Introduction to Formal Semantics
Lecture 10: Event Semantics

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Overview for today

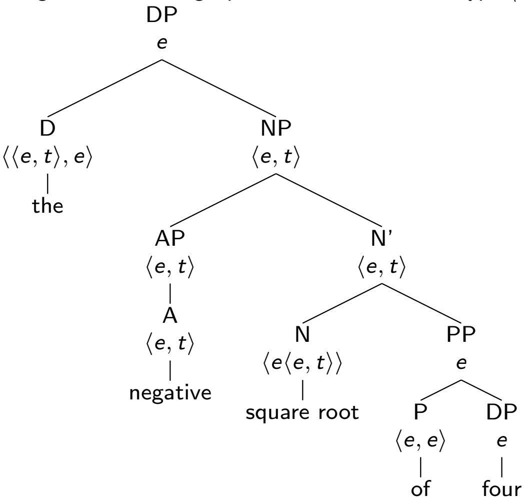
- Recap: tense and aspect
- Why event semantics?
- Verbs as predicates
- Verbs as quantifiers
- Conjunctions
- Negation

Reading:

- Coppock, E., and Champollion, L. (2021). Invitation to formal semantics. Manuscript, Boston University and New York University (Ch.11)

Quizz (Presupposition)

Compute a derivation for the following tree, translating *square root* as a constant type $\langle e \langle e, t \rangle \rangle$ and *four* of type e:



Quizz (Aspect)

Compute ‘inner’ aspect of the following sentences, use Verkuyl’s approach:

a. John drank the beer.
$[+Ts[+SQA]\quad[+Tvp[+ADDTO]\quad[+SQA]]]$ (terminative)

b. Ivan drinks beer.
$[-Ts[+SQA]\quad[-Tvp[+ADDTO]\quad[-SQA]]]$ (durative)

c. Students met the teacher.
$[-Ts[-SQA]\quad[+Tvp[+ADDTO]\quad[+SQA]]]$ (durative)

d. Three girls lifted four tables.
$[+Ts[+SQA]\quad[+Tvp[+ADDTO]\quad[+SQA]]]$ (terminative)

e. Judith ate sandwiches.
$[-Ts[+SQA]\quad[+Tvp[+ADDTO]\quad[-SQA]]]$ (durative)

Event Semantics: Motivation

What we did so far:

- We argued that the invented, symbolic language of logic and math is good way to think about natural languages
- We used symbols to represent meaning:
  - connecting terms like $\wedge$ $\vee$
  - track the order for meaning composition applying λ
  - to separate the actual from possible, $\exists$ from $\diamond$
  - to visualize how meaning can be narrowed down $\cap$ to nothing $\emptyset$ or expand $\cup$
- Basic assumption: verbs act as n-place predicates, e.g. travel $\rightsquigarrow T(x, y)$

Event Semantics: Motivation (cont.)

Example 1

Katarina grieved for many years $\rightsquigarrow$ G(k,m)
Katarina grieved $\rightsquigarrow$ G(k)

Event Semantics: Motivation (cont.)

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Are they two different events of grieving?

Event Semantics: Motivation (cont.)

Example 1

Katarina grieved for many years $\rightsquigarrow$ G(k,m)
Katarina grieved $\rightsquigarrow$ G(k)

Are they two different events of grieving?

Example 2

(1) Brutus stabbed Caesar. $stab_1(b, c)$
(2) Brutus stabbed Caesar on the forum $stab_2(b, c, f)$
(3) Brutus stabbed Caesar at noon $stab_3(b, c, n)$
(4) Brutus stabbed Caesar at noon on the forum $stab_4(b, c, n, f)$
(5) Brutus stabbed Caesar on the forum at noon $stab_5(b, c, f, n)$

Event Semantics: Motivation (cont.)

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Katarina grieved for many years $\rightsquigarrow$ G(k,m)
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(5) Brutus stabbed Caesar on the forum at noon $stab_5(b, c, f, n)$

How to explain the systematic logical entailment relations between the different uses of 'stab'

Event Semantics: Diamond Entailment

Example 2

(1) Brutus was a famous Roman politician.
(2) Brutus was a Roman politician.
(3) Brutus was a famous politician.
(4) Brutus was a politician.

Event Semantics: Diamond Entailment

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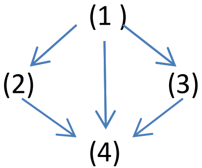

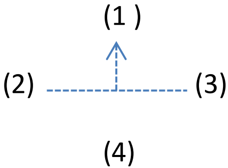

Event Semantics: Diamond Entailment (cont.)

Example 2

(1) Brutus stabbed Caesar at noon on the forum.
(2) Brutus stabbed Caesar on the forum.
(3) Brutus stabbed Caesar at noon.
(4) Brutus stabbed Caesar.

Event Semantics: Diamond Entailment (cont.)

Example 2

(1) Brutus stabbed Caesar at noon on the forum.
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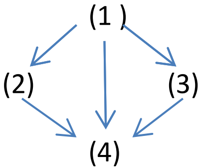

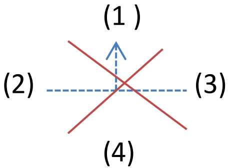

Event Semantics: Motivation (cont.)

Davidson (1967) proposed a new view - event semantics.

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Events are entities with locations in time and space. $G(e)$

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Events have participants - entities that are related to events by relations as thematic (or semantic) roles

Event Semantics: Motivation (cont.)

Davidson (1967) proposed a new view - event semantics.
Events are entities with locations in time and space. $G(e)$
Events have participants - entities that are related to events by relations as thematic (or semantic) roles

Example

Katarina grieved $\rightsquigarrow \exists e.[G(e) \wedge agent(k, e)]$
Katarina grieved for many years $\rightsquigarrow \exists e.[G(e) \wedge agent(k, e) \wedge time(e, many\_years)]$

Event Semantics: Events and Participants

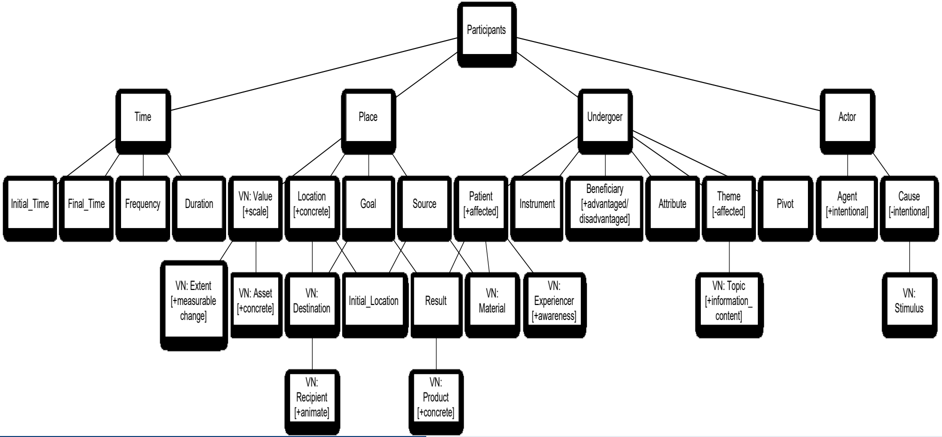
Eventuality: event, state, process or action which is being referred to by a verbal, adjectival or nominal predicate argument structure.
NOTE: Eventualities can also be described as "something that can be said to obtain or hold true, to happen or to occur"

Participant in an eventuality: entity involved in the eventuality

Semantic (thematic, theta) role: type of involvement of a participant in an eventuality.

Event Semantics: Semantic Roles

PropBank (Palmer, et. al., 2005): Arg_1, Arg_2, Arg_n, Arg_{MOD}
FrameNet (Fillmore 1976, Fillmore 1985, Fillmore & Baker 2010): Byer, Seller, Thing-To-Sell, Selling-Time, ...
VerbNet (Dang et al., 1998; Kipper et al, 2000; Kipper Schuler, 2005; Kipper et. al., 2008): Agent, Theme, Patient, ...
ISO 24617-5



Event Semantics: Approaches to Verbal Denotation

Example

Brutus stabbed Caesar.

Approach	**Verbal denotation**	**Example**
Traditional	$\lambda x \lambda y[stab(x, y)]$	stab(b,c)
Classical Davidsonian	$\lambda e \lambda x \lambda y[stab(e, x, y)]$	$\exists e[stab(e, b, c)]$
Neo-Davidsonian	$\lambda e[stab(e)]$	$\exists e[stab(e) \wedge agent(e, b) \wedge theme(e, c)]$
Landman (1996)	$\lambda e \lambda x \lambda y[stab(e) \wedge agent(e, x) \wedge theme(e, y)]$	$\exists e[stab(e, b, c)]$
Kratzer (2000)	$\lambda e \lambda y[stab(e, y)]$	$\exists e[agent(e, b) \wedge stab(e, c)]$

Event Semantics: Advantages

Capturing diamond entailments, classical Davidsonian style:

Example

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

(2) Brutus stabbed Caesar on the forum.
$\exists e[stabbing(e, brutus, caesar) \wedge loc(e) = forum]$

(3) Brutus stabbed Caesar at noon.
$\exists e[stabbing(e, brutus, caesar) \wedge time(e) = noon]$

(4) Brutus stabbed Caesar.
$\exists e[stabbing(e, brutus, caesar)$

Event Semantics: Advantages (cont.)

Capturing the same entailments, Neo-Davidsonian style:

Example

(1) Brutus stabbed Caesar on the forum at noon.

$\exists e[agent(e) = brutus \wedge stabbing(e) \wedge theme(e) = caesar \wedge loc(e) = forum \wedge time(e) = noon]$

(2) Brutus stabbed Caesar on the forum.

$\exists e[agent(e) = brutus \wedge stabbing(e) \wedge theme(e) = caesar \wedge loc(e) = forum]$

(3) Brutus stabbed Caesar at noon.

$\exists e[agent(e) = brutus \wedge stabbing(e) \wedge theme(e) = caesar \wedge time(e) = noon]$

(4) Brutus stabbed Caesar.

$\exists e[agent(e) = brutus \wedge stabbing(e) \wedge theme(e) = caesar]$

Event Semantics: Advantages of the Neo-Davidsonian approach

- 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

Example

a. $[\![[agent]]\!] = \lambda x \lambda e[agent(e) = x]$
b. $[\![[theme]]\!] = \lambda y \lambda e[agent(e) = y]$
c. $[\![stab]\!] = \lambda e[stab(e)]$
d. $[\![[agent]Brutus]\!] = \lambda e[agent(e) = brutus]$
e. $[\![[theme]Caesar]\!] = \lambda e[agent(e) = caesar]$
f. $[\![$ Brutus stab Caesar $]\!] = (c) \cap (d) \cap (e)$ *(sentence radical)*
g. $[\![$ Brutus stab Caesar $]\!] = \exists e \; e \in (c) \cap (d) \cap (e)$ *(full sentence)*

Event Semantics: Advantages (cont.)

