedge \exists x[{}^*\mathbf{boy}(x) \wedge |x| = 3 \wedge {}^*\mathbf{ag}(e) = \uparrow (x) \wedge \mathbf{piano}({}^*\mathbf{th}(e))]]$

- Landman (1996) proposes that noun phrases are ambiguous between sum and group interpretations.

(23) a. $[\![\text{John and Mary}_{\textit{sum}}]\!] = \mathbf{john} \oplus \mathbf{mary}$
b. $[\![\text{John and Mary}_{\textit{group}}]\!] = \uparrow (\mathbf{john} \oplus \mathbf{mary})$
c. $[\![\text{the boys}_{\textit{sum}}]\!] = \bigoplus \mathbf{boy}$
d. $[\![\text{the boys}_{\textit{group}}]\!] = \uparrow (\bigoplus \mathbf{boy})$
e. $[\![\text{three boys}_{\textit{sum}}]\!] = \lambda P.\exists x[{}^*\mathbf{boy}(x) \ \wedge \ |x| = 3 \ \wedge \ P(x)$
f. $[\![\text{three boys}_{\textit{group}}]\!] = \lambda P.\exists x[{}^*\mathbf{boy}(x) \ \wedge \ |x| = 3 \ \wedge \ P(\uparrow (x))$
g. $[\![\text{every boy}]\!] = \lambda P.\forall x[\mathbf{boy}(x) \rightarrow P(x)]$

h. $[\![\text{no boy}]\!] = \lambda P.\neg\exists x[\mathbf{boy}(x) \ \wedge \ P(x)]$

- Landman (1996) assumes that sum/group distinction models the collective/cumulative ambiguity:
  - Sum interpretations lead to *cumulative readings*
  - Group interpretations lead to *collective readings*
  - In some cases, one of the readings will be implausible or pragmatically dispreferred

(24) Three boys invited four girls.

(25) *Cumulative reading:*
$\exists e.{}^*\mathbf{invite}(e) \ \wedge \ {}^*\mathbf{boy}({}^*\mathbf{ag}(e)) \ \wedge \ |{}^*\mathbf{ag}(e)| = 3 \wedge$
${}^*\mathbf{girl}({}^*\mathbf{th}(e)) \ \wedge \ |{}^*\mathbf{th}(e)| = 4$
(+ meaning postulate on both thematic roles of *invite*)

(26) *Collective reading:*
$\exists e\exists x\exists y \ [{}^*\mathbf{invite}(e) \ \wedge \ {}^*\mathbf{boy}(x) \wedge \uparrow(x) = {}^*\mathbf{ag}(e) \ \wedge \ |x| = 3 \wedge$
${}^*\mathbf{girl}(y) \wedge \uparrow(y) = {}^*\mathbf{th}(e) \ \wedge \ |y| = 4]$

2.6 The compositional process in Landman (1996)

- The system in Landman (1996) is a hybrid between classical Davidsonian and Neo-Davidsonian theories. (The system in Parsons (1995), which elaborates on Parsons (1990), is similar in this respect.)

- Verbs have entries like this:

(27) $[\![\text{invite}]\!] = \lambda y\lambda x\lambda e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,y)]$

- Landman assumes a Scope Domain Principle:

(28) **Scope Domain Principle** (Landman, 1996, p. 442):
a. Quantificational noun phrases cannot be entered into scope domains.
b. Non-quantificational noun phrases can be entered into scope domains.

- In the context of Landman's theory, "scope domain" means "verbal denotation", "quantificational noun phrases" means "strong quantifiers", and "nonquantificational noun phrase" means "proper names, definites and indefinites".

- So what this means is:

(29) **Scope Domain Principle, my translation**

a. Proper names, definites, and indefinites can be interpreted in situ, and can therefore take part in scopeless (= cumulative and collective) readings.
b. Strong quantifiers like *every boy* and *no boy* must take scope over the event argument via quantifying-in (essentially the same thing as quantifier raising)

- In Landman's system, interpreting in situ is done by function application.
- For example:

(30) $[\![\text{invite}]\!]([\![\text{Mary}]\!])$
$= \lambda y \lambda x \lambda e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,y)](\mathbf{mary})$
$= \lambda x \lambda e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})]$

- If the types don't match, one of the following lifters is applied first:

(31) $\text{LIFT}([\![\text{intransitive\_verb}]\!]) \stackrel{\text{def}}{=} \lambda Q_{\langle et,t\rangle}.\lambda e.Q(\lambda x.[\![\text{intransitive\_verb}]\!](x)(e))$

(32) $\text{LIFT}([\![\text{transitive\_verb}]\!]) \stackrel{\text{def}}{=} \lambda Q_{\langle et,t\rangle}\lambda x \lambda e.Q(\lambda y.[\![\text{transitive\_verb}]\!](y)(x)(e))$

- Essentially, these lifters prepare the verb so that it takes a QNP as its next argument, instead of an entity-denoting noun phrase.
- Landman uses type d for entities and type e for events. Nowadays this is confusing since everyone else uses type e for entities. I'll convert his types to the more usual convention, and I'll use v for events.
- For example:

(33) $[\![\text{invite Mary}]\!]([\![\text{Three boys}_{sum}]\!])$
a. $= \text{LIFT}([\![\text{invite Mary}]\!])([\![\text{Three boys}_{sum}]\!])$
b. $= \text{LIFT}(\lambda x \lambda e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])([\![\text{Three boys}_{sum}]\!])$
c. $= \lambda Q \lambda e.Q(\lambda x.[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])([\![\text{Three boys}_{sum}]\!])$
d. $= \lambda Q \lambda e.Q(\lambda x.[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])(\lambda P.\exists x'[{}^*\mathbf{boy}(x') \wedge |x'| = 3 \wedge P(x')])$
e. $= \lambda e.(\lambda P.\exists x'[{}^*\mathbf{boy}(x') \wedge |x'| = 3 \wedge P(x')])(\lambda x.[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])$
f. $= \lambda e.\exists x'[{}^*\mathbf{boy}(x') \wedge |x'| = 3 \wedge (\lambda x.[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])(x')$
g. $= \lambda e.\exists x'[{}^*\mathbf{boy}(x') \wedge |x'| = 3 \wedge \mathbf{invite}(e) \wedge \mathbf{ag}(e,x') \wedge \mathbf{th}(e,\mathbf{mary})]$

- Then, existential closure (EC) applies.

(34) $\text{EC}(\lambda e.f(e)) \stackrel{\text{def}}{=} \exists e.f(e)$

(35) $\text{EC}(\lambda e.\exists x'[{}^*\mathbf{boy}(x') \wedge |x'| = 3 \wedge \mathbf{invite}(e) \wedge \mathbf{ag}(e,x') \wedge \mathbf{th}(e,\mathbf{mary})])$
a. $= \exists e.\exists x'[{}^*\mathbf{boy}(x') \wedge |x'| = 3 \wedge \mathbf{invite}(e) \wedge \mathbf{ag}(e,x') \wedge \mathbf{th}(e,\mathbf{mary})]$

- Strong quantifiers like *every boy* are interpreted via what Landman calls NQI or "non-scopal quantifying in" after existential closure applies.

- NQI corresponds to classical Montague quantifying-in, which is equivalent to quantifier raising (QR) as presented e.g. in Heim and Kratzer (1998).

- Roughly, NQI takes a QNP q that is just about to be combined with a VP v and asserts that the plural entity denoted by q is the plural agent of the event denoted by v.

- Landman calls this operation non-scopal because by itself it does not create any scopal dependencies between indefinites. These are all represented with existential quantifiers, and in the absence of other quantifiers, their relative order does not affect the truth conditions of a formula.

- Strong quantifiers create their own scopal dependencies, so it's not necessary to use SQI to create one for them. Here I give an LF in Heim and Kratzer (1998) style:

(36) $[\![$[[Every boy] [1 [EC [t$_1$ invite Mary]]]]$]\!]$

a. $= [\![\text{Every boy}]\!](\lambda x.\ ([\![\text{EC(invite Mary)}]\!](x))$

b. $= [\![\text{Every boy}]\!](\lambda x.\exists e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])$

c. $= (\lambda P.\forall x[\mathbf{boy}(x) \rightarrow P(x)])(\lambda x.\exists e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})])$

d. $= \forall x.\mathbf{boy}(x) \rightarrow \exists e[\mathbf{invite}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,\mathbf{mary})]$

- To create scopal dependencies involving plural quantifiers (*the boys, three boys*), Landman also has another quantifying-in rule: "scopal quantifying-in" or SQI.

- SQI adds a universal quantifier over every one of the atoms of the plural individual introduced by a plural quantifier.

- I find it easier to think of SQI as the combination of QR with a distributivity operator, call it [SQI-shift]. This operator is applied to the raised QNP before it is applied to the rest of the sentence.

(37) $[\![\text{[SQI-shift]}]\!]_{\langle\langle et,t\rangle,\langle et,t\rangle\rangle} = \lambda Q_{\langle et,t\rangle}.\lambda P_{et}.Q(\lambda x \forall x'\ [x' \in \mathbf{atoms}(x) \rightarrow P(x')])$

This operator takes a QNP Q and a property P and asserts that Q holds of the property that is true of any individuals that contains only atoms to which P applies.

- Here is the result of applying [SQI-shift] to the entry for *three boys*. (From here on I will use **3boys** as a shorthand for $\lambda x.|x| = 3 \wedge {}^*\mathbf{boy}(x)$, and so on.)

(38) $[\![\text{[SQI-shift]}]\!]([\![\text{three boys}]\!])_{\langle et,t\rangle}$
$= \lambda P_{et}.\exists x\ \mathbf{3boys}(x) \wedge \forall x'\ [x' \in \mathbf{atoms}(x) \rightarrow P(x')]$

- This takes a property and asserts that there are three boys and that the property applies to each of them.

- An example of [SQI-shift] is shown in Fig. 2.2.

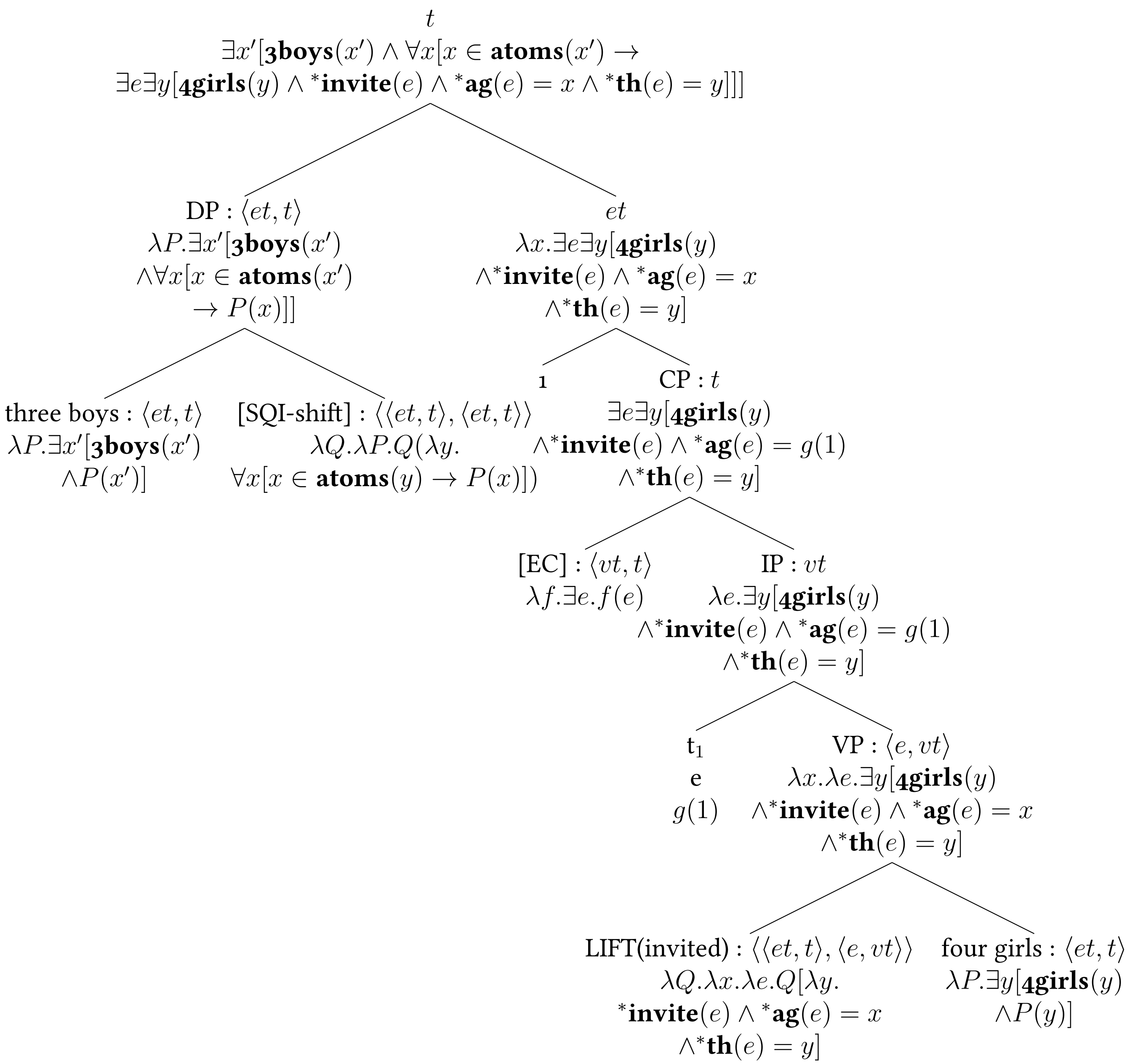


Figure 2.2: An example of the [SQI] operator, which simulates Landman's scopal quantifying-in.

