An embodied account of the syntactic domain of verbs

Alistair Knott

Department of Computer Science, University of Otago

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

The syntactic domain of verbs

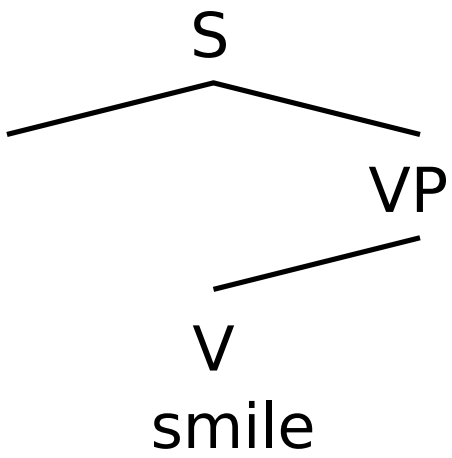
The main verb of a clause exerts influence over the whole clause.

It determines how many argument positions there are in the clause.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

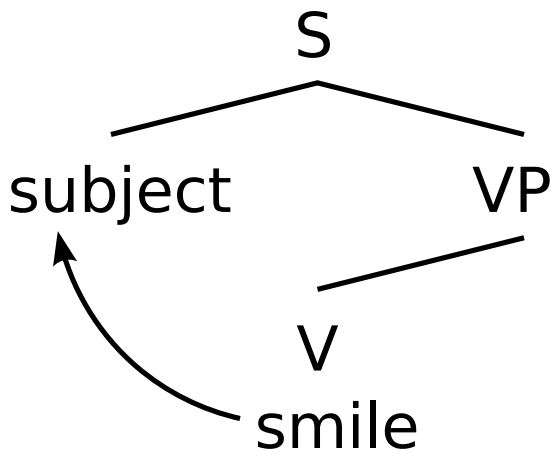
It determines how many argument positions there are in the clause.



The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

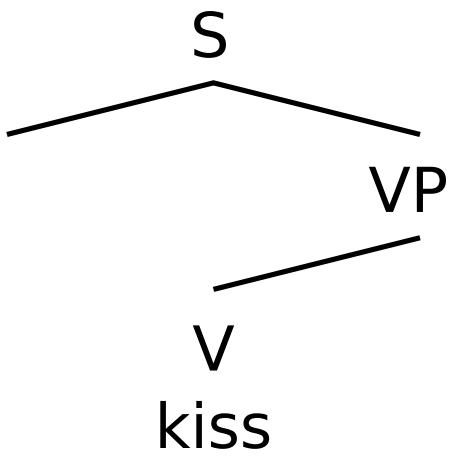
It determines how many argument positions there are in the clause.



The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

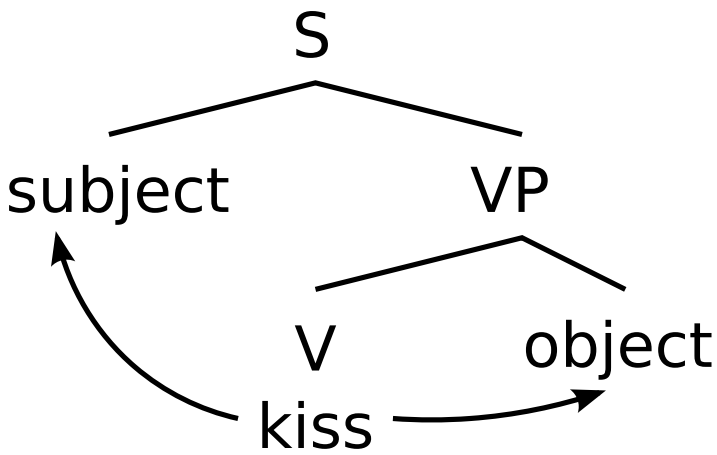
It determines how many argument positions there are in the clause.



The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

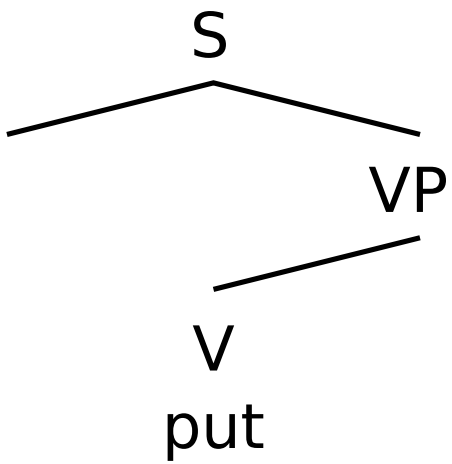
It determines how many argument positions there are in the clause.