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

Example

Jones did it slowly, deliberately, in the bathroom, with a knife, at midnight. What he did was butter a piece of toast. (Davidson, 1967)

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

Example

John saw Mary leave.

Semantic relations between gerunds and verbs (Parsons, 1990)

Example

They sang the song.
The singing of the song

Event Semantics: Advantages (cont.)

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

Example

Marry felled the tree.
The tree fell.

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

Example

a. three litres of water
b. three hours of running
c. run for three hours

and many more

Event Semantics: Composition

Predicates

stab $\rightsquigarrow \lambda e.Stab(e)$
butter $\rightsquigarrow \lambda e.Butter(e)$

Event Semantics: Composition

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Syntax

DP $\rightarrow \theta$ DP

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Lexicon

θ: [agent], [theme], [instrument], [recipient], [goal], [location], [time], ...

Event Semantics: Composition

Predicates

stab $\rightsquigarrow \lambda e.Stab(e)$
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Syntax

DP $\rightarrow \theta$ DP

Lexicon

θ: [agent], [theme], [instrument], [recipient], [goal], [location], [time], ...

theta Mapping

[agent] $\rightsquigarrow \lambda x \lambda e.agent(e) = x$
[theme] $\rightsquigarrow \lambda x \lambda e.theme(e) = x$
[instrument] $\rightsquigarrow \lambda x \lambda e.instrument(e) = x$
...

Event Semantics: Composition (cont.)

We need to introduce an operation that existentially binds the event variable – *existintial closure* as a type-shifting rule

Type-Shifting Rule 5: Existential Closure

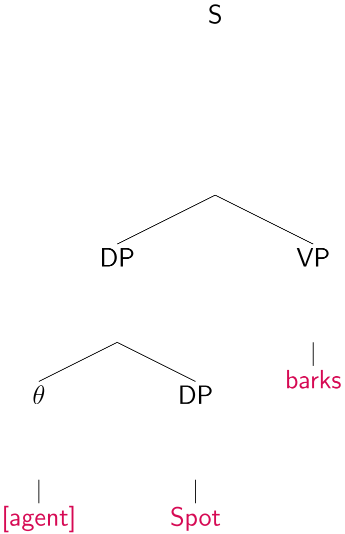
if $\alpha \rightsquigarrow \alpha'$, where α' is of a category $\langle v, t \rangle$, then:

$$\alpha \rightsquigarrow \exists e.\alpha'(e)$$

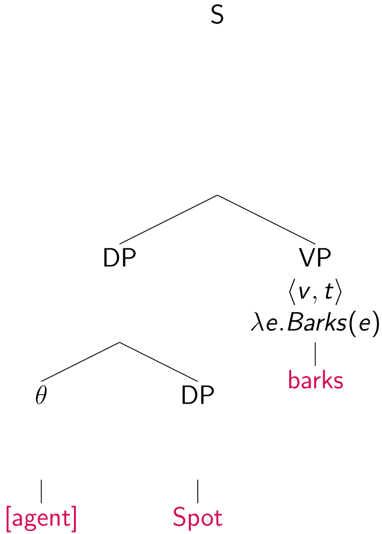
as well (as long as) e does not occur in α'; in that case, use a different variable of the same type

v stands for the type of event, so $\langle v, t \rangle$ is the type of an event predicate

Event Semantics: Composition (cont.)



Event Semantics: Composition (cont.)



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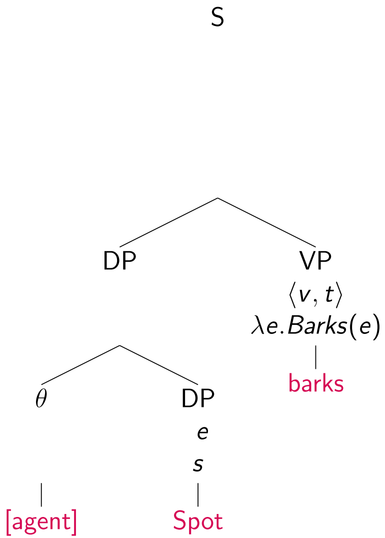

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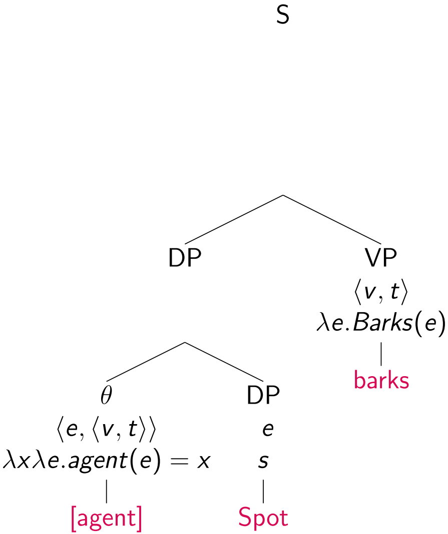

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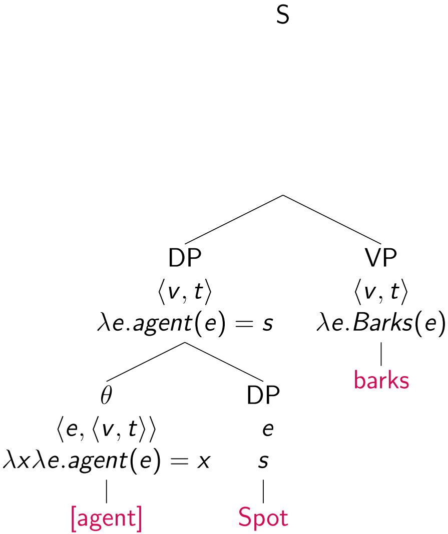


Event Semantics: Composition (cont.)

S

$\langle v, t\rangle$

$\lambda e.Bark(e) \wedge agent(e) = s$

DP

$\langle v, t\rangle$

$\lambda e.agent(e) = s$

θ

$\langle e, \langle v, t\rangle\rangle$

$\lambda x \lambda e.agent(e) = x$

[agent]

DP

e

s

Spot

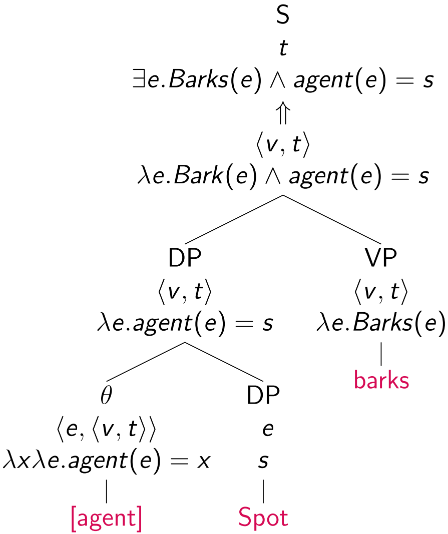
VP

$\langle v, t\rangle$

$\lambda e.Barks(e)$

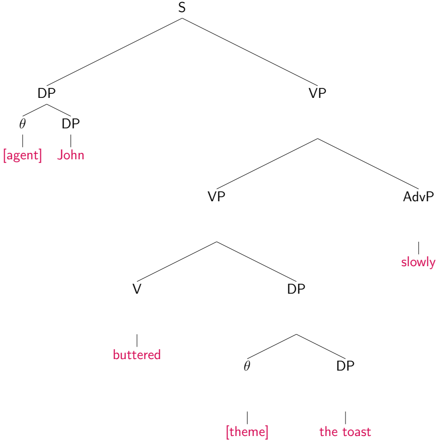
barks

Event Semantics: Composition (cont.)



Event Semantics: Composition with Adjunct

As event predicate: *slowly* $\rightsquigarrow \lambda e.Slow(e)$



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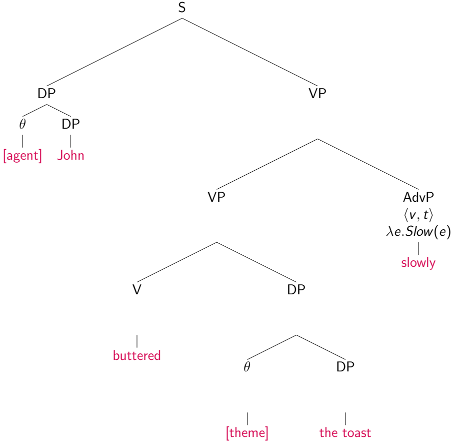

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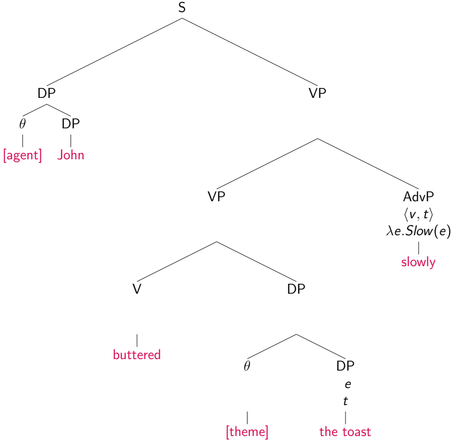

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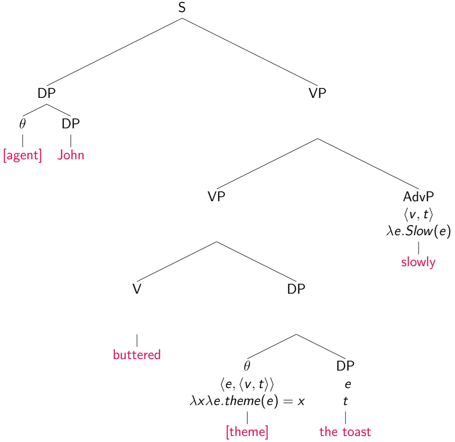

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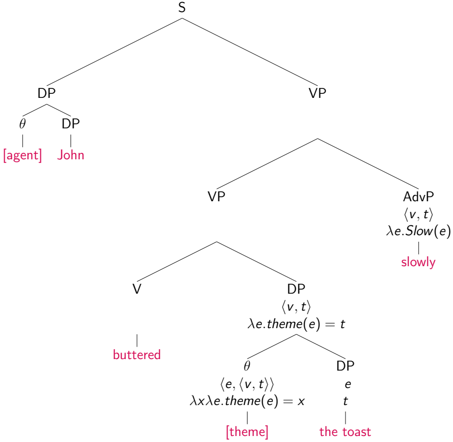