2.7 Recommended background reading

- Mereology surveys: Simons (1987), Casati and Varzi (1999), Varzi (2010), and Champollion and Krifka (2014)
- For the system presented today: Landman (1996, 2000)
- Link (1998): Link's collected work on mereology, available online at `standish.stanford.edu`
- For the next two lectures: Champollion (2014b). Available online at `http://ling.auf.net/lingbuzz/002118`

Day 3

Quantification and event semantics

Today: A closer look at how quantification interacts with event semantics. Presentation of the system described in Champollion (2011, 2014b), which focuses on scopal interactions of quantifiers.

3.1 Introduction

- Quantifiers + event semantics = a happy marriage?
- Beaver and Condoravdi (2007): NO
  "In Davidsonian Event Semantics the analysis of quantification is problematic: either quantifiers are treated externally to the event system and quantified in (cf. Landman, 2000), or else the definitions of the quantifiers must be greatly (and non-uniformly) complicated (cf. Krifka, 1989)"
- Note: Landman (2000) is an extended version of Landman (1996), which we have seen on Day 2. The "external treatment" refers to the NQI and SQI operations, which B & C consider problematic. We'll take a closer look at Krifka (1989) on Day 5.
- Eckardt (2009): NO
  "The semantic composition of even a simple sentence like *John likes most Fellini movies* requires quantifier raising, interpreted traces, coindexing, and lambda abstraction."
- Champollion (2011, 2014b): YES!
- If you're a syntactician, or if you're a semanticist who is used to covert movement, and if you're working on a language where there's independent evidence for covert syntactic movement, none of these assumptions might seem particularly bothersome. But if for whatever reason you want to avoid quantifier raising, interpreted traces, coindexing, and lambda abstraction, there is a simple way to do so. This is the topic of today's lecture.
- Previous implementations of the Neo-Davidsonian program, including those we have seen so far, require a syntactic treatment of quantifier scope, i.e. covert movement such as quantifying-in or quantifier raising.

- Situating this analysis:

truerule	No Events	Events
Syntactic Quantifier Scope	e.g. May (1985)	e.g. Landman (2000)
Semantic Quantifier Scope	e.g. Hendriks (1993)	*this presentation*

- Syntactic approaches to QR are widespread, but they are sometimes seen as problematic:
  - Some authors view QR per se as complex and cumbersome (e.g. Eckardt, 2009)
  - QR entails the presence of a representational level (Logical Form) because quantifier movement happens covertly. As such, it is not directly compositional (Jacobson, 1999; Barker, 2002). Simply put, "direct compositionality" means WYSIWYG – the syntax and the semantics work in tandem, and there is no mapping of syntactic derivations to a distinguished level of Logical Form.
  - Positing quantifier raising is problematic for languages in which surface scope determines semantic scope completely: additional stipulations are then needed to explain why quantifiers conspire to keep their relative order after they are raised.
- **Problem:** Can we keep the advantages of event semantics without committing ourselves to a representational view?
- **Solution:** This account relies on type shifting and will not require any covert movement.

3.2 Combining event semantics and quantification

- **Generalization:** The event quantifier always takes lowest possible scope with respect to other quantifiers

(1) No dog barks.

(2) a. $\neg\exists x[\mathbf{dog}(x) \wedge \exists e[\mathbf{bark}(e) \wedge \mathbf{ag}(e,x)]]$ No $>>$ $\exists e$
"There is no barking event that is done by a dog"
b. *$\exists e[\neg\exists x[\mathbf{dog}(x) \wedge \mathbf{bark}(e) \wedge \mathbf{ag}(e,x)]]$ *$\exists e$ $>>$ No
"There is an event that is not a barking by a dog"

- Perhaps (2b) is ruled out because it is trivial. That still leaves us with accounting for the possibility of (2a).
- Even with respect to fixed scope operators like negation, the event quantifier always seems to take low scope:

(3) Spot didn't bark.
a. ="There is no event in which Spot barks"

b. $\neq$“There is an event in which Spot did not bark”

- Independent motivation for the Scope Domain Principle:
- Unique Role Requirement: if a thematic role is specified for an event, it is uniquely specified. Thematic roles are partial functions from events to individuals.

(4) Every dog barks.

(5) a. $\forall x[\mathbf{dog}(x) \rightarrow \exists e[\mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ — EVERY >> $\exists e$
“For every dog there is a barking event that it did”
b. *$\exists e \forall x[\mathbf{dog}(x) \rightarrow [\mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ — *$\exists e$ >> EVERY
“There is a barking event that was done by every dog”

- Example (5b) violates the Scope Domain Principle. It also violates the Unique Role Requirement as long as there is more than one dog.
- An event semantic derivation is shown in Fig. 3.1. (This follows Kratzer (1996) and would look similar in Landman (2000).)

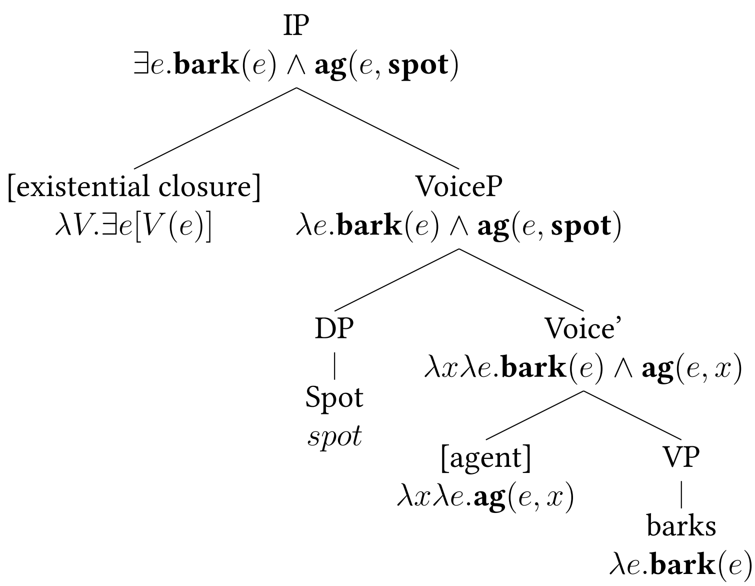


Figure 3.1: “Spot barks”, with quantifier raising

- Functional heads introduce thematic roles (for Kratzer (1996) only the agent role)
- Kratzer (1996) invents an “event identification” rule that combines the Voice head (*agent*) with the VP.

(6) f: $\langle e, vt \rangle$ g: $\langle vt \rangle$ $\Rightarrow$ h : $\langle e, vt \rangle$
$\lambda x \lambda e.\mathbf{ag}(e, x)$ $\lambda e.\mathbf{bark}(e)$ $\lambda x \lambda e.\mathbf{ag}(e, x) \wedge \mathbf{bark}(e)$
(Kratzer’s event identification rule)

- This rule can of course also be expressed as a silent operator:

(7) $[\![\text{[EVENT-ID]}]\!] = \lambda f_{\langle e,vt\rangle}.Lg_{\langle vt\rangle}.\lambda x.\lambda e.[g(e) \wedge f(x)(e)]$

- I won't go this route, and instead stay with Kratzer (1996) (or alternatively, suppress the presence of this operator in the trees). Nothing essential depends on this.

- Existential closure binds the event variable at the end.

- Problem: To give quantificational arguments scope above the event quantifier, the standard analysis requires quantifier raising and therefore a syntactic level of representation (LF) distinct from surface order. So no WYSIWYG, no direct compositionality.

- This is shown in Fig. 3.2: the quantifier is displaced compared with surface order.

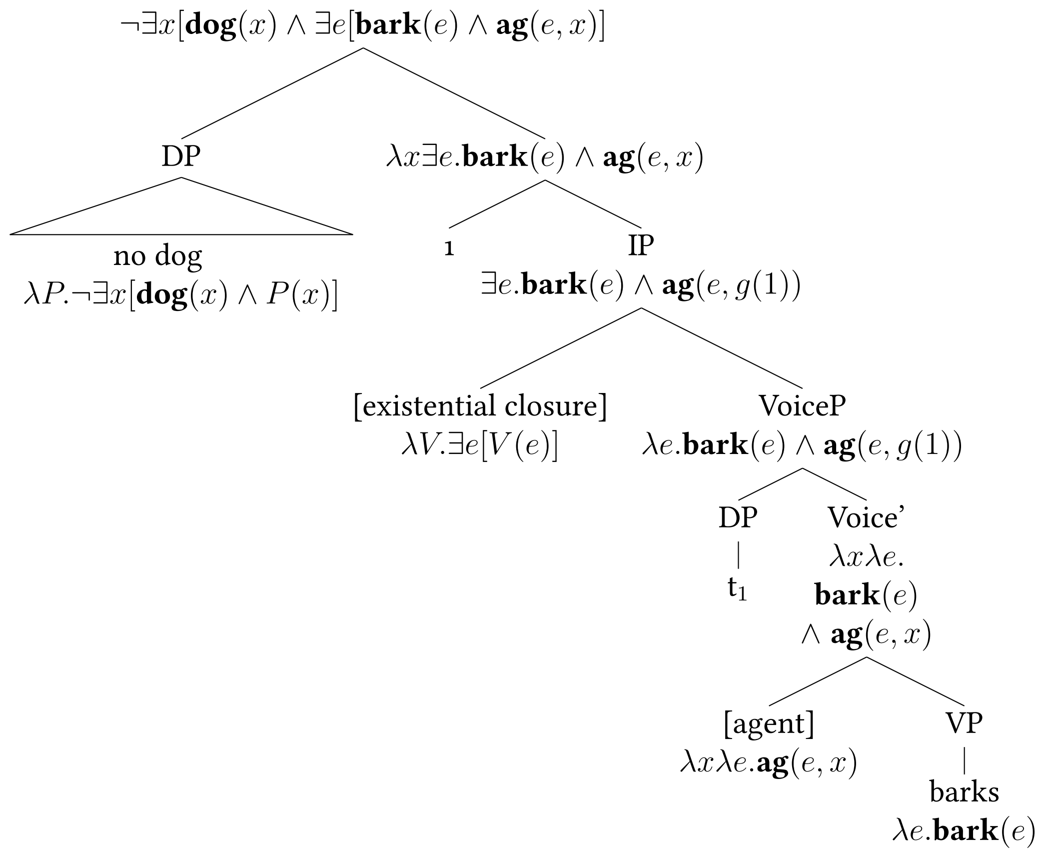


Figure 3.2: "No dog barks", with quantifier raising

3.3 The framework in Champollion (2014)

- **Shift (in typing/thinking):** Think of a verb V as being true of any set that contains a Ving event (instead of denoting the set of all Ving events). Not only verbs but all their projections hold of sets of events. So a VP like "kiss Mary" is true of any set that contains a kissing event whose theme is Mary, and so on up the sentence.