The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

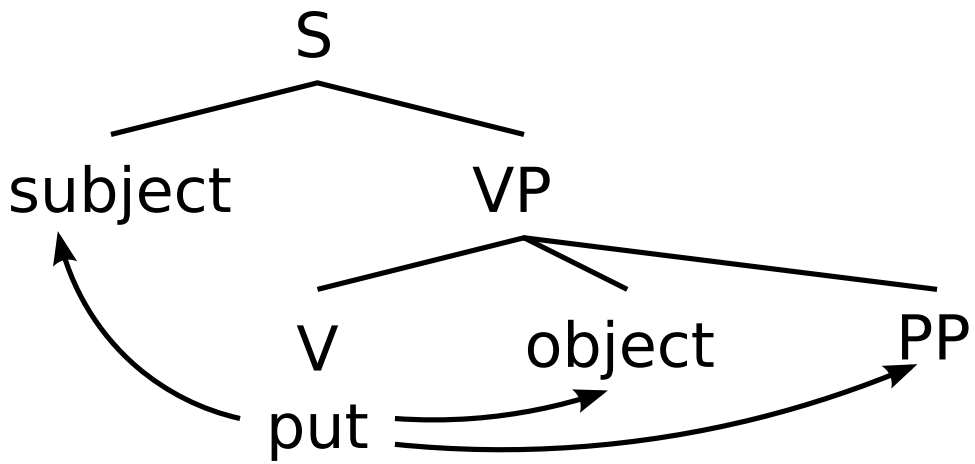
It determines how many argument positions there are in the clause.



The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It determines how many argument positions there are in the clause.



The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

In some languages, the *subject* must agree with the verb:

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

In some languages, the *subject* must agree with the verb:

John feeds[3/sing] the goats

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

In some languages, the *subject* must agree with the verb:

John[3/sing] feeds[3/sing] the goats

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

In some languages (e.g. Hindi), the *object* must agree with the verb.

John banana bought[masc/plur]

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

It can transmit its agreement features to its arguments.

In some languages (e.g. Hindi), the *object* must agree with the verb.

John banana[masc/plur] bought[masc/plur]

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

Verbs can appear at different positions within a clause.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

Verbs can appear at different positions within a clause.

They appear ‘high’ in VSO languages (e.g. Māori):

Chased	John	the dog

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

Verbs can appear at different positions within a clause.

The syntactic domain of verbs

The main verb of a clause exerts influence over the whole clause.

Verbs can appear at different positions within a clause.

They appear ‘low’ in SVO/SOV languages:

John		[chased	the dog]	(English)
John	it	[chased	]	(French)

Chomsky's account of the syntactic domain of verbs

Chomsky's account of the syntactic domain of verbs

Chomsky's Minimalist model:

Chomsky's account of the syntactic domain of verbs

Chomsky's Minimalist model:

1. Sentences have a phonetic form (PF), but also a logical form (LF).
   - The LF of a sentence represents its semantic structure.
   - LF is relatively invariant across languages.

Chomsky's account of the syntactic domain of verbs

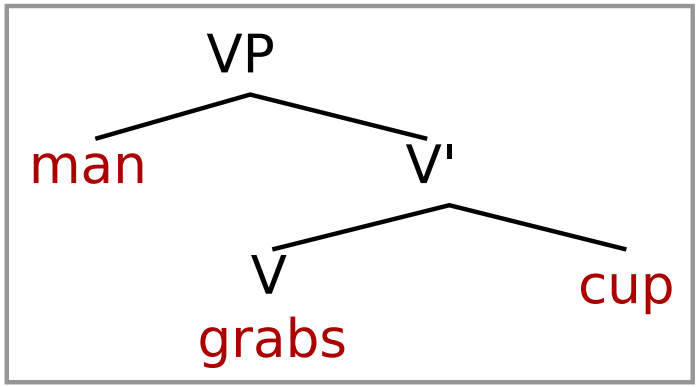
Chomsky's Minimalist model:

1. Sentences have a phonetic form (PF), but also a logical form (LF).
   - The LF of a sentence represents its semantic structure.
   - LF is relatively invariant across languages.