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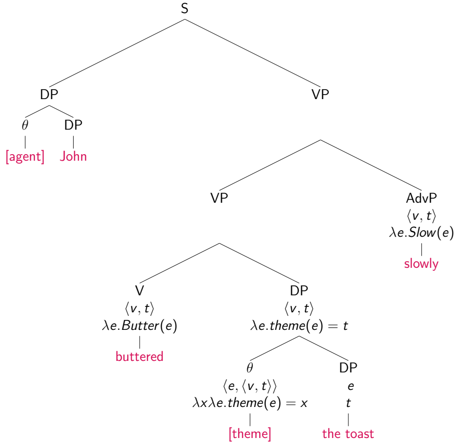

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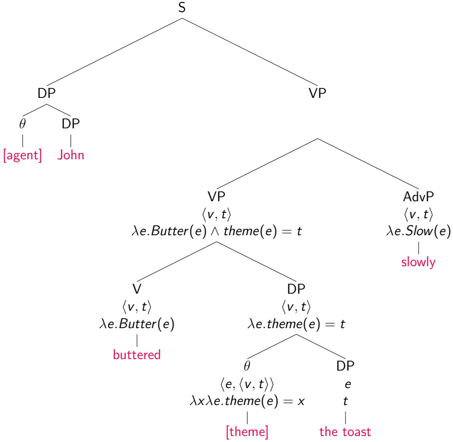

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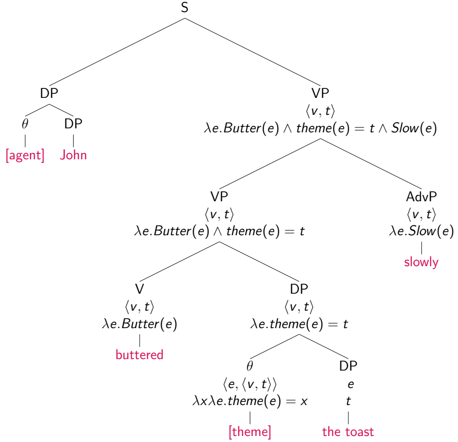
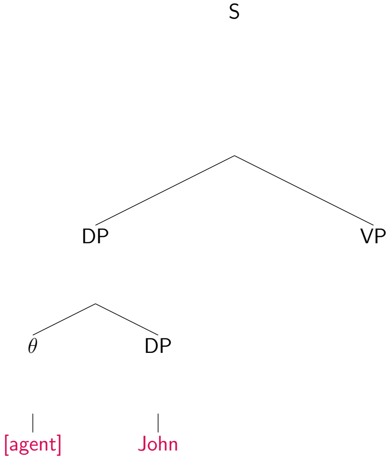
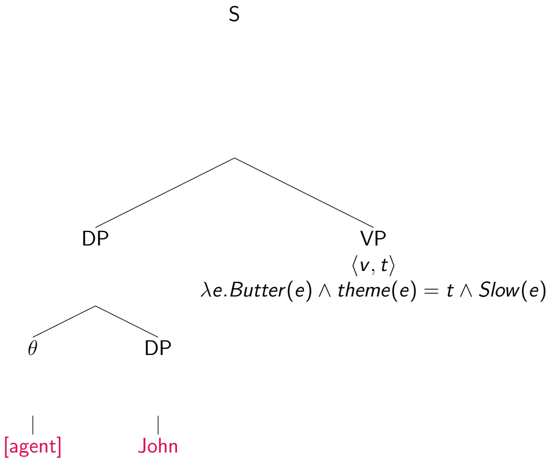
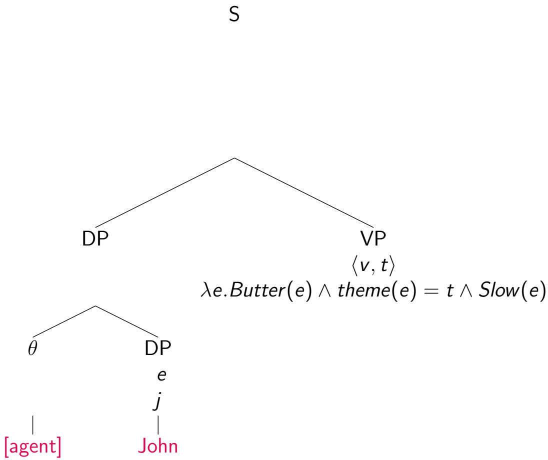


Event Semantics: Composition with Adjunct (cont.)

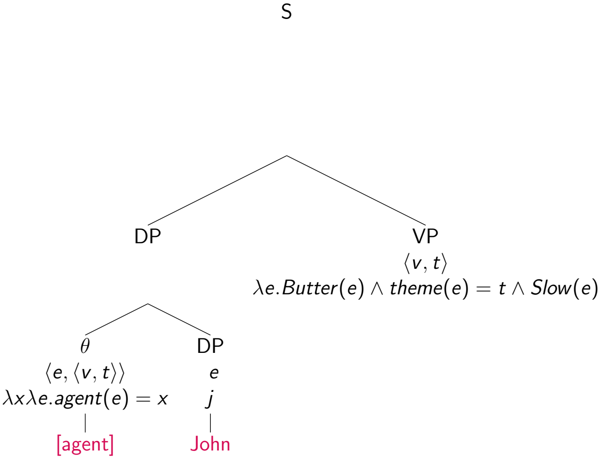


Event Semantics: Composition with Adjunct (cont.)




S
DP
VP
$\langle v, t \rangle$
$\lambda e.Butter(e) \wedge theme(e) = t \wedge Slow(e)$
θ
DP
e
j
[agent]
John

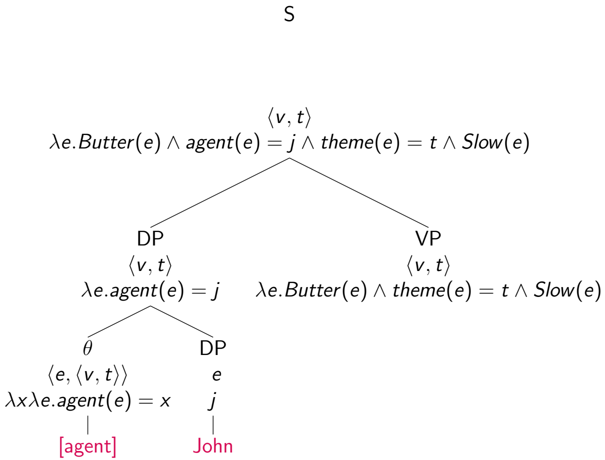
Event Semantics: Composition with Adjunct (cont.)



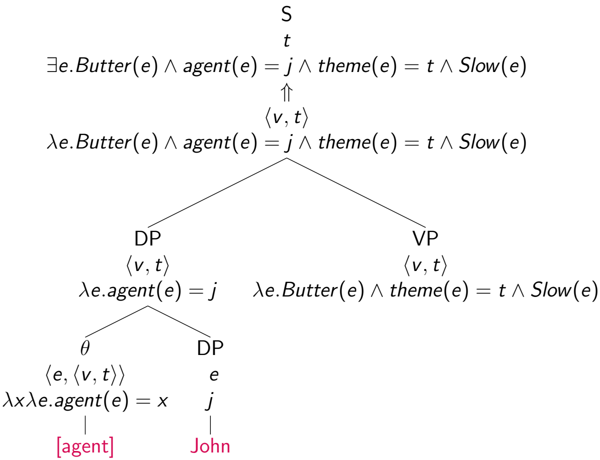
Event Semantics: Composition with Adjunct (cont.)

- S
  - DP, $\langle v, t \rangle$, $\lambda e.agent(e) = j$
    - θ, $\langle e, \langle v, t \rangle \rangle$, $\lambda x \lambda e.agent(e) = x$
      - [agent]
    - DP, e, j
      - John
  - VP, $\langle v, t \rangle$, $\lambda e.Butter(e) \land theme(e) = t \land Slow(e)$

Event Semantics: Composition with Adjunct (cont.)



Event Semantics: Composition with Adjunct (cont.)



Event Semantics: Quantification

Generalization: the event quantifier always takes lowest possible scope with respect to other quantifiers

Scope: example 1

No dog barks.
(a) $\neg\exists x[Dog(x) \wedge \exists e[Bark(e) \wedge agent(e, x)]]$
There is no barking event that is done by a dog
(b) $*\exists e\neg[Bark(e)\exists x[Dog(x) \wedge \wedge agent(e, x)]]$
There is an event that is not a barking by a dog

Scope: example 2

Every dog barks.
a. $\forall x[Dog(x) \rightarrow \exists e[Bark(e) \wedge agent(e) = x]]$
For every dog there is a barking event that it did
b. $*\exists e\forall x[Dog(x) \rightarrow [Bark(e) \wedge agent(e) = x]]$
There is a barking event that was done by every dog

Event Semantics: Quantification

a.

S

$\exists e \ldots Qx \ldots$

$\Uparrow$

$\lambda e \ldots Qx \ldots$

DP   VP

... Qx ... $\lambda e \ldots$

b.

S

$Qx \ldots \exists e \ldots$

$\Uparrow$

$\lambda f \ldots Qx \ldots \exists e \ldots$

DP   VP

... Qx ... $\lambda f \ldots \exists e \ldots$

Event Semantics: Verbs as Event Quantifiers

Verbs denote generalized quantifiers over events; introduce CONTINUATION VARIABLE (Barker & Shan, 2014)

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Verbs denote generalized quantifiers over events; introduce CONTINUATION VARIABLE (Barker & Shan, 2014)

New representation for Verbs $\langle\langle v, t\rangle, t\rangle$

$barks \rightsquigarrow \lambda f \exists e.Bark(e) \wedge f(e)$
$butter \rightsquigarrow \lambda f \exists e.Butter(e) \wedge f(e)$
...

Event Semantics: Verbs as Event Quantifiers

Verbs denote generalized quantifiers over events; introduce CONTINUATION VARIABLE (Barker & Shan, 2014)

New representation for Verbs $\langle\langle v, t\rangle, t\rangle$

barks $\rightsquigarrow \lambda f \exists e.Bark(e) \wedge f(e)$
butter $\rightsquigarrow \lambda f \exists e.Butter(e) \wedge f(e)$
...

New representation for θ of $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$

[agent] $\rightsquigarrow \lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e)$
[theme] $\rightsquigarrow \lambda x \lambda V \lambda f.V(\lambda e.theme(e) = x \wedge f(e)$
...