(8) a. Old Neo-Davidsonian approach: $[\![\text{kiss}]\!] = \lambda e.\mathbf{kiss}(e)$
b. This approach: $[\![\text{kiss}]\!] = \lambda f_{\langle vt \rangle}.\exists e.\mathbf{kiss}(e) \wedge f(e)$
(derivable from (8a) by Partee (1987)'s type-shifting principle A; other inspirations: existential closure, bare plurals, continuation semantics)

- Start with a verb and successively apply its arguments and adjuncts to it, as in event semantics. But the verb is now of type $\langle vt, t\rangle$ (where v is the type of events)
- Compared to syntactic approaches, putting existential closure into the lexical entry of the verb will automatically derive the fact that all other quantifiers always have to take scope above existential closure.
- Every argument/adjunct is a function from $\langle vt, t\rangle$ to $\langle vt, t\rangle$.

(9) $[\![\text{kiss Mary}]\!] = \lambda f.\exists e.\mathbf{kiss}(e) \wedge f(e) \wedge \mathbf{th}(e) = \mathbf{mary}$

- On the old approach, a verb phrase had to apply to an event, but there was no single event to which a verb phrase like "kiss every girl" could apply. Now, "kiss every girl" applies to any set of events that contains a potentially different kissing event for every girl. Noun phrases can retain their usual analysis as quantifiers over individuals.

(10) $[\![\text{kiss every girl}]\!] = \lambda P.\forall x.\mathbf{girl}(x) \rightarrow \exists e.\mathbf{kiss}(e) \wedge P(e) \wedge \mathbf{th}(e) = x$

- Noun phrases can retain their usual analysis as quantifiers over individuals. I assume that proper names are Montague-lifted to that type.

(11) a. $[\![\text{every girl}]\!] = \lambda P.\forall x.\mathbf{girl}(x) \rightarrow P(x)$
(12)
(12) $[\![\text{John}]\!] = \lambda P.P(\mathbf{john})$

- For a basic illustration, see Figure 3.3 ("John kissed every girl").
- We can handle scopal ambiguities in situ by type shifting the thematic roles (Figures 3.4 and 3.5)
- Every argument/adjunct filters out those event types that don't conform to its denotation (as in event semantics)
  - This also includes quantifiers: no QR, only in-situ application
- At the end you apply (13) to get a truth value.

(13) $[\![\text{closure}]\!] = \lambda e.\text{true}$ Alternative: $[\![\text{closure}]\!] = \lambda e.e \in s_{topic}$

This is different from existential closure: it asserts that the predicate is true of the set of all events. (Intuitively, one might think of the world as the set of all events that exist. The operator asserts that the sentence is true of the world.) Or restrict to events in the topic situation …

3.4 Recommended background reading

- For the system presented today: Champollion (2014b), available online at `http://ling.auf.net/lingbuzz/002118`
- For the next lecture: Champollion (2014b), continued.

- CP : t
 $\forall x[\mathbf{girl}(x) \rightarrow \exists e[\mathbf{kiss}(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \mathbf{th}(e) = x]]$
  - [closure] : vt
 $\lambda e.\mathbf{true}$
  - IP : $\langle vt, t\rangle$
 $\lambda f.\forall x[\mathbf{girl}(x) \rightarrow \exists e[\mathbf{kiss}(e) \wedge f(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \mathbf{th}(e) = x]]$
    - DP : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
 $\lambda V.\lambda f.V(\lambda e.[f(e) \wedge \mathbf{ag}(e) = \mathbf{john}])$
      - john : $\langle et, t\rangle$
 $\lambda P.P(\mathbf{john})$
      - [ag] : $\langle\langle et, t\rangle, \langle\langle vt, t\rangle, \langle vt, t\rangle\rangle\rangle$
 $\lambda Q.\lambda V.\lambda f. Q(\lambda x.V(\lambda e.[f(e) \wedge \mathbf{ag}(e) = x]))$
    - VP : $\langle vt, t\rangle$
 $\lambda f.\forall x[\mathbf{girl}(x) \rightarrow \exists e[\mathbf{kiss}(e) \wedge f(e) \wedge \mathbf{th}(e) = x]]$
      - kissed : $\langle vt, t\rangle$
 $\lambda f.\exists e[\mathbf{kiss}(e) \wedge f(e)]$
      - DP : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
 $\lambda V.\lambda f.\forall x[\mathbf{girl}(x) \rightarrow V(\lambda e.[f(e) \wedge \mathbf{th}(e) = x])]$
        - every girl :
 $\lambda P.\forall x[\mathbf{girl}(x) \rightarrow P(x)]$
        - [th] : $\langle\langle et, t\rangle, \langle\langle vt, t\rangle, \langle vt, t\rangle\rangle\rangle$
 $\lambda Q.\lambda V.\lambda f. Q(\lambda x.V(\lambda e.[f(e) \wedge \mathbf{th}(e) = x]))$

Figure 3.3: Illustration of the framework in Champollion (2011, 2014b), using the sentence "John kissed every girl."

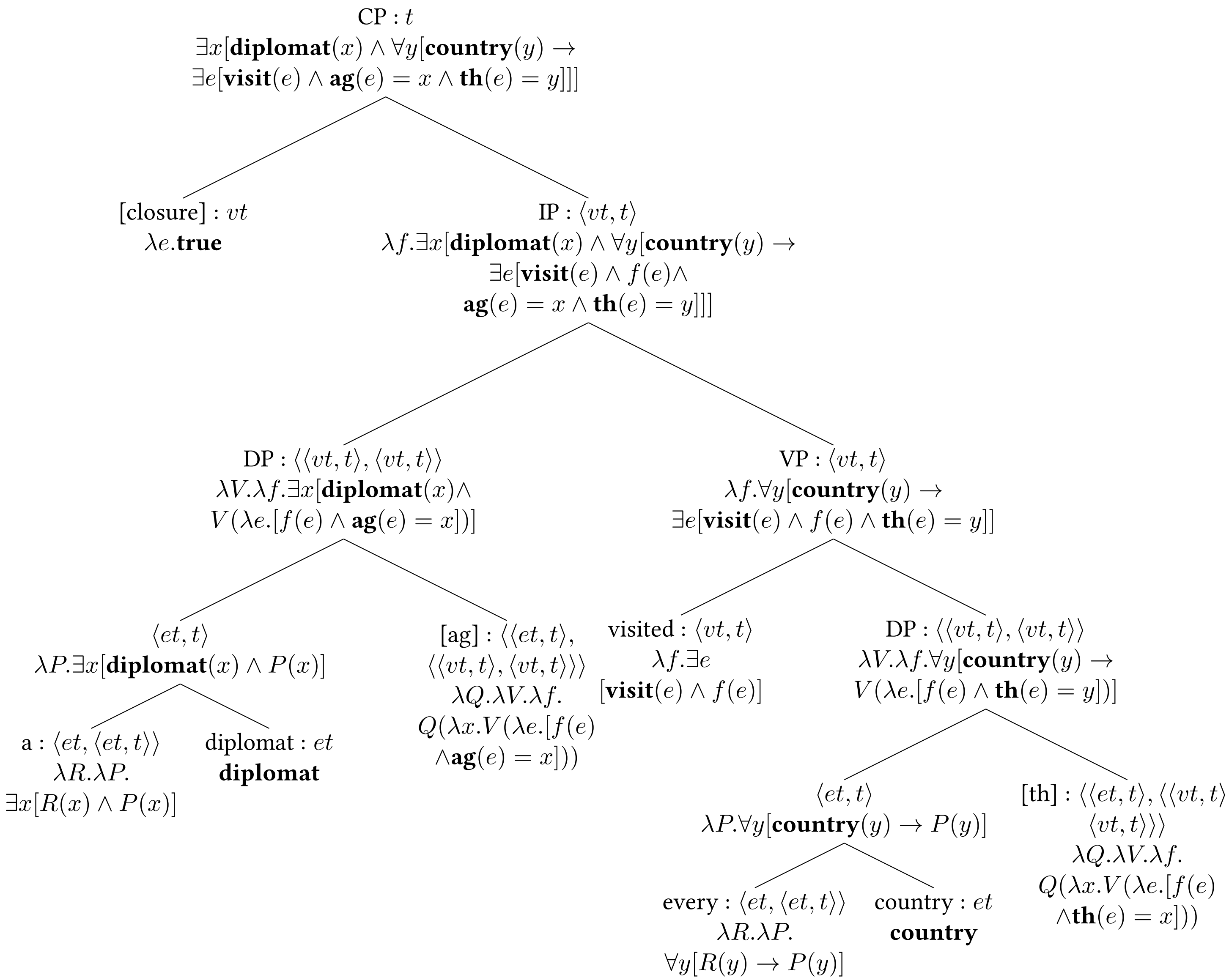


Figure 3.4: A diplomat visited every country (surface scope)

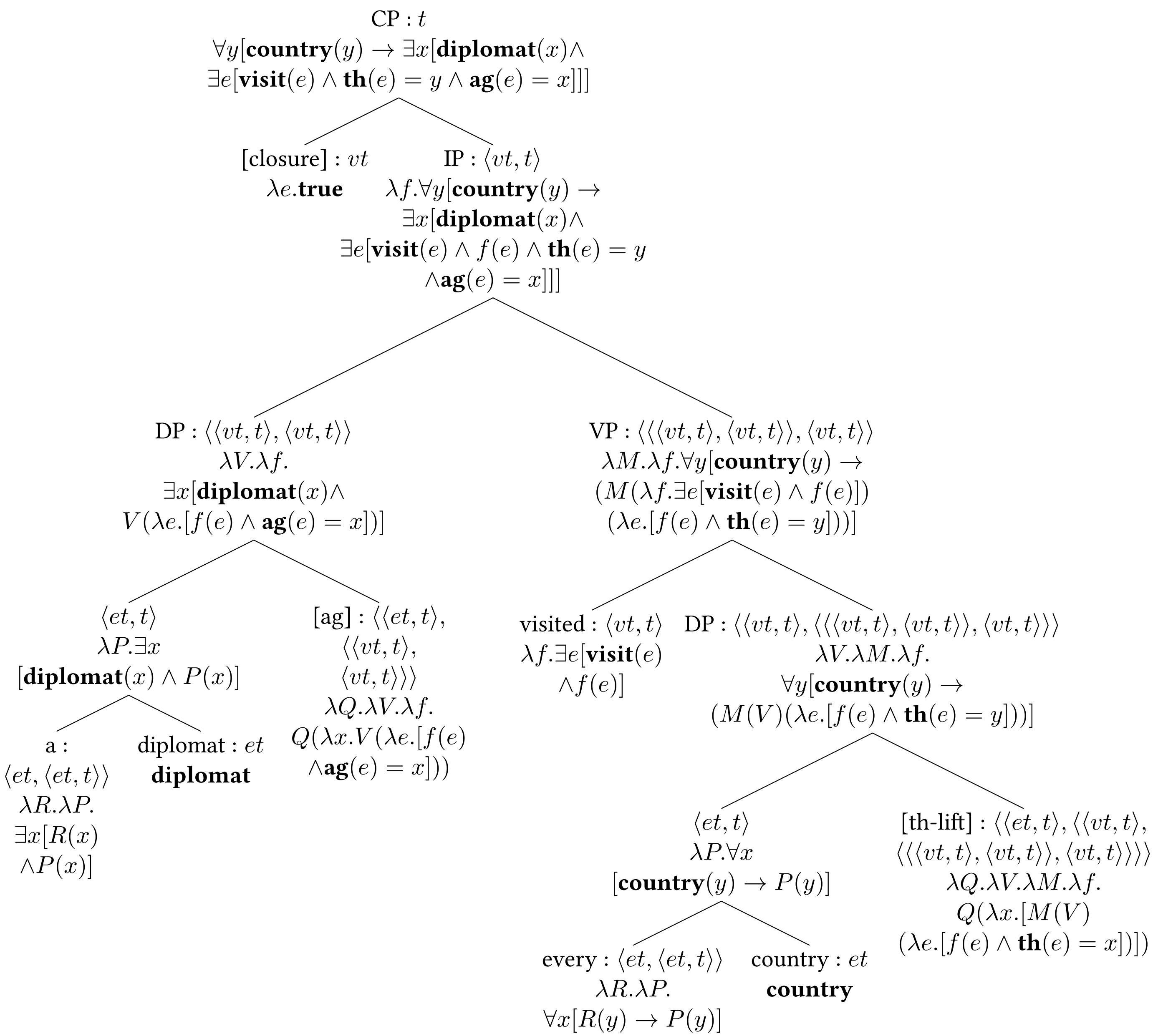


Figure 3.5: A diplomat visited every country (inverse scope)

Day 4

Negation and conjunction in event semantics

Today: Other scope-taking elements in Champollion (2011, 2014b): negation, aspectual adverbials, and coordination.