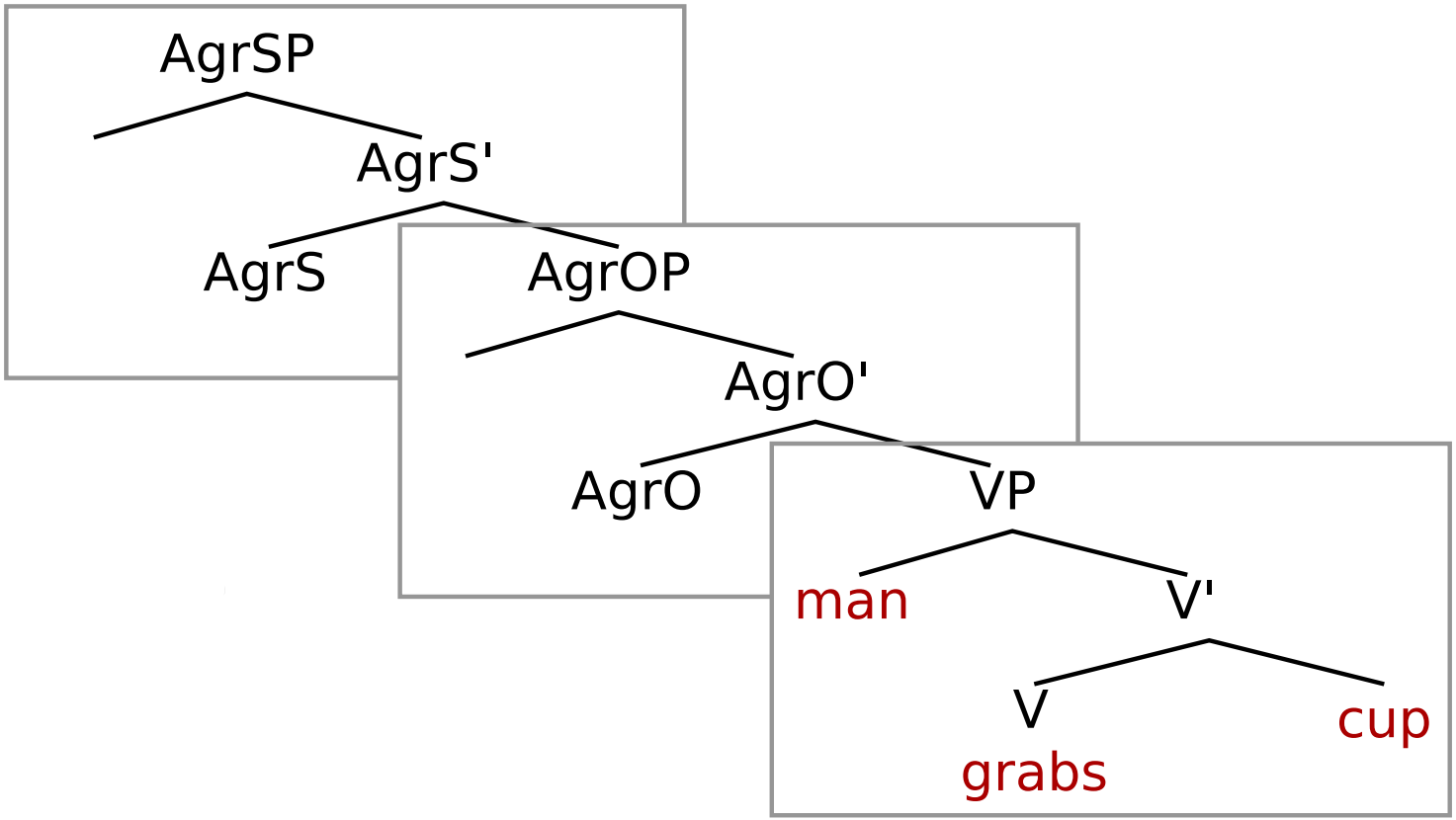
2. In the LF of a sentence, the main verb appears at *multiple positions*.