Event Semantics: Verbs as Event Quantifiers (cont.)

a. $\lambda f \exists e.[Barks(e) \wedge agent(e) = s \wedge f(e)](\lambda e.true)$

Event Semantics: Verbs as Event Quantifiers (cont.)

a. $\lambda f \exists e.[Barks(e) \wedge agent(e) = s \wedge f(e)](\lambda e.true)$
b. $\exists e.[Barks(e) \wedge agent(e) = s \wedge (\lambda e.true)(e)]$

Event Semantics: Verbs as Event Quantifiers (cont.)

a. $\lambda f \exists e.[Barks(e) \wedge agent(e) = s \wedge f(e)](\lambda e.true)$
b. $\exists e.[Barks(e) \wedge agent(e) = s \wedge (\lambda e.true)(e)]$
c. $\exists e.[Barks(e) \wedge agent(e) = s \wedge true]$

Event Semantics: Verbs as Event Quantifiers (cont.)

a. $\lambda f \exists e.[Barks(e) \wedge agent(e) = s \wedge f(e)](\lambda e.true)$
b. $\exists e.[Barks(e) \wedge agent(e) = s \wedge (\lambda e.true)(e)]$
c. $\exists e.[Barks(e) \wedge agent(e) = s \wedge true]$
d. $\exists e.[Barks(e) \wedge agent(e) = s]$

Event Semantics: Verbs as Event Quantifiers (cont.)

a. $\lambda f \exists e.[Barks(e) \wedge agent(e) = s \wedge f(e)](\lambda e.true)$
b. $\exists e.[Barks(e) \wedge agent(e) = s \wedge (\lambda e.true)(e)]$
c. $\exists e.[Barks(e) \wedge agent(e) = s \wedge true]$
d. $\exists e.[Barks(e) \wedge agent(e) = s]$

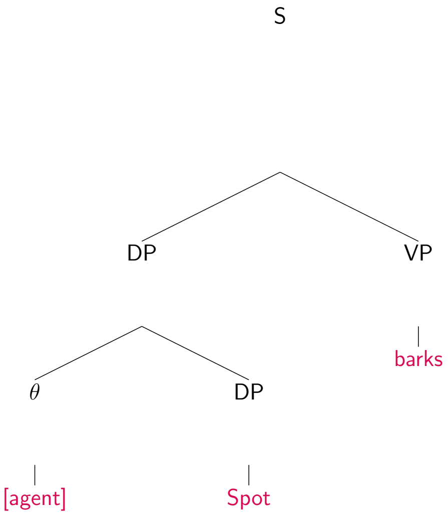
Type-Shifting Rule 6: Quantifier Closure

if $\alpha \rightsquigarrow \alpha'$, where α' is of a category $\langle\langle v, t\rangle, t\rangle$, then:

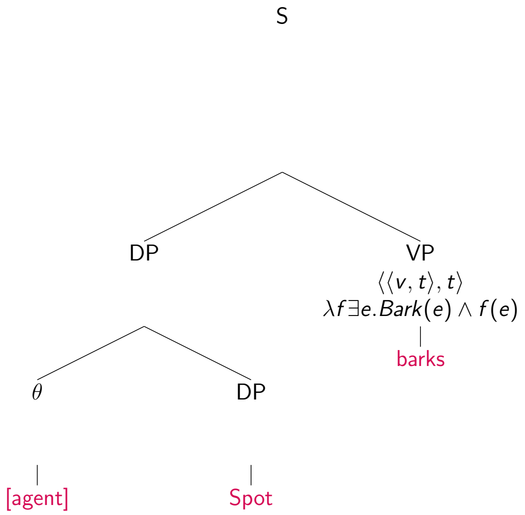
$$\alpha \rightsquigarrow \alpha'(\lambda e, true)$$

as well.

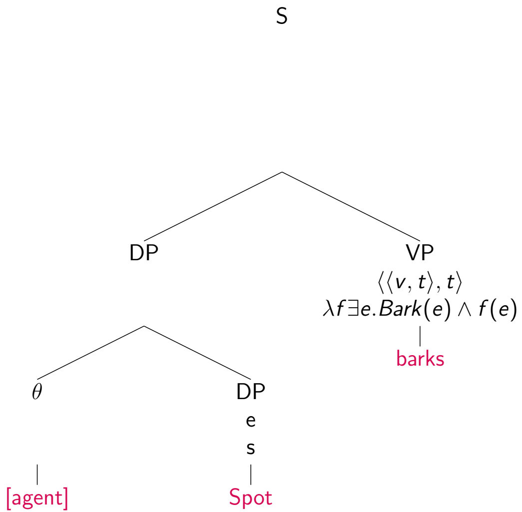
Event Semantics: Verbs as Event Quantifiers (cont.)



Event Semantics: Verbs as Event Quantifiers (cont.)



Event Semantics: Verbs as Event Quantifiers (cont.)



Event Semantics: Verbs as Event Quantifiers (cont.)

S

- DP
  - θ
    $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
    $\lambda x \lambda V \lambda f. V(\lambda e. agent(e) = x \wedge f(e)$
    - [agent]
  - DP
    e
    s
    - Spot
- VP
  $\langle\langle v, t\rangle, t\rangle$
  $\lambda f \exists e. Bark(e) \wedge f(e)$
  - barks

Event Semantics: Verbs as Event Quantifiers (cont.)

- S
  - DP
    $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$
    $\lambda V \lambda f.V(\lambda e.agent(e) = s \wedge f(e)$
    - θ
      $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e)$
      - [agent]
    - DP
      e
      s
      - Spot
  - VP
    $\langle\langle v,t\rangle,t\rangle$
    $\lambda f \exists e.Bark(e) \wedge f(e)$
    - barks

Event Semantics: Verbs as Event Quantifiers (cont.)

S

$\langle\langle v, t\rangle, t\rangle$

$\lambda f \exists e.Barks(e) \wedge agent(e) = s \wedge f(e)$

- DP
  $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
  $\lambda V \lambda f.V(\lambda e.agent(e) = s \wedge f(e)$
  - θ
    $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
    $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e)$
    - [agent]
  - DP
    e
    s
    - Spot
- VP
  $\langle\langle v, t\rangle, t\rangle$
  $\lambda f \exists e.Bark(e) \wedge f(e)$
  - barks

Event Semantics: Verbs as Event Quantifiers (cont.)

S

$\Uparrow$

$\langle\langle v, t\rangle, t\rangle$

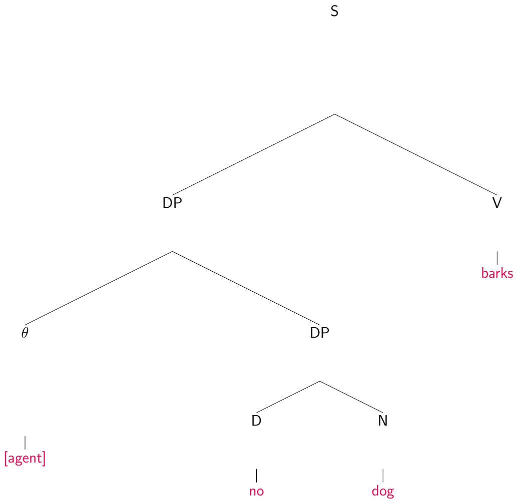
$\lambda f \exists e.Barks(e) \wedge agent(e) = s \wedge f(e)$

- DP
  $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
  $\lambda V \lambda f.V(\lambda e.agent(e) = s \wedge f(e)$
  - θ
    $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
    $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e)$
    - [agent]
  - DP
    e
    s
    - Spot
- VP
  $\langle\langle v, t\rangle, t\rangle$
  $\lambda f \exists e.Bark(e) \wedge f(e)$
  - barks

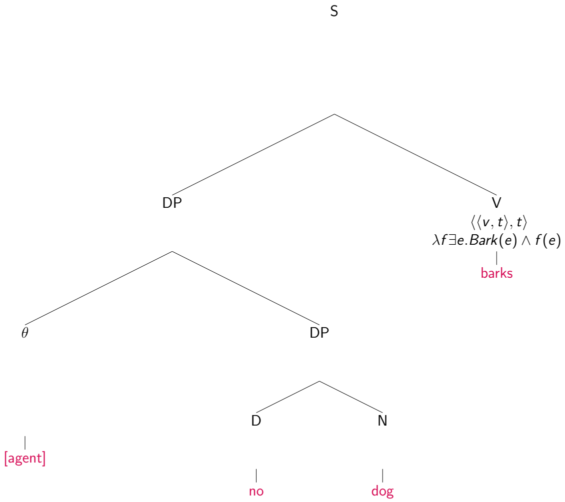
Event Semantics: Verbs as Event Quantifiers (cont.)

- S
  t
  $\exists e.Barks(e) \wedge agent(e) = s$
  $\Uparrow$
  $\langle\langle v, t\rangle, t\rangle$
  $\lambda f \exists e.Barks(e) \wedge agent(e) = s \wedge f(e)$
  - DP
    $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
    $\lambda V \lambda f.V(\lambda e.agent(e) = s \wedge f(e)$
    - θ
      $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
      $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e)$
      - [agent]
    - DP
      e
      s
      - Spot
  - VP
    $\langle\langle v, t\rangle, t\rangle$
    $\lambda f \exists e.Bark(e) \wedge f(e)$
    - barks

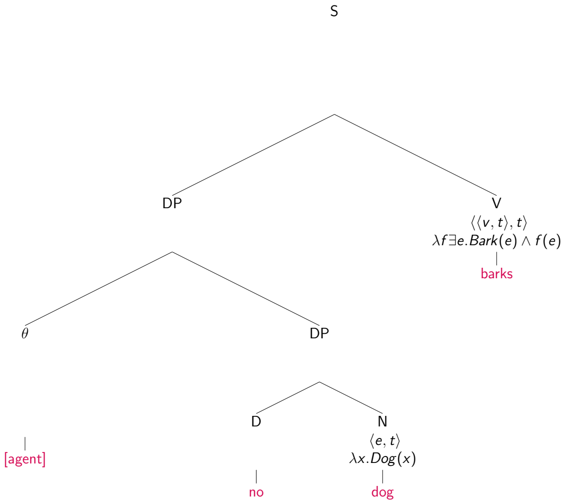
Event Semantics: Quantificational Noun Phrase



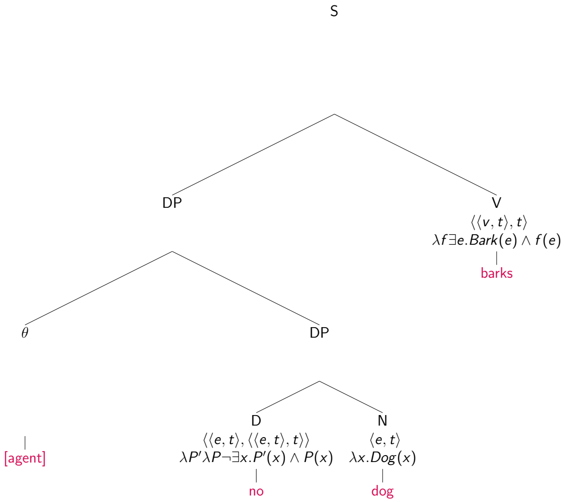
Event Semantics: Quantificational Noun Phrase