4.1 Negation

- Like other verbal modifiers, we can give negation the semantic type $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$.
- Negation has been considered particularly difficult for event semantics because it leads to apparent scope paradoxes (Krifka, 1989).
- *For*-adverbials can take scope both above negation and below it (Smith, 1975):

(1) John didn't laugh for two hours.
  a. For two hours, it was not the case that John laughed.
  b. It was not the case that John laughed for two hours.

- We have seen earlier that negation always takes scope above the event quantifier.

(2) No dog barks.

(3) a. $\neg\exists x[\mathbf{dog}(x) \wedge \exists e[\mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ No >> $\exists e$
  "There is no barking event that is done by a dog"
  b. *$\exists e[\neg\exists x[\mathbf{dog}(x) \wedge \mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ *$\exists e$ >> No
  "There is an event that is not a barking by a dog"

- So in (1a), the *for*-adverbial must take scope above the event quantifier.
- So if the event quantifier is introduced at the sentential level, the *for*-adverbial must be able to take scope there.

- But this is a controversial assumption, and there is no consensus on whether *for*-adverbials attach above or below the subject (Rathert, 2004).

- Krifka (1989) concludes that negation takes scope under the event quantifier.

- Given the background assumption that *for*-adverbials do not take scope at the sentential level, this is necessary in order to explain why *for*-adverbials take scope both above and below negation.

- But this decision requires translating negation in a nonstandard way. Krifka uses fusion (mereological sum) for this purpose.

(4) $[\![\text{did not}]\!]_{\text{Krifka}}$
$= \lambda P \lambda e \exists t[e = \bigoplus(\lambda e'[\tau(e') \leq t]) \wedge \neg\exists e''[P(e'') \wedge e'' \leq e]]$

- Based on this entry, Krifka translates a sentential event predicate like *John didn't laugh* as a predicate that is true of any fusion of events that all take place within some time, so long as none of them is an event of John's laughing:

(5) $[\![\text{John did not laugh}]\!] =$
$\exists e \exists t[e = \bigoplus(\lambda e'[\tau(e') \leq t])$
$\wedge \neg\exists e''[e'' \leq e \wedge \mathbf{laugh}(e'') \wedge \mathbf{ag}(e'') = \mathbf{john}]]$

- Krifka's fusion-based negation system has been both influential and controversially debated (de Swart, 1996; de Swart and Molendijk, 1999; Zucchi and White, 2001; Condoravdi, 2002; Giannakidou, 2002; Csirmaz, 2006).

- In the absence of a consensus on the status of negation-based fusions, it is worth revisiting the evidence that led to their introduction in the first place.

- One of the premises of the scope dilemma – the assumption that the event quantifier takes scope at the sentential level – is missing from our system.

- Even if the *for*-adverbial never takes scope at the sentential level, we are not forced to conclude that negation takes scope under the event quantifier.

- We can formulate the meaning of *not* in terms of logical negation, without fusions.

(6) $[\![\text{not}]\!] = \lambda V \lambda f \neg V(\lambda e[f(e)])$

(7) John did not laugh.
  a. $[_{\text{CP}}$ [closure] $[[_{\text{DP}}$ john [ag]] $[_{\text{VP}}$ did not laugh]]]
  b. $\neg\exists e[\mathbf{laugh}(e) \wedge \mathbf{ag}(e) = \mathbf{john}]$

- Let us now add an anaphoric treatment of tense to restrict the translation to the reference time (written t_{r}), as Krifka does.

(8) ⟦[past-closure]⟧
$= \lambda V[t_{\mathrm{r}} \ll \textbf{now} \ \wedge \ V(\lambda e[\tau(e) \subseteq t_{\mathrm{r}}])]$

- Note that $t_{\mathrm{r}} \ll \textbf{now}$ is not in the scope of V, so tense always has widest scope.

- The following translation generates the desired readings for (1).

(9) ⟦for two hours⟧
$= \lambda V \lambda f \exists t[\textbf{hours}(t) = 2 \wedge t \subseteq t_{\mathrm{r}}$
$\wedge \forall t'[t' \subseteq t \rightarrow V(\lambda e[f(e) \wedge \tau(e) = t'])]]$

- My analyses of (1a) and (1b) are shown in (10) and (11) respectively. Figures 4.1 and 4.2 show these derivations in detail.

- In both LFs, the *for*-adverbial takes scope at VP level.

(10) a. For two hours, it was not the case that John laughed.
b. [$_{\text{CP}}$ [[$_{\text{DP}}$ john [ag]] [$_{\text{VP}}$ [$_{\text{VP}}$ did not laugh] [$_{\text{PP}}$ for 2 hours]]]]
c. $t_{\mathrm{r}} \ll \textbf{now} \wedge \exists t[\textbf{hours}(t) = 2 \wedge t \subseteq t_{\mathrm{r}} \wedge \forall t'[t' \subseteq t \rightarrow$
$\neg\exists e[\textbf{laugh}(e) \wedge \textbf{ag}(e) = \textbf{john} \wedge \tau(e) = t' \subseteq t_{\mathrm{r}}]]]$

(11) a. It was not the case that John laughed for two hours.
b. [$_{\text{CP}}$ [[$_{\text{DP}}$ john [ag]] [$_{\text{VP}}$ did not [$_{\text{VP}}$ laugh [$_{\text{PP}}$ for 2 hours]]]]]
c. $t_{\mathrm{r}} \ll \textbf{now} \wedge \neg\exists t[\textbf{hours}(t) = 2 \wedge t \subseteq t_{\mathrm{r}} \wedge \forall t'[t' \subseteq t \rightarrow$
$\exists e[\textbf{laugh}(e) \wedge \textbf{ag}(e) = \textbf{john} \wedge \tau(e) = t' \subseteq t_{\mathrm{r}}]]]$

4.2 Conjunction

- The word *and* can be used both intersectively and collectively:

(12) a. John lies and cheats.
b. John and Mary met.

- On the intersective or "boolean" theory, the basic meaning of *and* is intersective (Winter, 2001; Champollion, 2013, 2014a).

- On the collective or "non-boolean" theory, the basic meaning of *and* are collective (Krifka, 1990; Lasersohn, 1995; Heycock and Zamparelli, 2005)

- Lasersohn (1995, ch. 14) claims that event semantics favors the collective theory.

- A closer look reveals that event semantics is also compatible with the intersective theory. See Champollion (2014b) for the full argument. Here I give the upshot.

- Lasersohn translates sentence radicals as event predicates.