The LF structure of *The man grabs a cup*

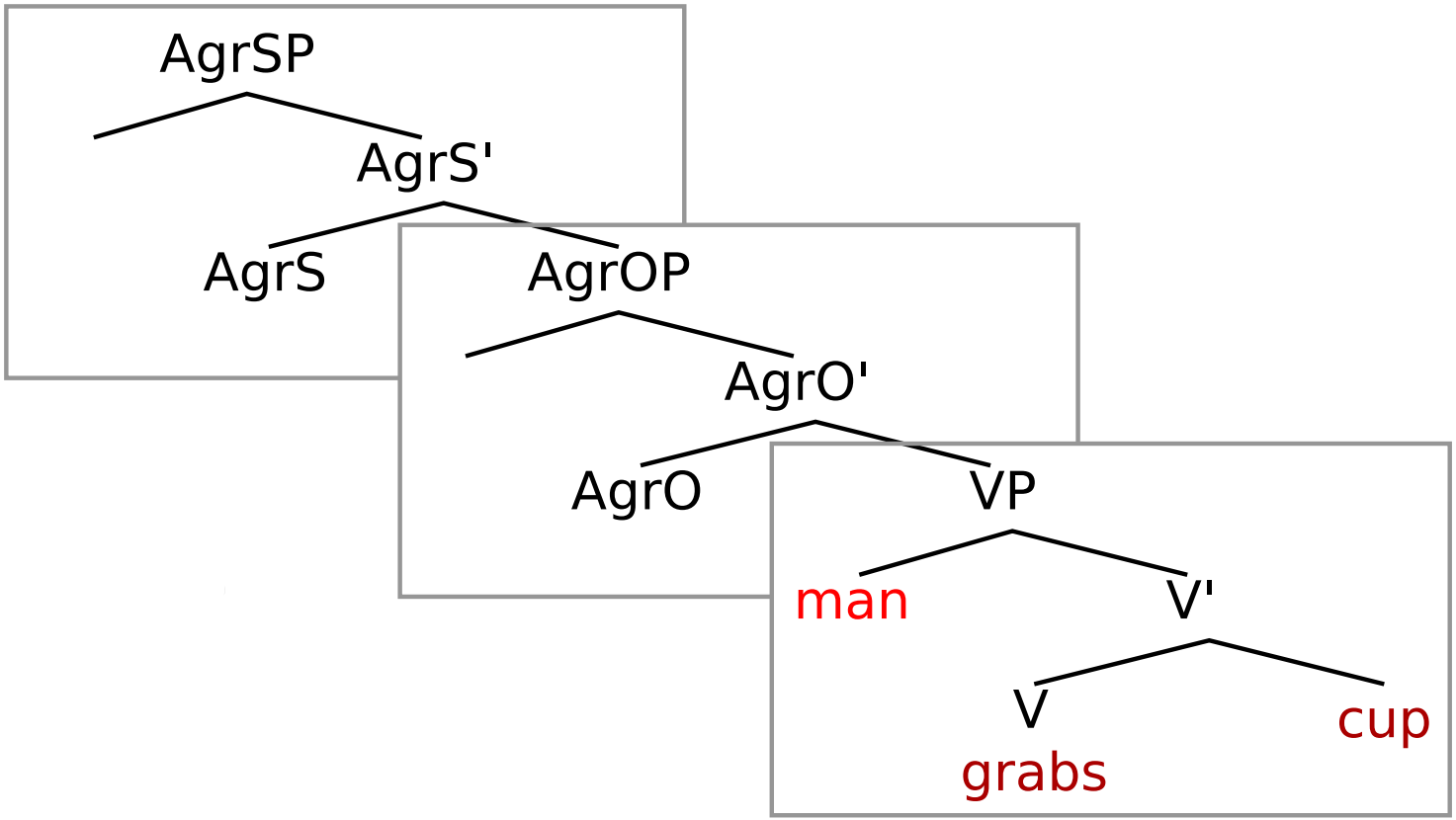
The LF structure of *The man grabs a cup*