Event Semantics: Quantificational Noun Phrase



Event Semantics: Quantificational Noun Phrase



Event Semantics: Quantificational Noun Phrase

S

DP

θ

[agent]

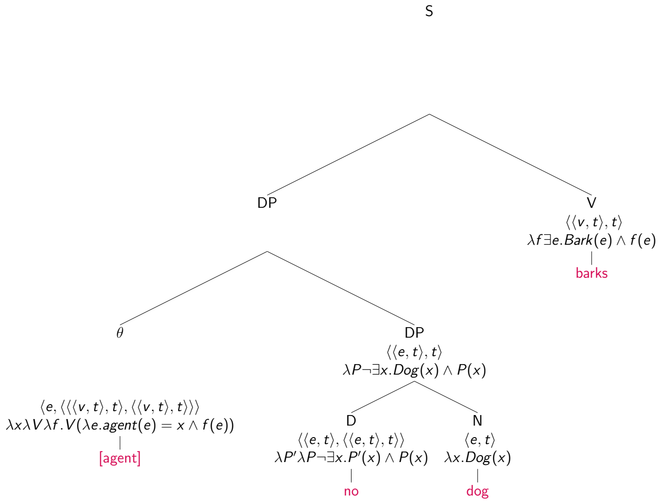
DP
$\langle\langle e,t\rangle,t\rangle$
$\lambda P \neg\exists x.Dog(x) \wedge P(x)$

D
$\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$
$\lambda P' \lambda P \neg\exists x.P'(x) \wedge P(x)$
no

N
$\langle e,t\rangle$
$\lambda x.Dog(x)$
dog

V
$\langle\langle v,t\rangle,t\rangle$
$\lambda f \exists e.Bark(e) \wedge f(e)$
barks

Event Semantics: Quantificational Noun Phrase



Event Semantics: Quantificational Noun Phrase

- S
  - DP
    - θ $\Uparrow$ $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$ $\lambda x \lambda V \lambda f. V(\lambda e. agent(e) = x \wedge f(e))$
      - [agent]
    - DP $\langle\langle e, t\rangle, t\rangle$ $\lambda P \neg\exists x. Dog(x) \wedge P(x)$
      - D $\langle\langle e, t\rangle, \langle\langle e, t\rangle, t\rangle\rangle$ $\lambda P' \lambda P \neg\exists x. P'(x) \wedge P(x)$
        - no
      - N $\langle e, t\rangle$ $\lambda x. Dog(x)$
        - dog
  - V $\langle\langle v, t\rangle, t\rangle$ $\lambda f \exists e. Bark(e) \wedge f(e)$
    - barks

Event Semantics: Quantificational Noun Phrase

- S
  - DP
    - θ
      $\langle\langle\langle e,t\rangle,t\rangle,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      $\lambda Q \lambda V \lambda f.Q(\lambda x.V(\lambda e.agent(e) = x \wedge f(e)))$
      $\Uparrow$
      $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
      - [agent]
    - DP
      $\langle\langle e,t\rangle,t\rangle$
      $\lambda P \neg\exists x.Dog(x) \wedge P(x)$
      - D
        $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$
        $\lambda P' \lambda P \neg\exists x.P'(x) \wedge P(x)$
        - no
      - N
        $\langle e,t\rangle$
        $\lambda x.Dog(x)$
        - dog
  - V
    $\langle\langle v,t\rangle,t\rangle$
    $\lambda f \exists e.Bark(e) \wedge f(e)$
    - barks

Event Semantics: Quantificational Noun Phrase

- S
  - DP
    $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$
    $\lambda V \lambda f \neg\exists x.Dog(x) \wedge V(\lambda e.agent(e) = x \wedge f(e))$
    - θ
      $\langle\langle\langle e,t\rangle,t\rangle,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      $\lambda Q \lambda V \lambda f.Q(\lambda x.V(\lambda e.agent(e) = x \wedge f(e)))$
      $\Uparrow$
      $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
      - [agent]
    - DP
      $\langle\langle e,t\rangle,t\rangle$
      $\lambda P \neg\exists x.Dog(x) \wedge P(x)$
      - D
        $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$
        $\lambda P' \lambda P \neg\exists x.P'(x) \wedge P(x)$
        - no
      - N
        $\langle e,t\rangle$
        $\lambda x.Dog(x)$
        - dog
  - V
    $\langle\langle v,t\rangle,t\rangle$
    $\lambda f \exists e.Bark(e) \wedge f(e)$
    - barks

Event Semantics: Quantificational Noun Phrase

S

$\langle\langle v,t\rangle,t\rangle$

$\lambda f \neg\exists x.Dog(x) \wedge \exists e.Bark(e) \wedge agent(e) = x \wedge f(e)$

DP

$\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$

$\lambda V \lambda f \neg\exists x.Dog(x) \wedge V(\lambda e.agent(e) = x \wedge f(e))$

V

$\langle\langle v,t\rangle,t\rangle$

$\lambda f \exists e.Bark(e) \wedge f(e)$

barks

θ

$\langle\langle\langle e,t\rangle,t\rangle,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$

$\lambda Q \lambda V \lambda f.Q(\lambda x.V(\lambda e.agent(e) = x \wedge f(e)))$

$\Uparrow$

$\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$

$\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$

[agent]

DP

$\langle\langle e,t\rangle,t\rangle$

$\lambda P \neg\exists x.Dog(x) \wedge P(x)$

D

$\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$

$\lambda P' \lambda P \neg\exists x.P'(x) \wedge P(x)$

no

N

$\langle e,t\rangle$

$\lambda x.Dog(x)$

dog

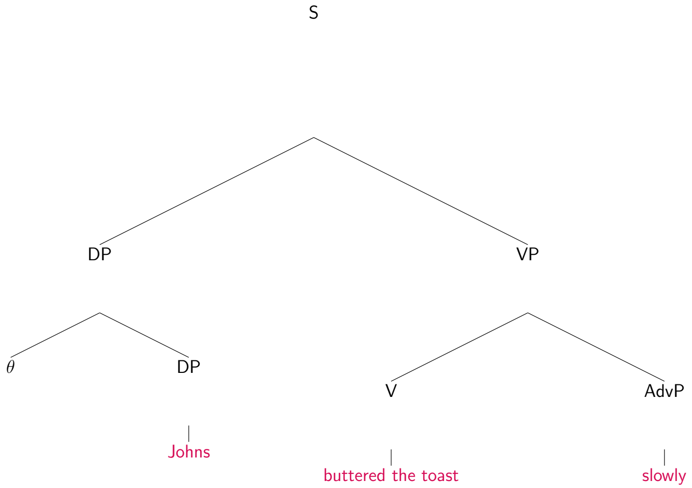
Event Semantics: Quantificational Noun Phrase

- S
  - $\Uparrow$
  - $\langle\langle v,t\rangle,t\rangle$
  - $\lambda f \neg\exists x.Dog(x) \wedge \exists e.Bark(e) \wedge agent(e) = x \wedge f(e)$
  - DP
    - $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$
    - $\lambda V \lambda f \neg\exists x.Dog(x) \wedge V(\lambda e.agent(e) = x \wedge f(e))$
    - θ
      - $\langle\langle\langle e,t\rangle,t\rangle,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      - $\lambda Q \lambda V \lambda f.Q(\lambda x.V(\lambda e.agent(e) = x \wedge f(e)))$
      - $\Uparrow$
      - $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
      - $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
      - [agent]
    - DP
      - $\langle\langle e,t\rangle,t\rangle$
      - $\lambda P \neg\exists x.Dog(x) \wedge P(x)$
      - D
        - $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$
        - $\lambda P' \lambda P \neg\exists x.P'(x) \wedge P(x)$
        - no
      - N
        - $\langle e,t\rangle$
        - $\lambda x.Dog(x)$
        - dog
  - V
    - $\langle\langle v,t\rangle,t\rangle$
    - $\lambda f \exists e.Bark(e) \wedge f(e)$
    - barks

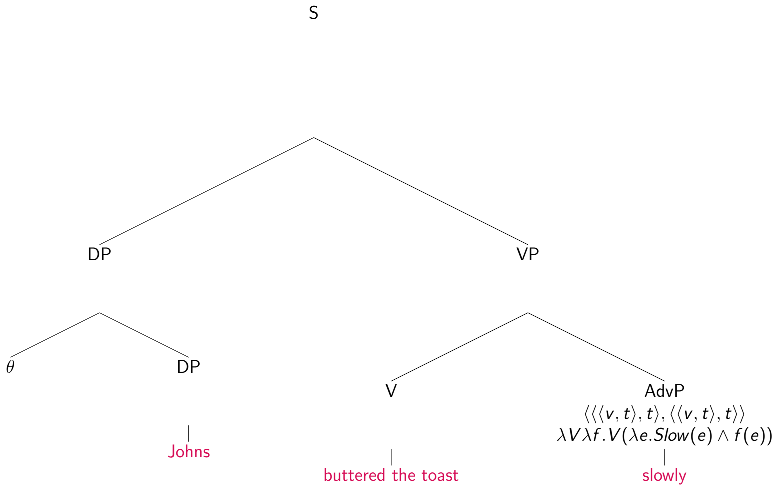
Event Semantics: Quantificational Noun Phrase

- S
  t
  $\neg\exists x.Dog(x) \wedge \exists e.Bark(e) \wedge agent(e) = x$
  $\Uparrow$
  $\langle\langle v, t\rangle, t\rangle$
  $\lambda f \neg\exists x.Dog(x) \wedge \exists e.Bark(e) \wedge agent(e) = x \wedge f(e)$
  - DP
    $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
    $\lambda V \lambda f \neg\exists x.Dog(x) \wedge V(\lambda e.agent(e) = x \wedge f(e))$
    - θ
      $\langle\langle\langle e, t\rangle, t\rangle, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
      $\lambda Q \lambda V \lambda f.Q(\lambda x.V(\lambda e.agent(e) = x \wedge f(e)))$
      $\Uparrow$
      $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
      $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
      - [agent]
    - DP
      $\langle\langle e, t\rangle, t\rangle$
      $\lambda P \neg\exists x.Dog(x) \wedge P(x)$
      - D
        $\langle\langle e, t\rangle, \langle\langle e, t\rangle, t\rangle\rangle$
        $\lambda P' \lambda P \neg\exists x.P'(x) \wedge P(x)$
        - no
      - N
        $\langle e, t\rangle$
        $\lambda x.Dog(x)$
        - dog
  - V
    $\langle\langle v, t\rangle, t\rangle$
    $\lambda f \exists e.Bark(e) \wedge f(e)$
    - barks