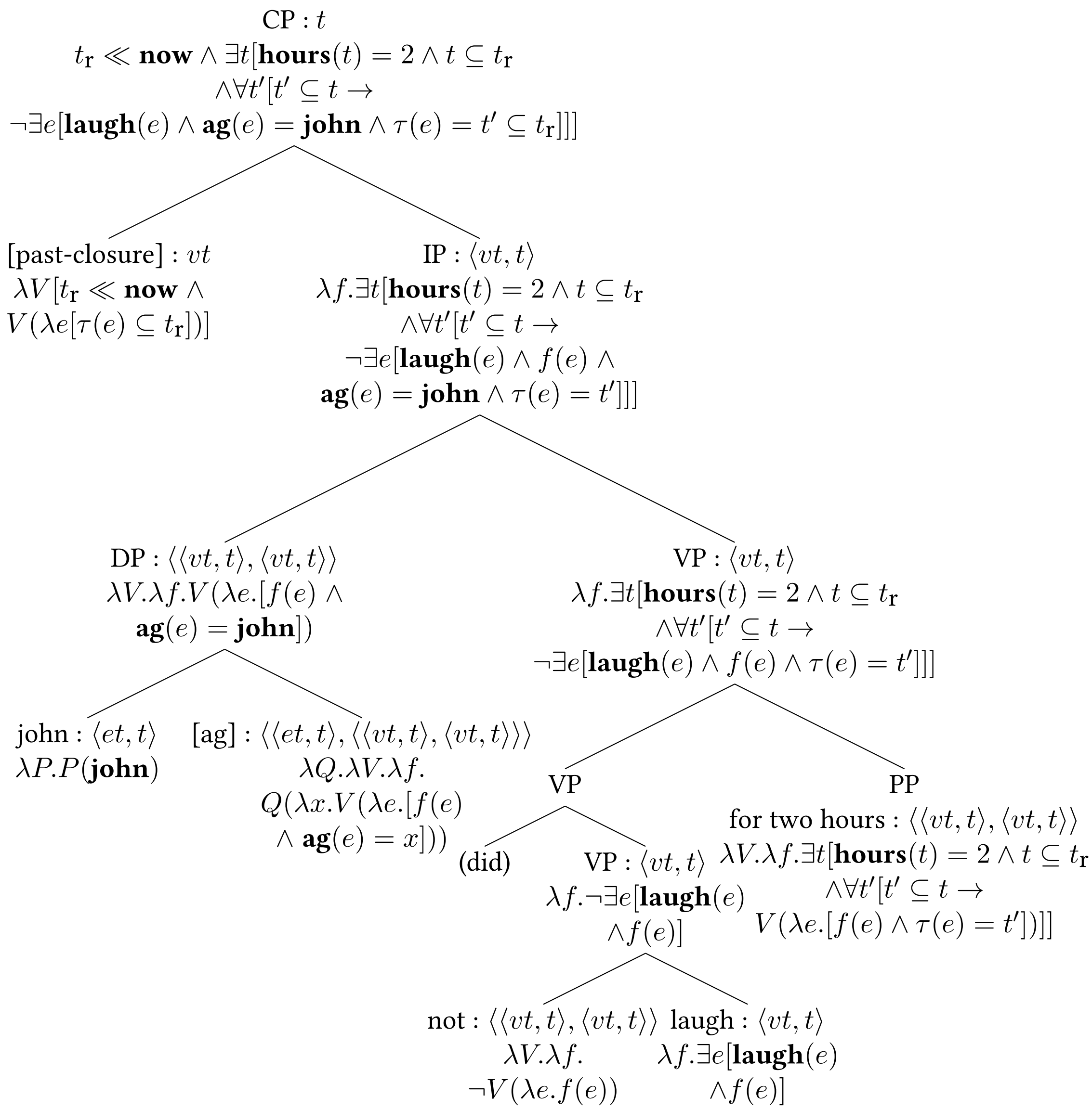


Figure 4.1: LF for Example (10): John [didn't laugh] for two hours

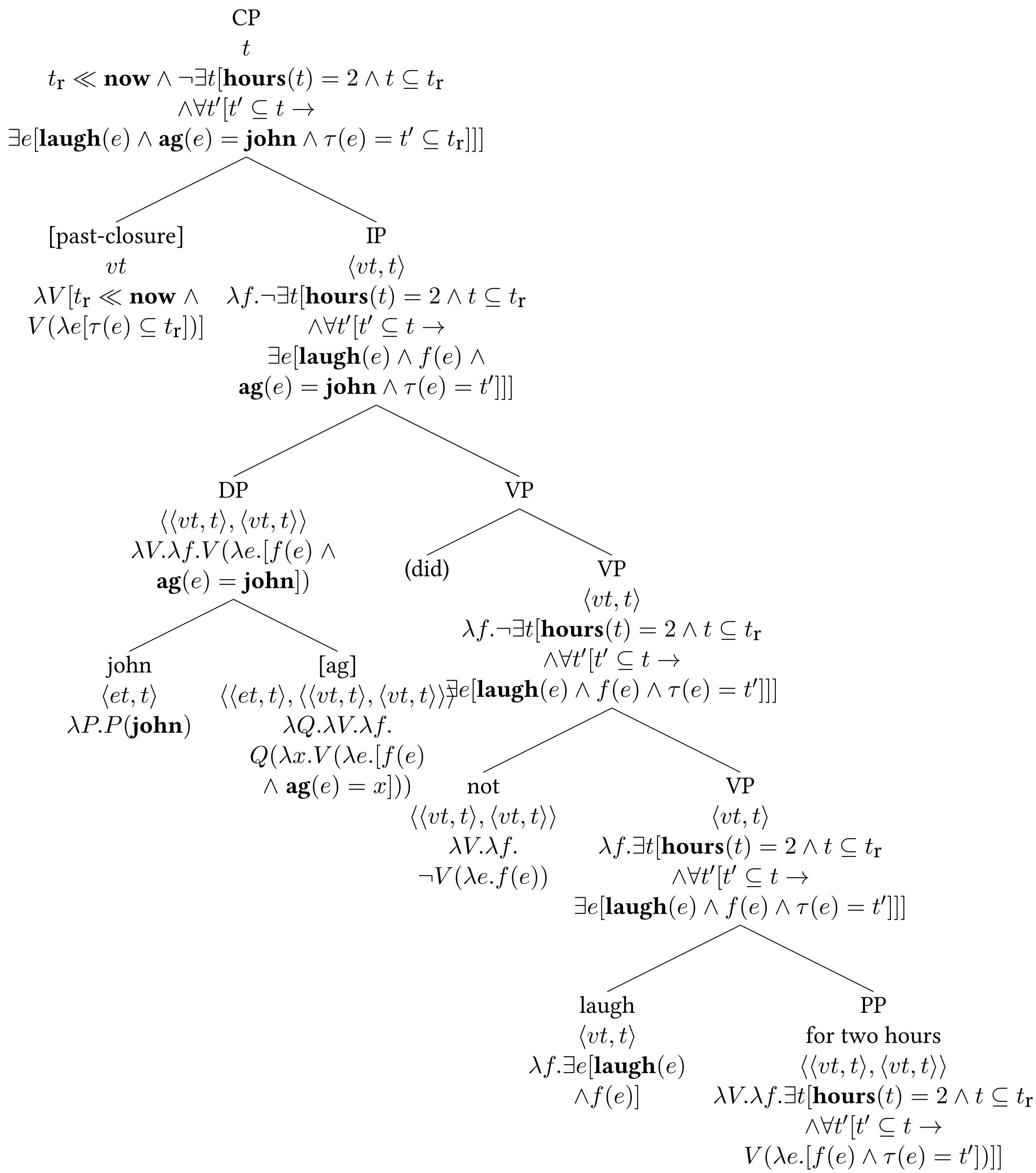


Figure 4.2: LF for Example (11): John didn't [laugh for two hours]

(13) a. $[\![\text{and}]\!]_{Lasersohn} = \lambda P_1.\lambda P_2.\lambda e.\exists e_1 \exists e_2.P_1(e_1) \wedge P_2(e_2) \wedge e = \{e_1, e_2\}$
b. $[\![\text{sing and dance}]\!]_{Lasersohn} = \lambda e.\exists e_1 \exists e_2.\mathbf{sing}(e_1) \wedge \mathbf{dance}(e_2) \wedge e = \{e_1, e_2\}$

- The intersective theory identifies *and* with the following rule (e.g. Partee and Rooth, 1983). Here τ ranges over types that end in t, and σ_1 and σ_2 range over any type.

(14)
$$\sqcap_{\langle \tau, \tau\tau \rangle} =_{def} \begin{cases} \wedge_{\langle t,tt \rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z) \sqcap_{\langle \sigma_2, \sigma_2\sigma_2 \rangle} Y(Z) & \text{if } \tau = \langle \sigma_1, \sigma_2 \rangle \end{cases}$$

- Applied to event predicates and event quantifiers:

(15) **Conjunction of event predicates:** (no event quantifier!)
$[\lambda e.F_{vt}(e)] \sqcap_{\langle vt, \langle vt,vt \rangle\rangle} [\lambda e.G_{vt}(e)]$
$= [\lambda e.F_{vt}(e) \wedge G_{vt}(e)]$

(16) **Conjunction of event quantifiers:** (two event quantifiers!)
$[\lambda f.\exists e.F_{vt}(e) \wedge f(e)] \sqcap_{\langle\langle vt,t \rangle, \langle\langle vt,t \rangle, \langle vt,t \rangle\rangle\rangle} [\lambda f.\exists e.G_{vt}(e) \wedge f(e)]$
$= [\lambda f.[\exists e.F_{vt}(e) \wedge f(e)] \wedge [\exists e'.G_{vt}(e') \wedge f(e')]]$

- The one-event view in (15) doesn't work well because it forces both verbal predicates to apply to the same event.

Exercise 4.1 Take Davidson's example of a ball that is at once rotating quickly and heating up slowly (Davidson, 1969). This example is generally taken to show that there must be two events involved, since one and the same event cannot be both quick and slow. Why is this an argument against (15)? How would you model the meaning of a sentence like (17) on the two-event view in (16)?

(17) The ball rotated quickly and heated up slowly.

□

- Let's have a look at the interaction of conjunction and indefinites.

- Sentence (22) is a classic (Rooth and Partee, 1982; Partee and Rooth, 1983).

(22) John caught and ate a fish.

- Rooth and Partee (1982) claim that this sentence only has a "one fish" reading (where the existential takes scope over the indefinite, i.e. John ate the fish he caught), and lacks a "two fish" reading (i.e. John caught a fish and ate a fish).

- The "one fish" reading is predicted by the intersective theory if transitive verbs are assumed to have type $\langle e, et \rangle$. The rule in (14) generates the following entry for *and* in this case:

(23) $\sqcap_{\langle\langle vt,t \rangle, \langle\langle vt,t \rangle, \langle vt,t \rangle\rangle\rangle} = \lambda V'.\lambda V.\lambda f.[V(f) \wedge V'(f)]$

- Hendriks (1993) argues that the "two fish" reading is dispreferred for pragmatic reasons but that it is available with the right continuation:

(24) John caught and ate a fish. The fish he caught was inedible, and the fish he ate caught his eye.

- Judgments on this kind of sentence vary Hendriks (1993), Bittner (1994), and Winter (1995). See for yourselves:

(25) a. John bought and sold a car.
b. John sold and bought a car.

- Additional question: What are the thematic roles assigned by the various verbs involved? In (22), are there two themes, or are there two different relations (*prey* and *food*)?

- What about conjunctions of unaccusative and unergative verbs:

(26) John walked and fell.

Exercise 4.2 Suppose that there are only *agent* and *theme*. How is the "one-fish" reading of (22) represented? How is the "two-fish" reading represented? □

- Here is how the verb phrase is derived. We conjoin the verbs directly, and apply the thematic role head to the object before the result is applied to the conjunction.

(30) a. $[\![$[catch and eat]$]\!]$ = $\lambda f.[\exists e.\mathbf{catch}(e) \wedge f(e)] \wedge [\exists e'.\mathbf{eat}(e') \wedge f(e')]$
b. $[\![$[th]$]\!]$ = $\lambda Q \lambda V \lambda f[Q(\lambda x[V(\lambda e[f(e) \ \wedge \ \mathbf{th}(e) = x])])]$
c. $[\![$[a fish]$]\!]$ = $\lambda P \exists x.\mathbf{fish}(x) \wedge P(x)$
d. $[\![$[th]([a fish])$]\!]$ = $\lambda V \lambda f[\exists x[\mathbf{fish}(x) \wedge [V(\lambda e[f(e) \ \wedge \ \mathbf{th}(e) = x])]]]$
e. $[\![$[th]([a fish])$]\!]$($[\![$[catch and eat]$]\!]$) = $\lambda f[\exists x.\mathbf{fish}(x) \wedge [\exists e.\mathbf{catch}(e) \wedge f(e) \ \wedge \ \mathbf{th}(e) = x] \wedge [\exists e'.\mathbf{eat}(e') \wedge f(e') \ \wedge \ \mathbf{th}(e') = x]]$

- As for the "two-fish" reading, for those speakers that have it, we can generate it by adding an additional lexical entry for our silent theme head into the grammar – call it [th2].

- This entry combines first with the verb and then with the object. First attach [th2] to each of the verbs, then intersect, and finally apply the conjunction to the object.

- Intersection is done by an application of the rule in (14), which in this case gives the following result (don't try this at home! :)

(31) $\sqcap_{\langle\langle\langle et,t\rangle,\langle vt,t\rangle\rangle,\langle\langle\langle et,t\rangle,\langle vt,t\rangle\rangle,\langle\langle et,t\rangle,\langle vt,t\rangle\rangle\rangle\rangle} = \lambda C.\lambda C'.\lambda Q.\lambda f.[(C'(Q)(f)) \wedge (C(Q)(f))]$

- Here, we exploit the fact that our theme heads expect their arguments to be of type $\langle et, t\rangle$, similarly to the transitive verbs in Montague (1973).

(32) a. $[\![$[th2]$]\!] = \lambda V \lambda Q \lambda f[Q(\lambda x[V(\lambda e[f(e) \ \wedge \ \mathbf{th}(e) = x])])]$
b. $[\![$catch$]\!] = \lambda f.\exists e.\mathbf{catch}(e) \wedge f(e)$
c. $[\![$[[th2] catch]$]\!] = \lambda Q \lambda f[Q(\lambda x[\exists e.\mathbf{catch}(e) \wedge [f(e) \ \wedge \ \mathbf{th}(e) = x]])]$
d. $[\![$[[th2] eat]$]\!] = \lambda Q \lambda f[Q(\lambda y[\exists e'.\mathbf{eat}(e') \wedge [f(e') \ \wedge \ \mathbf{th}(e') = y]])]$
e. $[\![$[[th2] catch] and [[th2] eat]]$]\!] = \lambda Q \lambda f[Q(\lambda x[\exists e.\mathbf{catch}(e) \wedge [f(e) \ \wedge \ \mathbf{th}(e) = x]])] \sqcap \lambda Q \lambda f[Q(\lambda y[\exists e'.\mathbf{eat}(e') \wedge [f(e') \ \wedge \ \mathbf{th}(e') = y]])]$
$= \lambda Q.\lambda f.[Q(\lambda x[\exists e.\mathbf{catch}(e) \wedge [f(e) \ \wedge \ \mathbf{th}(e) = x]])$
$\wedge Q(\lambda y[\exists e'.\mathbf{eat}(e') \wedge [f(e') \ \wedge \ \mathbf{th}(e') = y]])]$
f. $[\![$[a fish]$]\!] = \lambda P \exists x.\mathbf{fish}(x) \wedge P(x)$
g. $[\![$(32e)$]\!]([\![$(32f)$]\!]) = \lambda f.$
$[\exists x.\mathbf{fish}(x) \wedge \exists e.\mathbf{catch}(e) \wedge f(e) \ \wedge \ \mathbf{th}(e) = x]$
$\wedge[\exists y.\mathbf{fish}(y) \wedge \exists e'.\mathbf{eat}(e') \wedge f(e') \ \wedge \ \mathbf{th}(e') = y]$

- We can make [th2] available on a per-speaker basis.
- If different thematic roles are involved in the catching and in the eating, things get a bit more complicated yet. See Champollion (2014b) for details.

4.3 Conclusion

- Neo-Davidsonian event semantics does not pose a particular problem when it is combined with standard accounts of quantification, be they syntactic or semantic.
- This then provides a simple account for the fact that quantifiers always take scope above existential closure, a fact which is difficult to model otherwise.
- Such a claim would be problematic especially in case of languages where quantifiers otherwise take scope in situ.
- The framework proposed in Champollion (2014b) combines the strengths of event semantics and type-shifting accounts of quantifiers.
- It is therefore well suited for applications to languages where word order is free and quantifier scope is determined by surface order.
- Adopting event semantics does not commit us to choosing one theory of coordination over another. In particular, adopting the intersective theory is compatible with event semantics.