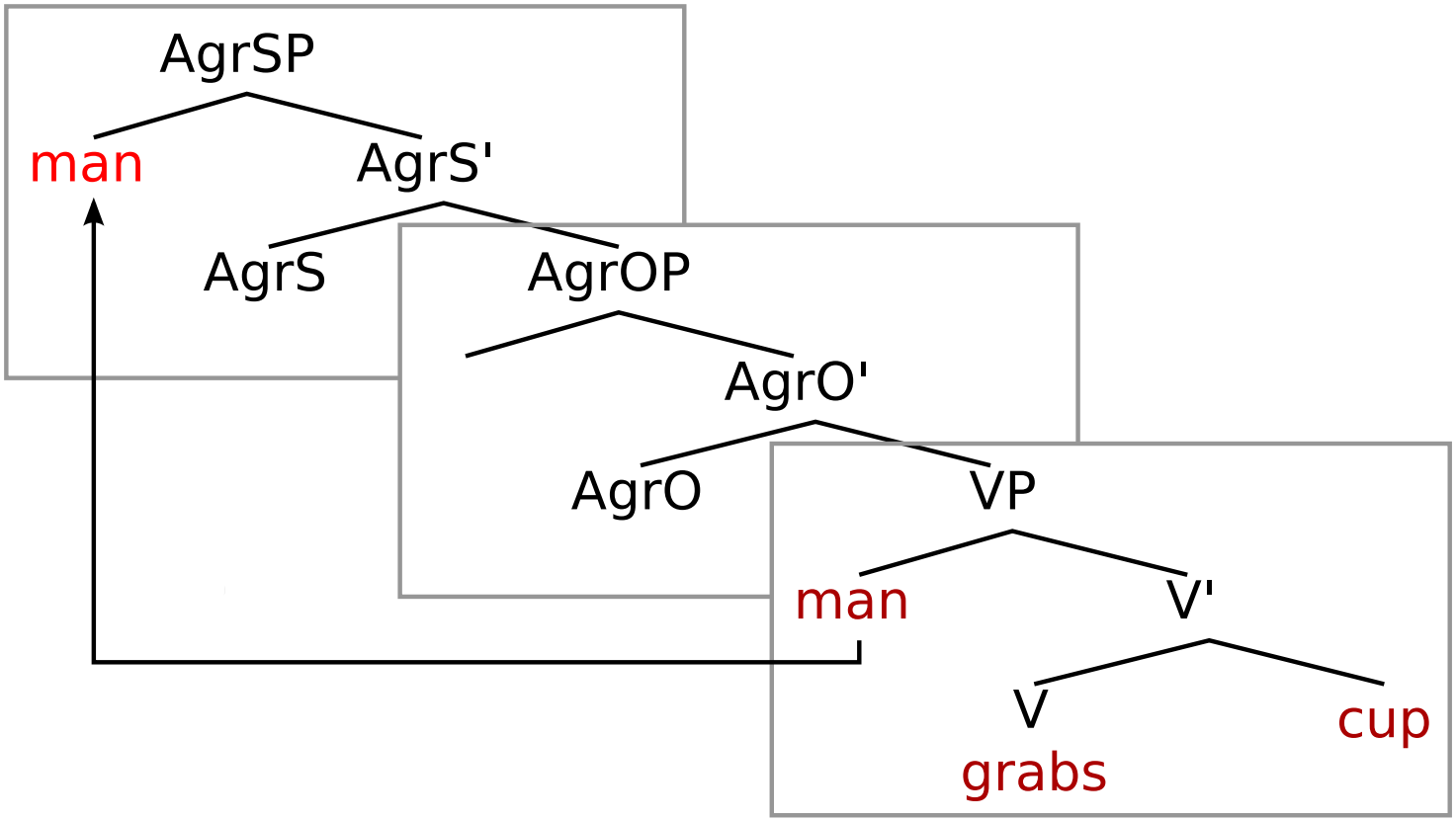
The LF structure of *The man grabs a cup*



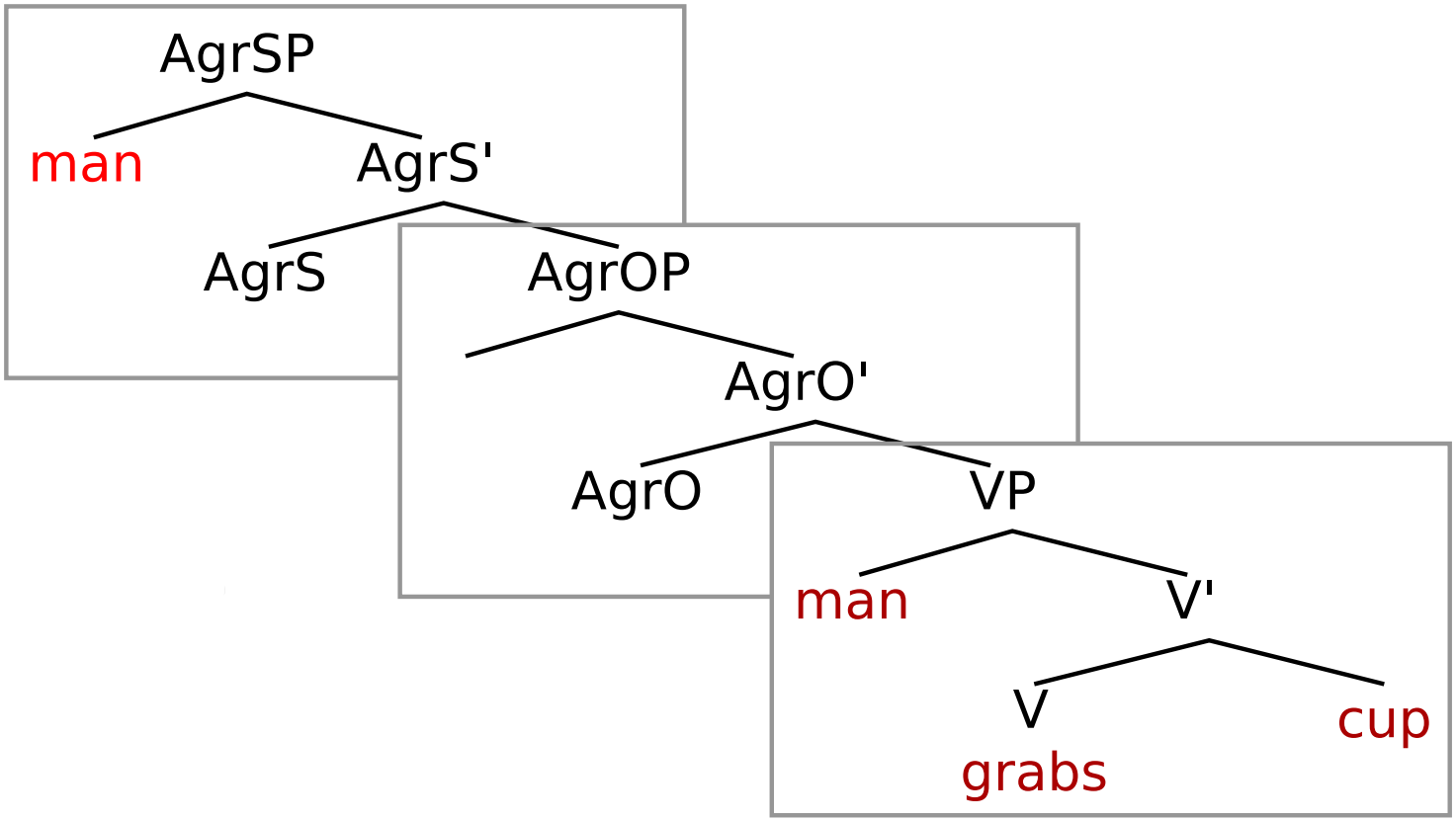
The LF structure of *The man grabs a cup*