Event Semantics: Quantificational Adjuncts



Event Semantics: Quantificational Adjuncts



Event Semantics: Quantificational Adjuncts

S

DP — θ, DP (Johns)

VP — V, AdvP

V: $\langle\langle v, t\rangle, t\rangle$

$\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$

buttered the toast

AdvP: $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$

$\lambda V \lambda f.V(\lambda e.Slow(e) \wedge f(e))$

slowly

Event Semantics: Quantificational Adjuncts

- S
  - DP
    - θ
    - DP
      - Johns
  - VP
    $\langle\langle v, t\rangle, t\rangle$
    $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge Slow(e) \wedge f(e)$
    - V
      $\langle\langle v, t\rangle, t\rangle$
      $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$
      - buttered the toast
    - AdvP
      $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
      $\lambda V \lambda f.V(\lambda e.Slow(e) \wedge f(e))$
      - slowly

Event Semantics: Quantificational Adjuncts

S

DP

θ

DP
e
j
Johns

VP
$\langle\langle v, t\rangle, t\rangle$
$\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge Slow(e) \wedge f(e)$

V
$\langle\langle v, t\rangle, t\rangle$
$\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$
buttered the toast

AdvP
$\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
$\lambda V \lambda f.V(\lambda e.Slow(e) \wedge f(e))$
slowly

Event Semantics: Quantificational Adjuncts

S

DP

θ
$\langle e, \langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$
$\lambda x \lambda V \lambda f. V(\lambda e.agent(e) = x \wedge f(e))$

DP
e
j
Johns

VP
$\langle\langle v,t\rangle,t\rangle$
$\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge Slow(e) \wedge f(e)$

V
$\langle\langle v,t\rangle,t\rangle$
$\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$
buttered the toast

AdvP
$\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$
$\lambda V \lambda f. V(\lambda e.Slow(e) \wedge f(e))$
slowly

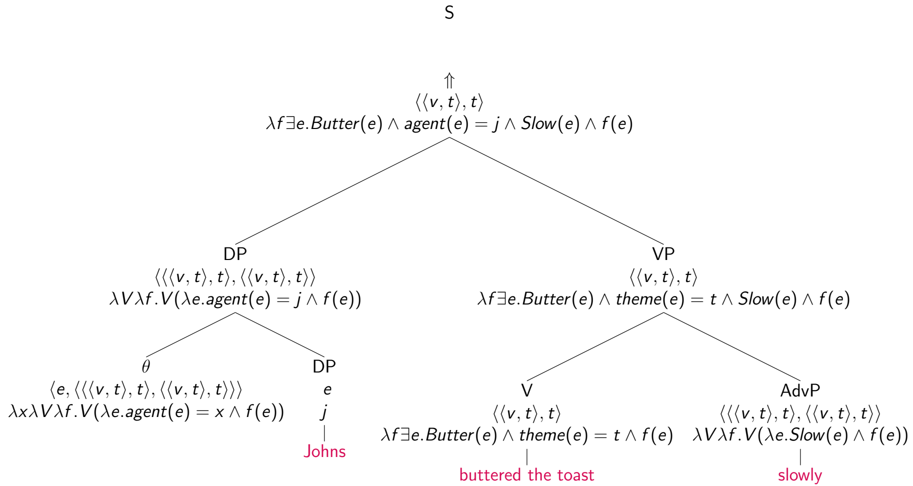
Event Semantics: Quantificational Adjuncts

- S
  - DP: $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$, $\lambda V \lambda f.V(\lambda e.agent(e) = j \wedge f(e))$
    - θ: $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$, $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
    - DP: e, j
      - Johns
  - VP: $\langle\langle v,t\rangle,t\rangle$, $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge Slow(e) \wedge f(e)$
    - V: $\langle\langle v,t\rangle,t\rangle$, $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$
      - buttered the toast
    - AdvP: $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$, $\lambda V \lambda f.V(\lambda e.Slow(e) \wedge f(e))$
      - slowly

Event Semantics: Quantificational Adjuncts

- S: $\langle\langle v,t\rangle,t\rangle$ — $\lambda f \exists e.Butter(e) \wedge agent(e) = j \wedge Slow(e) \wedge f(e)$
  - DP: $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$ — $\lambda V \lambda f.V(\lambda e.agent(e) = j \wedge f(e))$
    - θ: $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$ — $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
    - DP: e — j
      - Johns
  - VP: $\langle\langle v,t\rangle,t\rangle$ — $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge Slow(e) \wedge f(e)$
    - V: $\langle\langle v,t\rangle,t\rangle$ — $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$
      - buttered the toast
    - AdvP: $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$ — $\lambda V \lambda f.V(\lambda e.Slow(e) \wedge f(e))$
      - slowly

Event Semantics: Quantificational Adjuncts



Event Semantics: Quantificational Adjuncts

- S
  t
  $\exists e.agent(e) = j \wedge Butter(e) \wedge theme(e) = t \wedge Slow(e)$
  $\Uparrow$
  $\langle\langle v, t\rangle, t\rangle$
  $\lambda f \exists e.Butter(e) \wedge agent(e) = j \wedge Slow(e) \wedge f(e)$
  - DP
    $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
    $\lambda V \lambda f.V(\lambda e.agent(e) = j \wedge f(e))$
    - θ
      $\langle e, \langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle\rangle$
      $\lambda x \lambda V \lambda f.V(\lambda e.agent(e) = x \wedge f(e))$
    - DP
      e
      j
      - Johns
  - VP
    $\langle\langle v, t\rangle, t\rangle$
    $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge Slow(e) \wedge f(e)$
    - V
      $\langle\langle v, t\rangle, t\rangle$
      $\lambda f \exists e.Butter(e) \wedge theme(e) = t \wedge f(e)$
      - buttered the toast
    - AdvP
      $\langle\langle\langle v, t\rangle, t\rangle, \langle\langle v, t\rangle, t\rangle\rangle$
      $\lambda V \lambda f.V(\lambda e.Slow(e) \wedge f(e))$
      - slowly

Event Semantics: Negation

Example

Spot didn't bark.

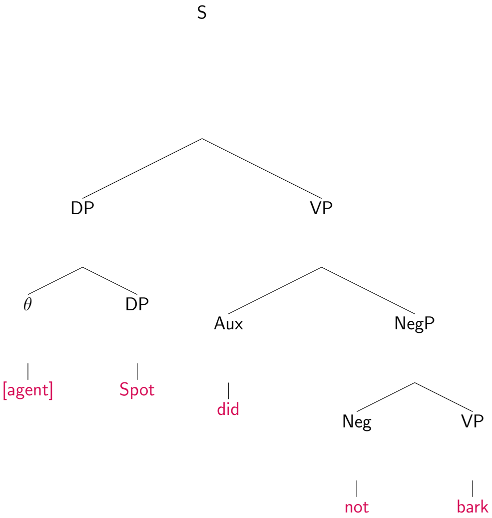
a. $\exists e.\neg[Bark(e) \wedge agent(e) = s]$

There is an event that is not a barking by Spot

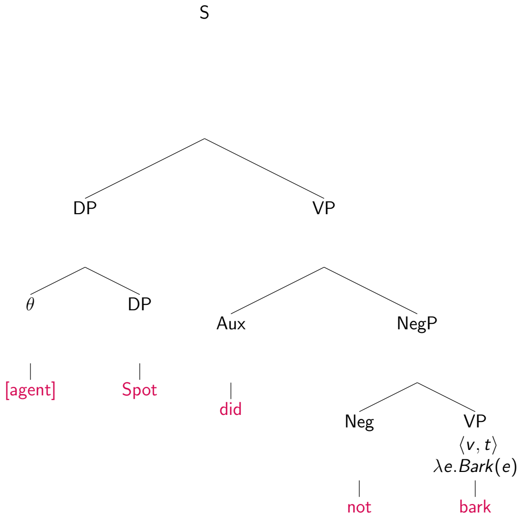
b. $\neg[\exists e.Bark(e) \wedge agent(e) = s]$

There is no barking event that is done by Spot

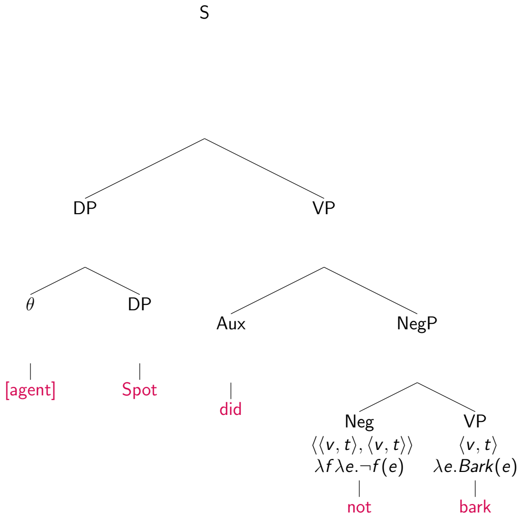
Event Semantics: Negation in (a) Reading



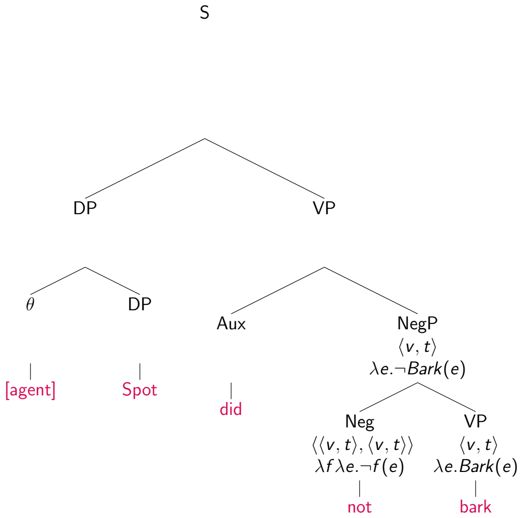
Event Semantics: Negation in (a) Reading



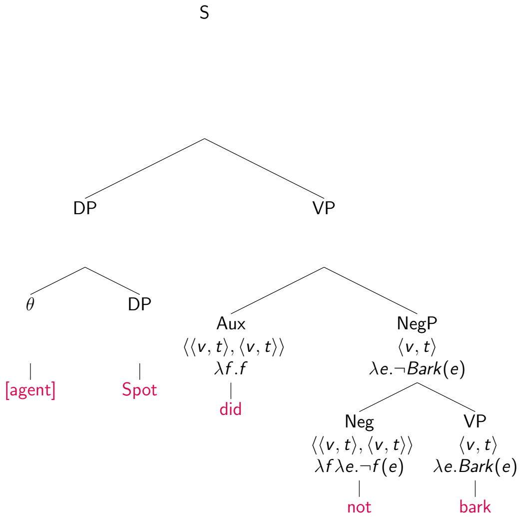
Event Semantics: Negation in (a) Reading