4.4 Recommended background reading

- For this lecture: on negation, Krifka (1989), and of course Horn (1989). On conjunction, Lasersohn (1995), Winter (2001), and Champollion (2013, 2014a).
- For the next lecture: Krifka (1989) and Beaver and Condoravdi (2007)

Day 5

Alternative approaches

Today: A look at the systems in Krifka (1989) (merging GQ theory and event semantics) and Beaver and Condoravdi (2007) (replacing event types by special assignment functions).

5.1 Krifka (1989): Algebraic event semantics

- The goal of Krifka (1989) is to combine event semantics with the full range of quantifiers treated by generalized quantifier theory (Barwise and Cooper, 1981)

(1) a. Most girls sang.
    b. Less than three girls sang.

- Landman (1996) does not do this, and while the last chapters of Landman (2000) does present a relevant system, I will focus on the one in Krifka (1989) here

- Van Benthem's Problem: (van Benthem, 1986)

(2) Less than three girls sang.
    a. Wrong paraphrase: "There was an event which contained singing by less than three girls"

Exercise 5.1 What is wrong with this paraphrase? What would be a better one?□

- Krifka introduces the concept of a **maximal** event. Intuitively, an event is maximal iff it contains everything that occurs within a certain stretch of time.

- Given this, Krifka suggests the following paraphrase as an improvement:

(4) *Most / Less than three girls sang* is true iff there is a **maximal** event which contains singing events of more than half / less than three of the girls.

- Formally:

(5) **Definition: MaXimal Event (Krifka, 1989)**
$\mathbf{MXE}(e) \overset{\text{def}}{=} \exists t[e = \bigoplus(\lambda e'.\tau(e') \leq t)]$
(An event is maximal iff is the sum of all the events whose runtimes are parts of a given temporal interval.)

- For example, Krifka uses maximal events as part of his definition of negation that we have seen in the previous lecture:

(6) $[\![\text{did not}]\!]_{\text{Krifka}}$
$= \lambda P \lambda e \exists t[e = \bigoplus(\lambda e'[\tau(e') \leq t]) \wedge \neg\exists e''[P(e'') \wedge e'' \leq e]]$
$= \lambda P \lambda e \exists t[\mathbf{MXE}(e) \wedge \neg\exists e''[P(e'') \wedge e'' \leq e]]$

- How could we define the meaning of arbitrary quantifiers based on this?

- According to generalized quantifier theory (Barwise and Cooper, 1981)

(7) $[\![\text{less than three girls}]\!] = \lambda P.\{x|\mathbf{girl}(x)\} \cap \{x|P(x)\} < 3$

(8) $[\![\text{most girls}]\!] = \lambda P.\frac{\{x|\mathbf{girl}(x)\} \cap \{x|P(x)\}}{\{x|\mathbf{girl}(x)\}} > {}^1\!/_2$

- To translate this into event semantics, we need to be able to count the girls in an event.

- Let's introduce the type n of natural numbers, and write n for variables over numbers and N for sets of numbers.

(9) $\mathbf{max}(\mathrm{N}) \overset{\text{def}}{=}$ the highest number in N

- The following is a streamlined version of Krifka's proposal, slightly adapted to match the assumptions I made in Chapter 2:

(10) $[\![[\text{less than three girls}]_{ag}]\!]$
$= \lambda V_{\langle vt \rangle} \lambda e.[\mathbf{MXE}(e) \wedge \mathbf{max}(\lambda n \exists e' \leq e.V(e) \wedge {}^*\mathbf{girl}({}^*\mathbf{ag}(e')) \wedge |{}^*\mathbf{ag}(e')| = n) < 3]$

- After this entry combines with a verbal predicate V, it describes maximal events e such that the maximal number of girls that are agents of a Ving subevent of e is less than three.

- This verbal predicate is assumed to be of type vt, a set of events.

- For example:

(11) $[\![\text{sing}]\!] = \lambda e.{}^*\mathbf{sing}(e)$

- Krifka actually includes "hooks" to the various arguments of a verb in its denotation. I ignore this here for convenience as it does not affect the types:

(12) $[\![\text{sing}_{\textit{Krifka}}]\!] = \lambda e.{}^{*}\mathbf{sing}(e) \wedge {}^{*}\text{ag}(e, x_s)$

- We can then apply existential closure as usual:

(13) $[\![\text{[closure]}]\!]([\![\text{[less than three girls]}_{ag}]\!]([\![\text{sing}]\!]))$
$= \exists e.[\mathbf{MXE}(e) \wedge \mathbf{max}(\lambda n \exists e' \leq e.{}^{*}\mathbf{sing}(e) \wedge {}^{*}\mathbf{girl}({}^{*}\mathbf{ag}(e')) \wedge |{}^{*}\mathbf{ag}(e')| = n)] < 3$

- This is true iff there is a maximal event e such that the maximal number of girls that are agents of a singing subevent of e is less than three.

- On the system in Champollion (2011, 2014b), we can reuse the traditional entries in (7) and (8). We don't need maximal events.

(14) a. $[\![\text{less than three girls}]\!]$
$= \lambda P.\{x|\mathbf{girl}(x)\} \cap \{x|P(x)\} < 3$
b. $[\![\text{[ag] less than three girls}]\!]$
$= \lambda V \lambda f.\{x|\mathbf{girl}(x)\} \cap \{x|V(\lambda e.[f(e) \wedge \textsc{ag}(e) = x])\} < 3$
c. $[\![\text{[closure]}]\!] = \lambda V.V(\lambda e.\mathbf{true})$
d. $[\![\text{sing}]\!] = \lambda f \exists e[\mathbf{sing}(e) \wedge f(e)]$
e. $[\![\text{[ag] less than three girls sing}]\!]$
$= \lambda f.\{x|\mathbf{girl}(x)\} \cap \{x|\exists e[\mathbf{sing}(e) \wedge f(e) \wedge \textsc{ag}(e) = x]\} < 3$
f. $[\![\text{[closure] [ag] less than three girls sing}]\!]$
$= \{x|\mathbf{girl}(x)\} \cap \{x|\exists e[\mathbf{sing}(e) \wedge \textsc{ag}(e) = x]\} < 3$

- Special complications arise when non-upward-entailing quantifiers interact with each other in cumulative readings (Krifka, 1999; Brasoveanu, 2010). I will not go into details here.

(15) Exactly three boys invited exactly six girls.

5.2 Beaver and Condoravdi (2007): Linking semantics

- Beaver and Condoravdi (2007, here: B&C) propose to move away from event semantics (Davidson, 1967) as a theory of verbal modification.

- Linking semantics provides a clean and compositional account of the interaction of events and quantifiers. But their rejection of event semantics brings problems.

- The main point of this section is that we can have our cake and eat it too: we can reconcile B&C with Davidsonian event semantics and keep the strengths of both systems.

5.3 Argument reduction

- In event semantics, modifiers (*at noon*, *on the forum*) are interpreted conjunctively.

- So, entailments like (16) are modeled as logical entailments (17).

(16) Jones buttered the toast at noon. ⇒ Jones buttered the toast.

(17) $[\exists e.\mathbf{butter}(e) \wedge \mathbf{ag}(e) = j \wedge \mathbf{th}(e) = t \wedge \tau(e) = \mathbf{noon}]$
$\Rightarrow [\exists e.\mathbf{butter}(e) \wedge \mathbf{ag}(e) = j \wedge \mathbf{th}(e) = t]$

- As we have seen, this is considered to be a very powerful argument in favor of event semantics.
- In linking semantics, verbs and VPs denote sets of partial functions called "role assignments".
- These role assignments map a small number of labels to appropriate values (Table 5.1).

Label	Value
ARG1 (agent)	john
ARG2 (theme)	toast
T (time)	noon

Table 5.1: An example of a role assignment, called g_1.

- So in a model where John kicked Bill at 1pm, the sets denoted by *kick*, by *kick Bill* and by *John kick Bill* each contain at least the role assignment g_1 in Table 5.1.
- In linking semantics the entailment in (18) is nonlogical, ie. it no longer comes for free as it does in Davidsonian event semantics.

(18) $\mathbf{butter}([\text{ARG1}, j;\ \text{ARG2}, toast;\ \text{T}, \mathbf{noon}]) \Rightarrow \mathbf{butter}([\text{ARG1}, j;\ \text{ARG2}, toast])$

- So B&C enforce it for each verb via an "argument reduction" principle:

(19) **Argument reduction axiom.** For any verb V and model M, if $f \in [\![V]\!]_M$, $g \subset f$, and every argument of V is in dom(g), then $g \in [\![V]\!]_M$.

- This says that if V holds of a role assignment R, it also holds of any restriction of R.
- This ensures diamond entailments.
- A major motivation for event semantics is to *explain* these entailments by reducing them to the fact that $p \wedge q$ entails p. So it seems that this motivation does not carry over to linking semantics.

5.4 Temporal closure

- Linking semantics treats time via a nonlogical axiom.

- B&C represent the surface scope reading of a sentence like (20a) as in (20b).

(20) a. A diplomat visited every country.
b. $\exists t.t < \textsc{now} \wedge \exists x.\textbf{diplomat}(x) \wedge \forall y.\textbf{country}(y) \rightarrow \textbf{visit}([\textsc{arg1}, x; \textsc{arg2}, y; \textsc{t}, t])$

- This by itself requires all the visits to happen simultaneously at time t.

- To relax this requirement, B&C introduce a "temporal closure" principle:

(21) **Temporal closure axiom.** For any verb V and model M, if $f \in [\![V]\!]_M$, $f(\textsc{t})$ is temporally included in $g(\textsc{t})$ and f differs from g at most with respect to the value it gives to T, then $g \in [\![V]\!]_M$.
(If a verb applies to a role assignment which maps T to a given interval t, then for each of its superintervals t', the verb also applies to an otherwise equal role assignment that maps T to t'.)

- This hard-wired approach overgenerates:

(22) a. It took John five years to learn Russian.
b. $\not\Rightarrow$ It took John ten years to learn Russian.

- This invalid argument is predicted valid since temporal closure makes (23a) entail (23b).

(23) a. $\exists t.t < \textsc{now} \wedge \textbf{years}(t) = 5 \wedge \textbf{learn}([\textsc{arg1}, j; \textsc{arg2}, r; \textsc{t}, t])$
b. $\exists t'.t' < \textsc{now} \wedge \textbf{years}(t') = 10 \wedge \textbf{learn}([\textsc{arg1}, j; \textsc{arg2}, r; \textsc{t}, t'])$

- The nature of the problem is that, in effect, temporal closure causes *It took John five years to learn Russian* to be interpreted as *It took John five or less years to learn Russian.*

5.5 Recasting linking semantics as event semantics

- The basic insight is that role assignments are very similar to sets of events.

- So g_1 above corresponds to the property of being an event whose agent is John, etc.

- This could in principle apply to more than one event (e.g. a slapping and a kicking).

- So a role assignment corresponds to a set of events and not just to one event.

- Verbal projections in linking semantics denote sets of role assignments.

- The system in Champollion (2011, 2014b, which I will call C) is similar in that verbal projections denote sets of sets of events. (Linking semantics served as inspiration for this system.)

- The linking semantics derivation shown in (24) translates to its C-style counterpart in (25).

- Here f, g range over role assignments or over sets of events, L over sets of role assignments, V over sets of sets of events.

- Roughly, $f + [\textsc{arg1}, m]$ extends f by a new entry that maps ARG1 to m.