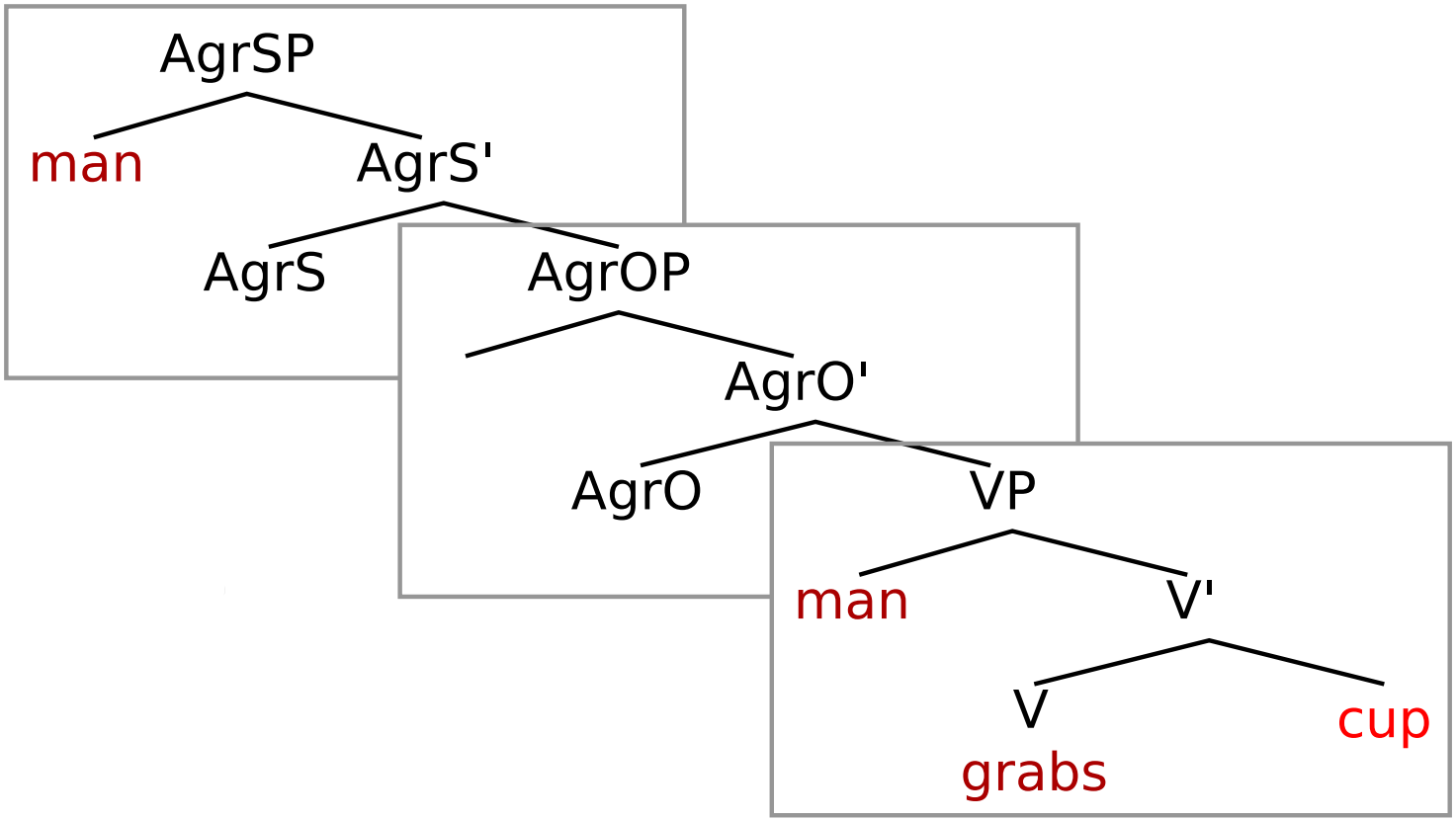
The LF structure of *The man grabs a cup*