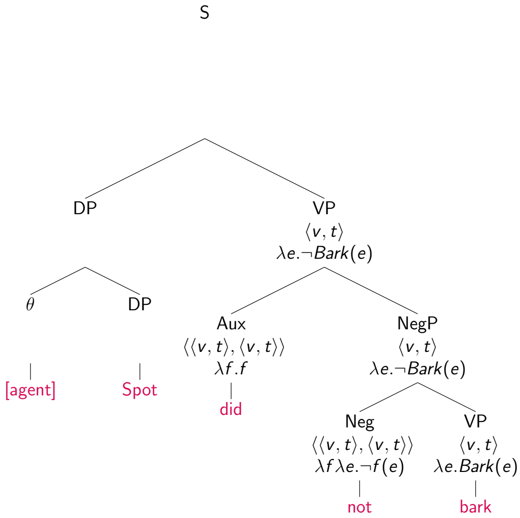
Event Semantics: Negation in (a) Reading



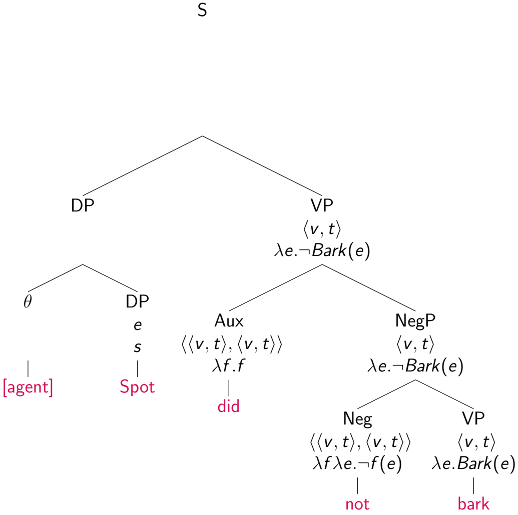
Event Semantics: Negation in (a) Reading



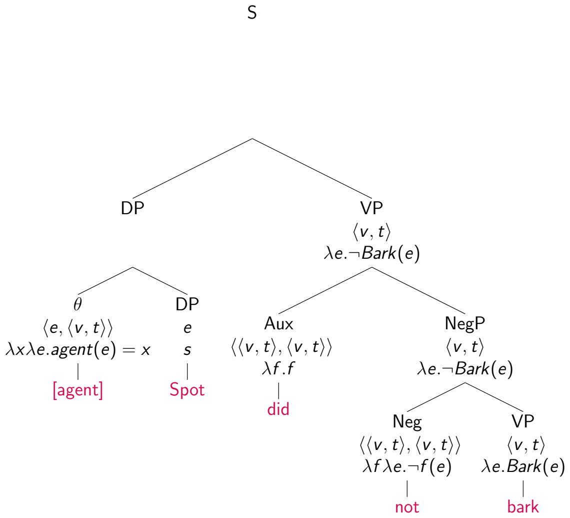
Event Semantics: Negation in (a) Reading



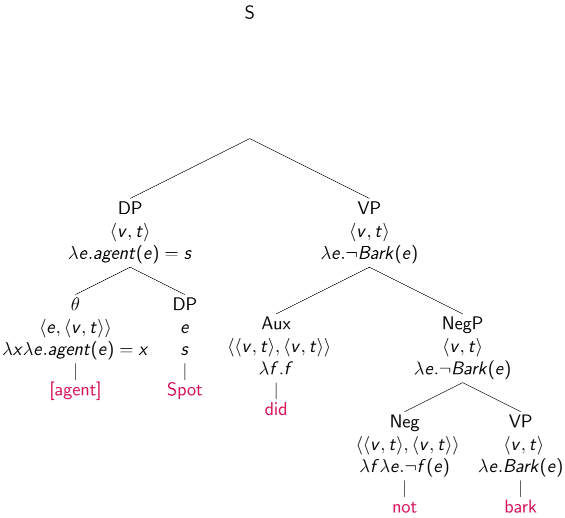
Event Semantics: Negation in (a) Reading



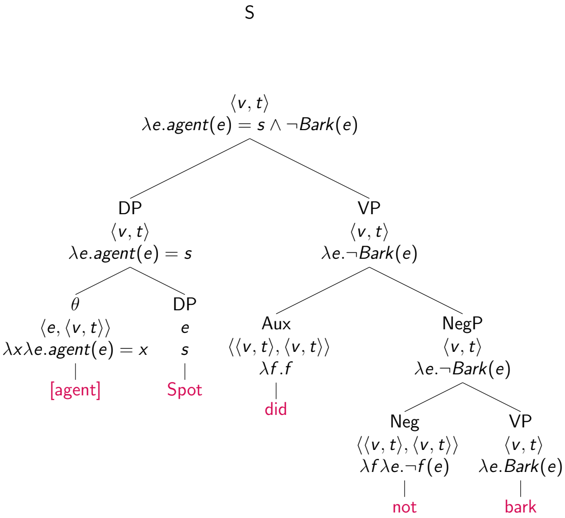
Event Semantics: Negation in (a) Reading



Event Semantics: Negation in (a) Reading



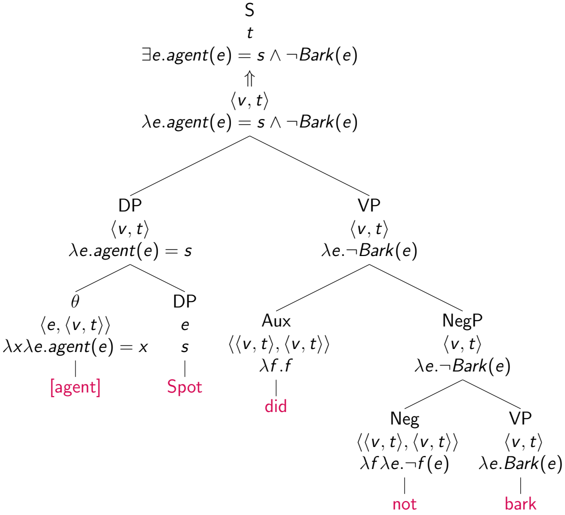
Event Semantics: Negation in (a) Reading



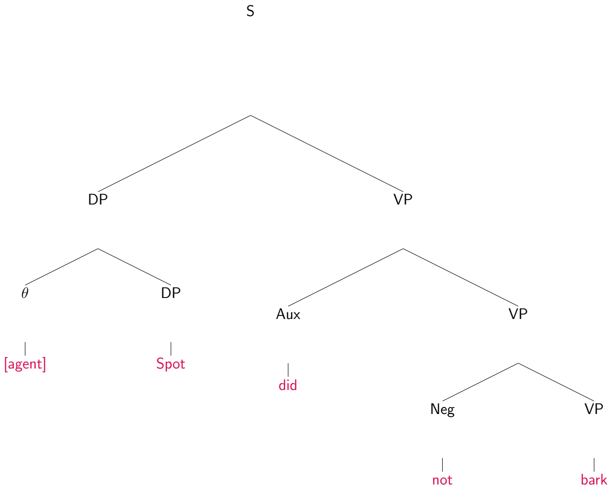
Event Semantics: Negation in (a) Reading

- S
  - $\Uparrow$
  - $\langle v, t \rangle$
  - $\lambda e.agent(e) = s \wedge \neg Bark(e)$
    - DP — $\langle v, t \rangle$ — $\lambda e.agent(e) = s$
      - θ — $\langle e, \langle v, t \rangle \rangle$ — $\lambda x \lambda e.agent(e) = x$
        - [agent]
      - DP — e — s
        - Spot
    - VP — $\langle v, t \rangle$ — $\lambda e.\neg Bark(e)$
      - Aux — $\langle \langle v, t \rangle, \langle v, t \rangle \rangle$ — $\lambda f.f$
        - did
      - NegP — $\langle v, t \rangle$ — $\lambda e.\neg Bark(e)$
        - Neg — $\langle \langle v, t \rangle, \langle v, t \rangle \rangle$ — $\lambda f \lambda e.\neg f(e)$
          - not
        - VP — $\langle v, t \rangle$ — $\lambda e.Bark(e)$
          - bark

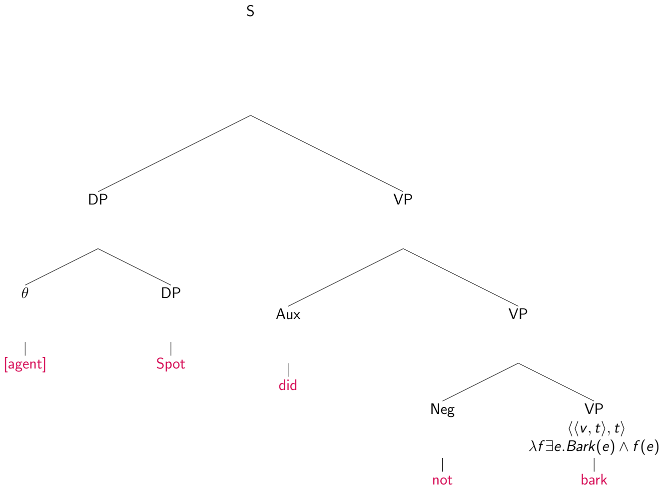
Event Semantics: Negation in (a) Reading



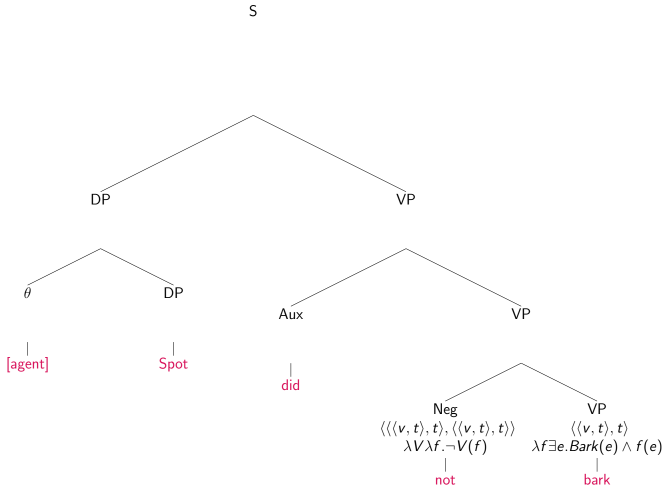
Event Semantics: Negation in (b) Reading