(24)
a. $[\![\text{Mary}]\!] = \lambda P.P(m)$
b. $[\![\text{Mary:}\textsc{arg1}]\!] = \lambda L \lambda f.L(f + [\textsc{arg1}, m])]$
c. $[\![\text{-ed}]\!] = \lambda L \lambda f.L(f) \wedge f(\textsc{t}) < \textsc{now}$
d. $[\![\text{laugh -ed}]\!] = \lambda g.\mathbf{laugh}(g) \wedge g(\textsc{t}) < \textsc{now}$
e. $[\![\text{Mary:}\textsc{arg1}\text{ laugh -ed}]\!] = \lambda f.\mathbf{laugh}(f + [\textsc{arg1}, m]) \wedge f(\textsc{t}) < \textsc{now}$
f. $M \models$ Mary laughed iff $\exists t[\mathbf{laugh}([\textsc{t}, t; \textsc{arg1}, m]) \wedge t < \textsc{now}]$

(25)
a. $[\![\text{Mary}]\!] = \lambda P.P(m)$
b. $[\![\text{[ag] Mary}]\!] = \lambda V \lambda f.V(\lambda e.[f(e) \wedge \textsc{ag}(e) = \text{mary}])]$
c. $[\![\text{-ed}]\!] = \lambda V \lambda f \exists t[t < \textsc{now} \wedge V(\lambda e[f(e) \wedge \tau(e) \subseteq t])]$
d. $[\![\text{[closure]}]\!] = \lambda V.V(\lambda e.\mathbf{true})$
e. $[\![\text{laugh}]\!] = \lambda f \exists e[\mathbf{laugh}(e) \wedge f(e)]$
f. $[\![\text{[closure] [ag] Mary laugh -ed}]\!] = \exists t[t < \textsc{now} \wedge \exists e[\mathbf{laugh}(e) \wedge \textsc{ag}(e) = \text{mary} \wedge \tau(e) \subseteq t]]$

- In (25), I have deviated from linking semantics in distinguishing between the runtime of the event, $\tau(e)$, and the reference time interval of the sentence, t.

- Following standard practice, the morpheme *-ed* contributes both past tense and perfective aspect, so it relates $\tau(e)$ and t by temporal inclusion, written as $\subseteq$ (25c). This removes the need for the temporal closure principle.

- I represent (20a) (repeated below as (26)) as in (27). The underlined bit requires that each visit is contained within the reference interval, but does not require all visits to take place at the same time.

(26) A diplomat visited every country.

(27) $\exists t.t < \textsc{now} \wedge \exists x.\mathbf{d}(x) \wedge \forall y.\mathbf{c}(y) \rightarrow \exists e.\mathbf{v}(e) \wedge \mathbf{ag}(e) = x \wedge \mathbf{th}(e) = x \wedge \underline{\tau(e) \subseteq t}$

- I translate the matrix clauses of (22) as in (28).

(28) $[\![\text{It took John } n \text{ years to}]\!]$
$= \lambda V \exists t.t < \textsc{now} \wedge \mathbf{years}(t) = n \wedge V(\lambda e.\mathbf{ag}(e) = j \wedge \tau(e) = t)$

- The embedded clause does not have past tense (it is untensed), and therefore does not contribute $\subseteq$.

- The underlined parts of (29) and (30) block the undesired inference in (22). This is so because we have $=$ where linking semantics has $\subseteq$ by the Temporal Closure Principle.

(29) $\exists t.t < \textsc{now} \wedge \underline{\textbf{years}(t) = 5} \wedge \exists e[\textbf{learn}(e) \wedge \textbf{ag}(e) = j \wedge \textbf{th}(e) = r \wedge \underline{\tau(e) = t}]$
'There is a past event of John learning Russian whose duration is exactly five years.'

(30) $\exists t.t < \textsc{now} \wedge \underline{\textbf{years}(t) = 10} \wedge \exists e[\textbf{learn}(e) \wedge \textbf{ag}(e) = j \wedge \textbf{th}(e) = r \wedge \underline{\tau(e) = t}]$
'There is a past event of John learning Russian whose duration is exactly ten years.'

5.6 Recommended background reading

- Krifka (1989) and Beaver and Condoravdi (2007) (were discussed today)
- Krifka (1999) and Brasoveanu (2010) (for GQ theory and scopeless readings)

Appendix A

Solutions to exercises

Answer to Exercise 1.1:

(7) a. Brutus stabbed Caesar on the forum at noon.
b. Brutus stabbed Caesar on the forum.
c. Brutus stabbed Caesar at noon.
d. Brutus stabbed Caesar.

The following entailment relations hold: (7a) entails all others; (7d) is entailed by all others; neither (7b) nor (7c) entails the other. When you arrange these sentences on a sheet accordingly and draw arrows between them, it looks like a diamond.

Answer to Exercise 1.2:

(18) a. Brutus did not stab Caesar on the forum at noon.
b. Brutus did not stab Caesar on the forum.
c. Brutus did not stab Caesar at noon.
d. Brutus did not stab Caesar.

The following entailment relations hold: (18a) is entailed by all others; (18d) entails all others; neither (18b) nor (18c) entails the other. Analogous entailments also hold between the following formulas:

(19) a. $\neg\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{loc}(e) = \mathbf{forum} \wedge \mathbf{time}(e) = \mathbf{noon}]$
b. $\neg\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{loc}(e) = \mathbf{forum}]$
c. $\neg\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{time}(e) = \mathbf{noon}]$
d. $\neg\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar})]$

(20) a. Nobody stabbed Caesar on the forum at noon.
b. Nobody stabbed Caesar on the forum.
c. Nobody stabbed Caesar at noon.
d. Nobody stabbed Caesar.

The following entailment relations hold: (20a) is entailed by all others; (20d) entails all others; neither (20b) nor (20c) entails the other. Analogous entailments also hold between the following formulas:

(21) a. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar}) \wedge \textbf{loc}(e) = \textbf{forum} \wedge \textbf{time}(e) = \textbf{noon}]$
b. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar}) \wedge \textbf{loc}(e) = \textbf{forum}]$
c. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar}) \wedge \textbf{time}(e) = \textbf{noon}]$
d. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar})]$

Answer to Exercise 2.1: If we consider $e_4 = e_1 \oplus e_2 \oplus e_3$, we have a counterexample to the cumulativity assumption for thematic roles, for the following reasons. The themes of e_1, e_2, e_3 are the hole, the rosebush, and the soil, while the theme of e_4 is just the rosebush. The theme of e_4 is not the sum of the themes of e_1, e_2, and e_3. This violates cumulativity.

One way to respond to this challenge is to reject the assumption that the mereological parthood relation should model all parthood relations that can be intuitively posited. In this case, we do not need to assume that e_4 is actually the sum of e_1, e_2, and e_3. Even though the existence of e_4 can be traced back to the occurrence of e_1, e_2, and e_3, nothing forces us to assume that these three events are actually parts of e_4, just like we do not consider a plume of smoke to be part of the fire from which it comes, even though its existence can be traced back to the fire. Without the assumption that e_4 contains e_1 through e_3 as parts, Kratzer's objection against cumulativity vanishes. See also Williams (2009) and Piñón (2011) for more discussion.

Answer to Exercise 4.1: If the conjoined verb phrases in the sentence (18) are interpreted as event predicates, as in (19a), they cannot be interpreted intersectively. By contrast, if the conjoined verb phrases are interpreted as event quantifiers, as on the present proposal, the intersective interpretation is unproblematic. This is because rule (14), repeated below as (20), ends up causing logical conjunction to have wide scope over the event quantifiers (19b). Of course, in order for the present proposal to work, the meanings of modifiers like *quickly* have to be lifted appropriately, as in (21).

(18) The ball rotated quickly and heated up slowly.

(19) $[\![\text{rotate quickly}]\!] \sqcap [\![\text{heat up slowly}]\!] =$
a. $\lambda e.\textbf{rotate}(e) \wedge \textbf{quickly}(e) \wedge \textbf{heat-up}(e) \wedge \textbf{slowly}(e)$
b. $\lambda f.[\exists e.\textbf{rotate}(e) \wedge \textbf{quickly}(e) \wedge f(e)]$
$\wedge[\exists e'.\textbf{heat-up}(e') \wedge \textbf{slowly}(e') \wedge f(e')]$

(20) $$\sqcap_{\langle\tau,\tau\tau\rangle} =_{def} \begin{cases} \wedge_{\langle t,tt\rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z) \sqcap_{\langle\sigma_2,\sigma_2\sigma_2\rangle} Y(Z) & \text{if } \tau = \langle\sigma_1, \sigma_2\rangle \end{cases}$$

(21) $[\![\text{quickly}]\!] = \lambda V.\lambda f.V(\lambda e.\textbf{quickly}(e) \wedge f(e))$

When the verb phrase denotation (19b) is combined with the denotation of the subject, the result predicts that sentence (17) is true just in case there is an event e in which the ball rotated quickly and there is an event e' in which it heated up slowly.

Answer to Exercise 4.2:

(27) John caught and ate a fish.

Supposing that there are only *agent* and *theme*, the "one-fish" reading of (27) can be represented as follows:

(28) $[\exists x.\mathbf{fish}(x) \wedge [\exists e.\mathbf{catch}(e) \wedge \mathbf{ag}(e) = j \wedge \mathbf{th}(e) = x] \wedge [\exists e'.\mathbf{eat}(e') \wedge \mathbf{ag}(e') = j \wedge \mathbf{th}(e') = x]]$

And this is the "two-fish" reading:

(29) $[\exists x.\mathbf{fish}(x) \wedge \exists e.\mathbf{catch}(e) \wedge \mathbf{ag}(e) = j \wedge \mathbf{th}(e) = x] \wedge [\exists y.\mathbf{fish}(y) \wedge \exists e'.\mathbf{eat}(e') \wedge \mathbf{ag}(e') = j \wedge \mathbf{th}(e') = y]$

Answer to Exercise 5.1:

(3) Less than three girls sang.

a. Wrong paraphrase: "There was an event which contained singing by less than three girls"

The thing that is wrong about this paraphrase is that it is true even if three or more girls sang. For whenever three girls sing, you can take two of them away and the girl sings. So there is an event in which that girl sings, and the paraphrase is true in virtue of that event.

For a better paraphrase, see the main text.

Bibliography

Bach, Emmon (1986). "The algebra of events". In: *Linguistics and Philosophy* 15, pp. 5–16.

Barker, Chris (1992). "Group terms in English: representing groups as atoms". In: *Journal of Semantics* 9.1, pp. 69–93.

Barker, Chris (2002). "Continuations and the nature of quantification". In: *Natural Language Semantics* 10, pp. 211–242.

Barwise, Jon and Robin Cooper (1981). "Generalized quantifiers and natural language". In: *Linguistics and Philosophy* 4, pp. 159–219.

Beaver, David and Cleo Condoravdi (2007). "On the logic of verbal modification". In: *Proceedings of the Sixteenth Amsterdam Colloquium*. Ed. by Maria Aloni, Paul Dekker, and Floris Roelofsen. Amsterdam, Netherlands: University of Amsterdam, pp. 3–9.

van Benthem, Johan (1986). *Essays in logical semantics*. Dordrecht, Netherlands: Reidel.

Bittner, Maria (1994). "Cross-linguistic Semantics". In: *Linguistics and Philosophy* 17, pp. 53–108.

Brasoveanu, Adrian (2010). "Modified Numerals as Post-Suppositions". In: *Logic, Language and Meaning*. Ed. by Maria Aloni et al. Vol. 6042. Lecture Notes in Computer Science. Berlin, Germany: Springer, pp. 203–212.

Carlson, Gregory N. (1984). "Thematic roles and their role in semantic interpretation". In: *Linguistics* 22, pp. 259–279.

Carlson, Gregory N. (1998). "Thematic roles and the individuation of events". In: *Events and grammar*. Ed. by Susan Rothstein. Dordrecht, Netherlands: Kluwer, pp. 35–51.

Casati, Roberto and Achille C. Varzi (1999). *Parts and places*. MIT Press.

Castañeda, Hector-Neri (1967). "Comments". In: *The logic of decision and action*. Ed. by Nicholas Rescher. University of Pittsburgh Press.

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

Champollion, Lucas (2011). "Quantification and negation in event semantics". In: *The Baltic International Yearbook of Cognition, Logic and Communication* 6.

Champollion, Lucas (2013). "Man and woman: the last obstacle to boolean coordination". In: *Proceedings of the 19th Amsterdam Colloquium*. Ed. by Maria Aloni, Michael Franke, and Floris Roelofsen, pp. 83–90.