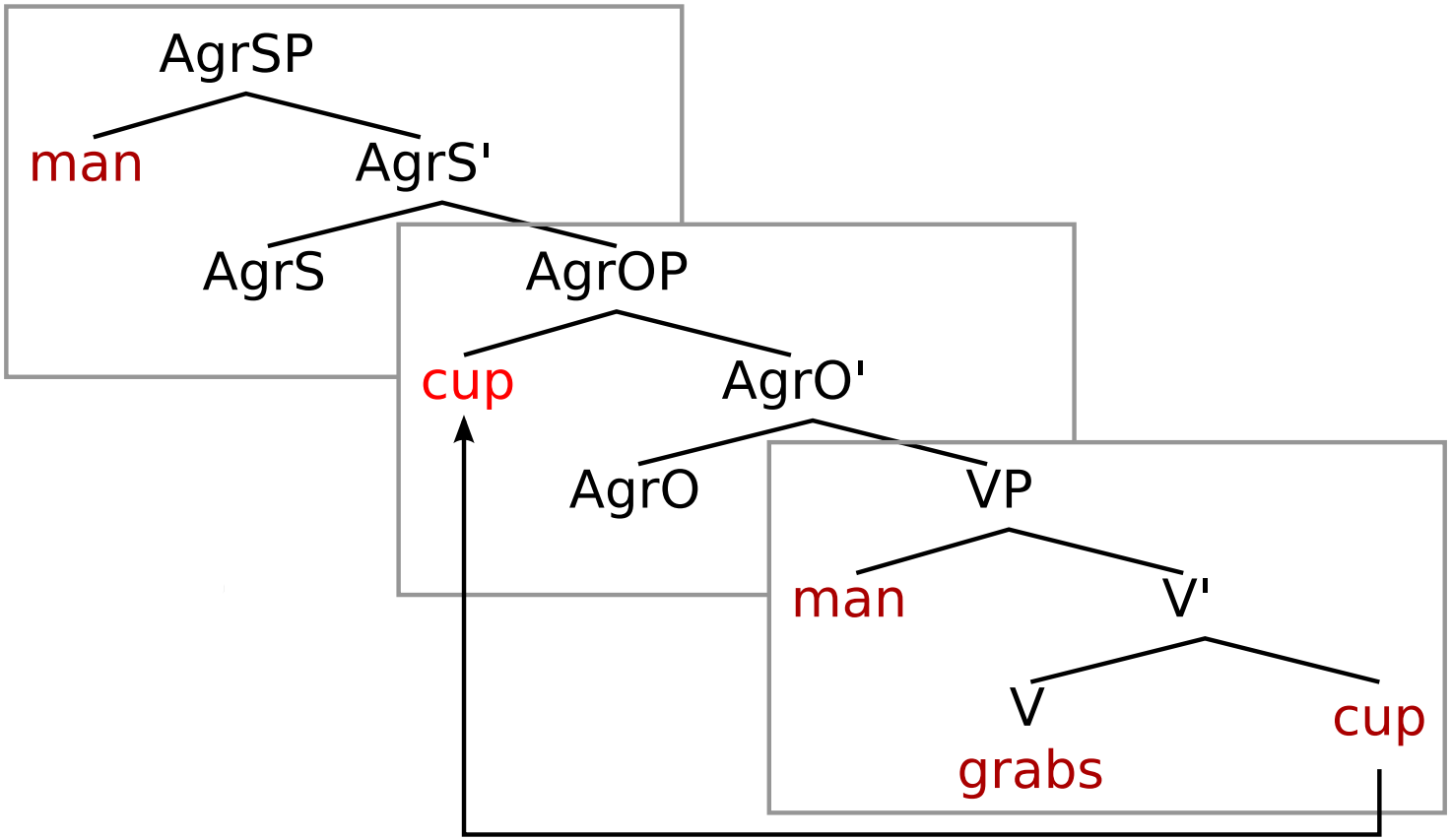
The LF structure of *The man grabs a cup*