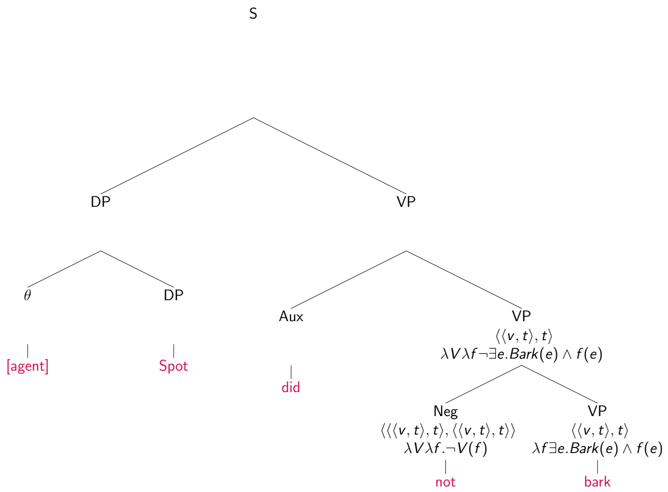
Event Semantics: Negation in (b) Reading



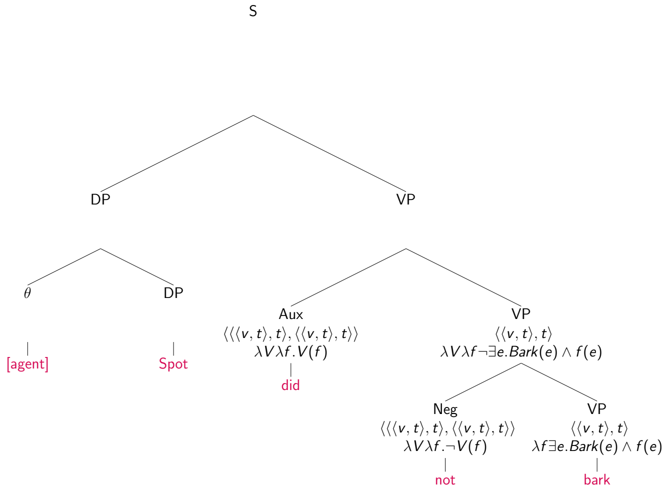
Event Semantics: Negation in (b) Reading



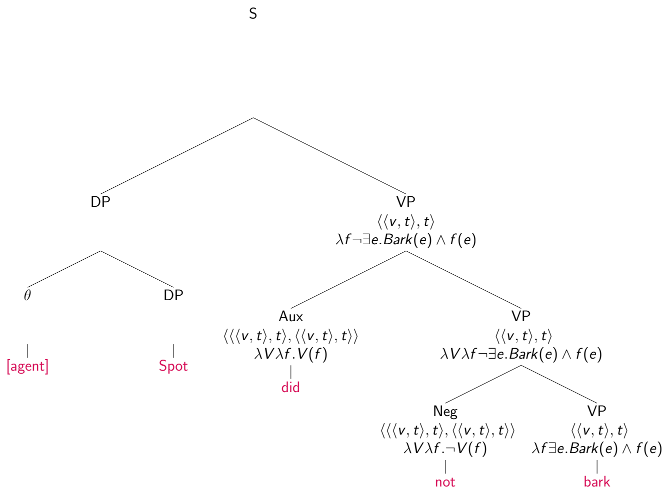
Event Semantics: Negation in (b) Reading



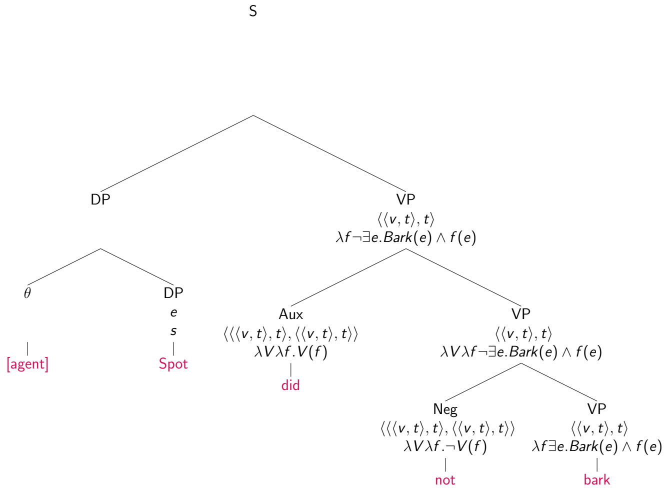
Event Semantics: Negation in (b) Reading



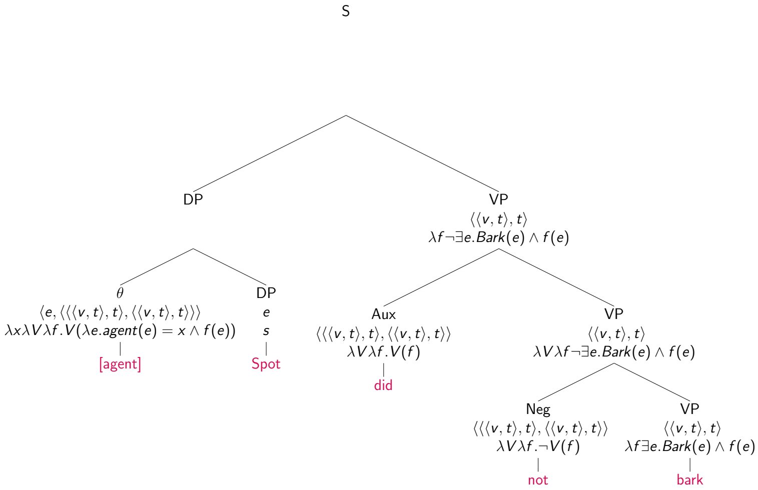
Event Semantics: Negation in (b) Reading



Event Semantics: Negation in (b) Reading



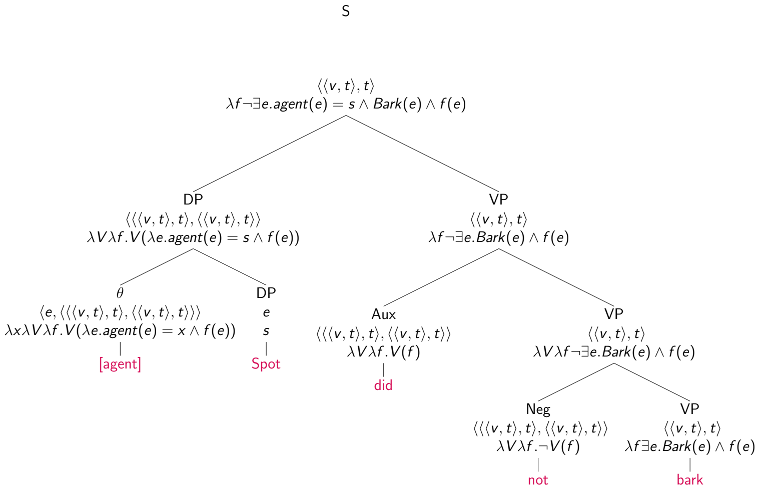
Event Semantics: Negation in (b) Reading



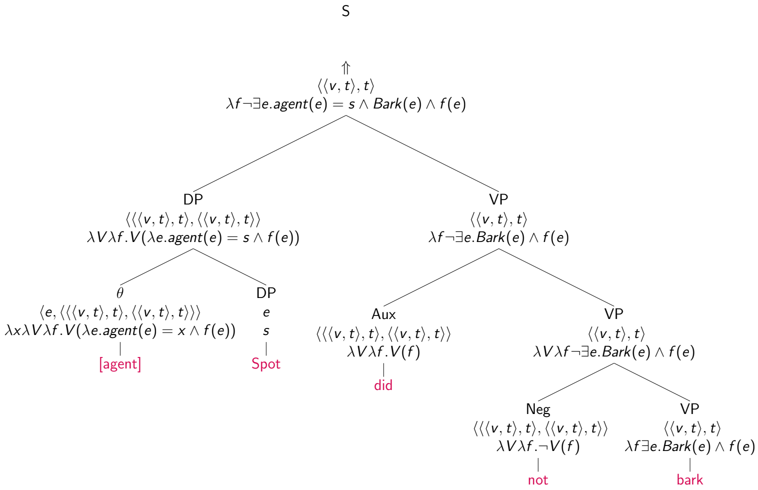
Event Semantics: Negation in (b) Reading

- S
  - DP $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$ $\lambda V\lambda f.V(\lambda e.agent(e)=s\wedge f(e))$
    - θ $\langle e,\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle\rangle$ $\lambda x\lambda V\lambda f.V(\lambda e.agent(e)=x\wedge f(e))$
      - [agent]
    - DP e s
      - Spot
  - VP $\langle\langle v,t\rangle,t\rangle$ $\lambda f\neg\exists e.Bark(e)\wedge f(e)$
    - Aux $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$ $\lambda V\lambda f.V(f)$
      - did
    - VP $\langle\langle v,t\rangle,t\rangle$ $\lambda V\lambda f\neg\exists e.Bark(e)\wedge f(e)$
      - Neg $\langle\langle\langle v,t\rangle,t\rangle,\langle\langle v,t\rangle,t\rangle\rangle$ $\lambda V\lambda f.\neg V(f)$
        - not
      - VP $\langle\langle v,t\rangle,t\rangle$ $\lambda f\exists e.Bark(e)\wedge f(e)$
        - bark

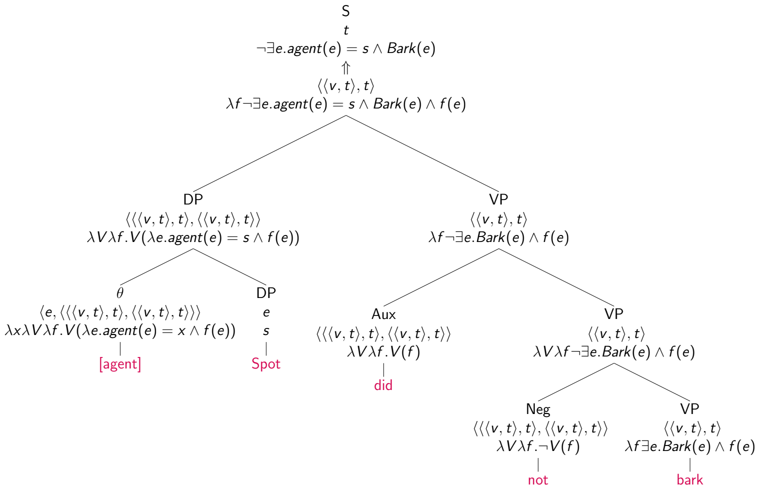
Event Semantics: Negation in (b) Reading



Event Semantics: Negation in (b) Reading



Event Semantics: Negation in (b) Reading



Quizz for Today

TBA