Champollion, Lucas (2014a). "Ten men and women got married today". Submitted. URL: `http://ling.auf.net/lingbuzz/002025`.

Champollion, Lucas (2014b). "The interaction of compositional semantics and event semantics". Submitted. URL: `http://ling.auf.net/lingbuzz/002118`.

Champollion, Lucas and Manfred Krifka (2014). "Mereology". In: *Cambridge handbook of semantics*. Ed. by Paul Dekker and Maria Aloni. Cambridge University Press.

Champollion, Lucas, Josh Tauberer, and Maribel Romero (2007). “The Penn Lambda Calculator: Pedagogical software for natural language semantics”. In: *Proceedings of the Grammar Engineering Across Frameworks (GEAF) 2007 Workshop*. Ed. by Tracy Holloway King and Emily Bender. CSLI Online Publications. Stanford, CA.

Chomsky, Noam (1981). *Lectures on government and binding*. Dordrecht, Netherlands: Foris.

Chomsky, Noam (1995). *The Minimalist Program*. Cambridge, MA: MIT Press.

Condoravdi, Cleo (2002). “Punctual *until* as a scalar NPI”. In: *The nature of the word*. Ed. by Sharon Inkelas and Kristin Hanson. Cambridge, MA: MIT Press, pp. 631–654.

Csirmaz, Aniko (2006). “Aspect, Negation and Quantifiers”. In: *Event Structure And The Left Periphery*. Ed. by Liliane Haegeman et al. Vol. 68. Studies in Natural Language and Linguistic Theory. Springer Netherlands, pp. 225–253.

Davidson, Donald (1967). “The logical form of action sentences”. In: *The logic of decision and action*. Ed. by Nicholas Rescher. Pittsburgh, PA: University of Pittsburgh Press, pp. 81–95.

Davidson, Donald (1969). “The individuation of events”. In: *Essays in honor of Carl G. Hempel*. Springer, pp. 216–234.

De Swart, Henriëtte and Arie Molendijk (1999). “Negation and the temporal structure of narrative discourse”. In: *Journal of Semantics* 16, pp. 1–42.

Dowty, David R. (1991). “Thematic proto-roles and argument selection”. In: *Language* 67.3, pp. 547–619.

Eckardt, Regine (2009). “A logic for easy linking semantics”. In: *Proceedings of the Nineteenth Amsterdam Colloquium*. Amsterdam, Netherlands.

Giannakidou, Anastasia (2002). “UNTIL, aspect and negation: A novel argument for two untils”. In: *Semantics and linguistic theory (SALT)*. Vol. 12, pp. 84–103.

Groenendijk, Jeroen, Theo Janssen, and Martin Stokhof, eds. (1984). *Truth, interpretation and information: selected papers from the Third Amsterdam Colloquium*. Dordrecht, Netherlands: Foris.

Gruber, Jeffrey S. (1965). “Studies in lexical relations”. PhD thesis. Cambridge, MA: Massachusetts Institute of Technology.

Heim, Irene and Angelika Kratzer (1998). *Semantics in Generative Grammar*. Oxford, UK: Blackwell Publishing.

Hendriks, Herman (1993). “Studied flexibility”. PhD thesis. Amsterdam, Netherlands: University of Amsterdam.

Heycock, Caroline and Roberto Zamparelli (2005). “Friends and colleagues: Plurality, coordination, and the structure of DP”. In: *Natural Language Semantics* 13.3, pp. 201–270.

Higginbotham, James (1983). “The logic of perceptual reports: An extensional alternative to situation semantics”. In: *The Journal of Philosophy*, pp. 100–127.

Horn, Laurence (1989). *A natural history of negation*. CSLI Publications.

Jacobson, Pauline (1999). “Towards a variable-free semantics”. In: *Linguistics and Philosophy*, pp. 117–184.

Kipper-Schuler, Karin (2005). “VerbNet: A broad-coverage, comprehensive verb lexicon”. PhD thesis. Philadelphia, PA: University of Pennsylvania.

Kratzer, Angelika (1995). “Stage-level and individual-level predicates”. In: *The generic book*. Ed. by Gregory N. Carlson and Francis Jeffry Pelletier. Chicago, IL: University of Chicago Press, pp. 125–175.

Kratzer, Angelika (1996). “Severing the external argument from its verb”. In: *Phrase structure and the lexicon.* Ed. by J. Rooryck and L. Zaring. Dordrecht, Netherlands: Kluwer.

Kratzer, Angelika (2000). “The Event Argument and the Semantics of Verbs, chapter 2”. Manuscript. Amherst: University of Massachusetts, Amherst, MA.

Kratzer, Angelika (2003). “The Event Argument and the Semantics of Verbs, chapter 3”. Manuscript. Amherst: University of Massachusetts, Amherst, MA.

Kratzer, Angelika (2007). “On the plurality of verbs”. In: *Event structures in linguistic form and interpretation.* Ed. by Johannes Dölling, Tatjana Heyde-Zybatow, and Martin Schäfer. Berlin, Germany: de Gruyter, pp. 269–300.

Krifka, Manfred (1986). *Nominalreferenz und Zeitkonstitution. Zur Semantik von Massentermen, Pluraltermen und Aspektklassen.* Munich, Germany (published 1989): Fink.

Krifka, Manfred (1989). “Nominal reference, temporal constitution and quantification in event semantics”. In: *Semantics and contextual expression.* Ed. by Renate Bartsch, Johan van Benthem, and P. van Emde Boas. Dordrecht, Netherlands: Foris, pp. 75–115.

Krifka, Manfred (1990). “Boolean and non-boolean ‘and’”. In: *Papers from the Second Symposium on Logic and Language.* Ed. by László Kálmán and László Pólos. Budapest, Hungary: Akadémiai Kiadó, pp. 161–188.

Krifka, Manfred (1992). “Thematic relations as links between nominal reference and temporal constitution”. In: *Lexical Matters.* Ed. by Ivan A. Sag and Anna Szabolcsi. Stanford, CA: CSLI Publications, pp. 29–53.

Krifka, Manfred (1998). “The origins of telicity”. In: *Events and grammar.* Ed. by Susan Rothstein. Dordrecht, Netherlands: Kluwer, pp. 197–235.

Krifka, Manfred (1999). “At Least Some Determiners Aren’t Determiners”. In: *The Semantics/Pragmatics Interface from Different Points of View.* Ed. by K. Turner. Amsterdam, Netherlands: Elsevier, pp. 257–291.

Kroch, Anthony S. (1974). “The semantics of scope in English”. PhD thesis. Cambridge, MA: Massachusetts Institute of Technology.

Landman, Fred (1989). “Groups, I”. In: *Linguistics and Philosophy* 12, pp. 559–605.

Landman, Fred (1996). “Plurality”. In: *Handbook of Contemporary Semantics.* Ed. by Shalom Lappin. Oxford, UK: Blackwell Publishing, pp. 425–457.

Landman, Fred (2000). *Events and plurality: The Jerusalem lectures.* Dordrecht, Netherlands: Kluwer.

Lasersohn, Peter (1989). “On the readings of plural noun phrases”. In: *Linguistic Inquiry* 20, pp. 130–134.

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

Levin, Beth (1993). *English verb classes and alternations: A preliminary investigation.* Chicago, IL: University of Chicago Press.

Link, Godehard (1983). “The logical analysis of plurals and mass terms: A lattice-theoretical approach”. In: *Meaning, use and interpretation of language.* Ed. by Reiner Bäuerle, Christoph Schwarze, and Arnim von Stechow. Berlin, Germany: de Gruyter, pp. 303–323.

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

Marantz, Alec (1984). *On the nature of grammatical relations.* Cambridge, MA: MIT Press.

Markosian, Ned (2009). “Time”. In: *The Stanford Encyclopedia of Philosophy.* Ed. by Edward N. Zalta. Fall 2009. Stanford, CA. URL: http://plato.stanford.edu/archives/fall2009/entries/time/.

May, Robert (1985). *Logical form: Its structure and derivation.* Cambridge, MA: MIT Press.

Montague, Richard (1973). "The proper treatment of quantification in ordinary English". In: *Approaches to Natural Language: Proceedings of the 1970 Stanford Workshop on Grammar and Semantics.* Ed. by Jaakko Hintikka, Julius Moravcsik, and Patrick Suppes. Dordrecht, Netherlands: Dordrecht, pp. 221–242.

Montague, Richard (1974). *Formal Philosophy: Selected Papers of Richard Montague. Edited and with an introduction by R. H. Thomason.* Yale University Press, New Haven.

Mourelatos, Alexander P. D. (1978). "Events, Processes, and States". In: *Linguistics and Philosophy* 2, pp. 415–434.

Parsons, Terence (1990). *Events in the semantics of English.* Cambridge, MA: MIT Press.

Parsons, Terence (1995). "Thematic relations and arguments". In: *Linguistic Inquiry*, pp. 635–662.

Partee, Barbara H. (1987). "Noun phrase interpretation and type-shifting principles". In: *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers.* Ed. by Jeroen Groenendijk, Dick de Jongh, and Martin Stokhof. Dordrecht, Netherlands: Foris, pp. 115–143.

Partee, Barbara H. and Mats Rooth (1983). "Generalized conjunction and type ambiguity". In: *Meaning, use and interpretation of language.* Berlin, Germany: de Gruyter, pp. 361–383.

Pietroski, Paul M. (2005). *Events and semantic architecture.* Oxford University Press.

Pietroski, Paul M. (2006). "Interpreting concatenation and concatenates". In: *Philosophical Issues* 16.1, pp. 221–245.

Piñón, Christopher (2011). *Themes, cumulativity, and event descriptions.* Handout of a talk at Dimensions of Grammar workshop, Konstanz, Germany.

Pylkkänen, Liina (2008). *Introducing arguments.* Cambridge, MA: MIT Press.

Rathert, Monika (2004). *Textures of time.* Berlin, Germany: Akademie Verlag.

Roberts, Craige (1987). "Modal subordination, anaphora, and distributivity". PhD thesis. Amherst, MA: University of Massachusetts.

Rooth, Mats and Barbara H. Partee (1982). "Conjunction, type ambiguity and wide scope *or*". In: *Proceedings of the First West Coast Conference on Formal Linguistics (WCCFL 1).*

Scha, Remko (1981). "Distributive, collective and cumulative quantification". In: *Formal methods in the study of language.* Ed. by Jeroen Groenendijk, Theo Janssen, and Martin Stokhof. Reprinted in Groenendijk, Janssen, and Stokhof, 1984. Amsterdam, Netherlands: Mathematical Center Tracts.

Schein, Barry (1986). "Event logic and the interpretation of plurals". PhD thesis. Cambridge, MA: Massachusetts Institute of Technology.

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

Sharvy, Richard (1980). "A more general theory of definite descriptions". In: *The Philosophical Review* 89, pp. 607–624.

Simons, P. (1987). *Parts: a study in ontology.* Clarendon Press.

Smith, Steven Bradley (1975). *Meaning and negation.* The Hague, Netherlands: Mouton.

de Swart, Henriëtte (1996). "Meaning and use of *not … until*". In: *Journal of Semantics* 13, pp. 221–263.

Varzi, Achille C. (2010). "Mereology". In: *The Stanford Encyclopedia of Philosophy.* Ed. by Edward N. Zalta. Spring 2010. Stanford, CA. URL: `http://plato.stanford.edu/archives/spr2010/entries/mereology/`.

Williams, Alexander (2009). "Themes, cumulativity, and resultatives: Comments on Kratzer 2003". In: *Linguistic Inquiry* 40.4, pp. 686–700.

Winter, Yoad (1995). “Syncategorematic conjunction and structured meanings”. In: *Proceedings of the Fifth Conference on Semantics and Linguistic Theory (SALT V)*. Ed. by Mandy Simons and Teresa Galloway.

Winter, Yoad (2001). *Flexibility principles in Boolean semantics*. Cambridge, MA: MIT Press.

Zucchi, Sandro and Michael White (2001). “Twigs, sequences and the temporal constitution of predicates”. In: *Linguistics and Philosophy* 24, pp. 187–222.