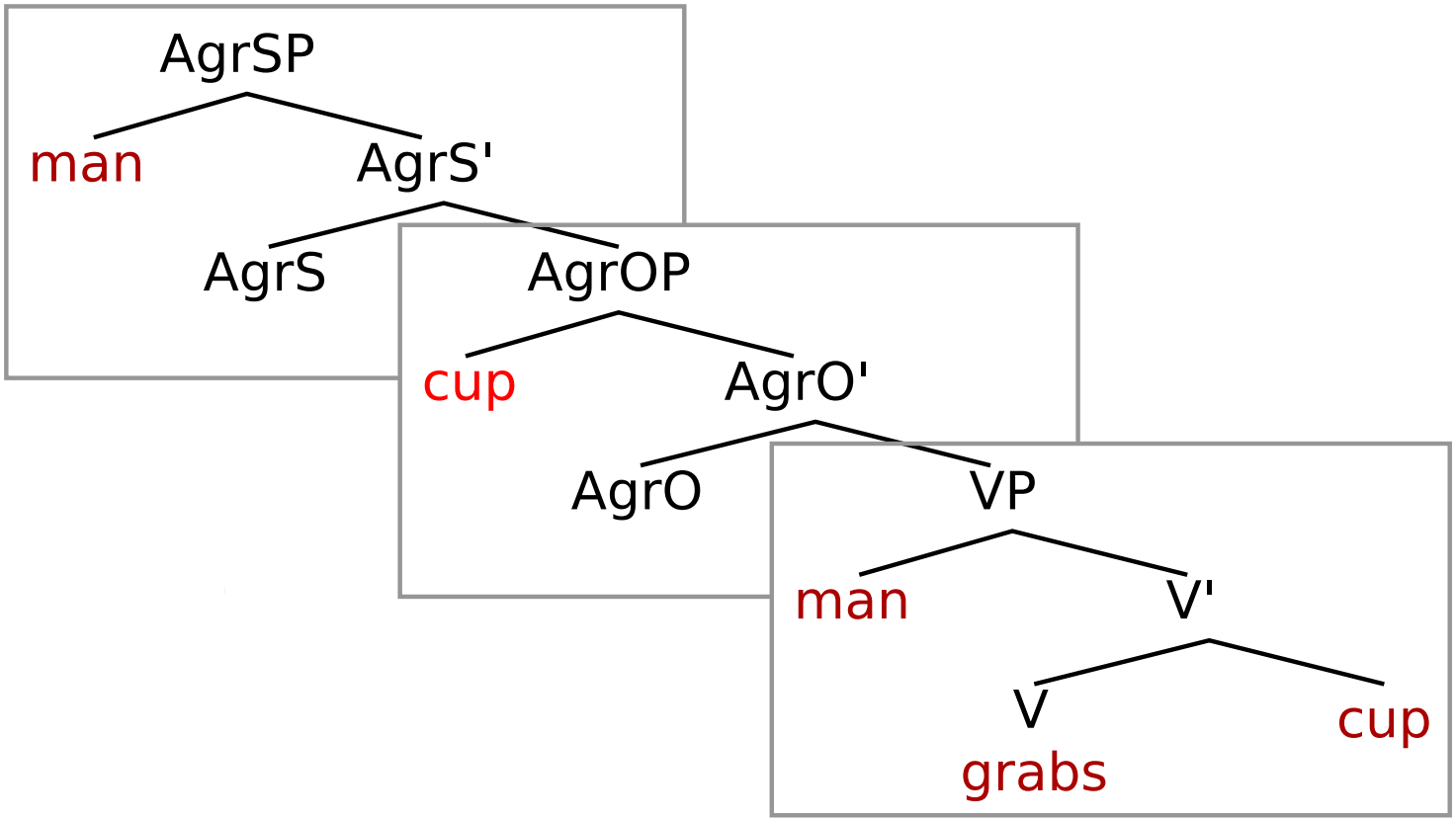
The LF structure of *The man grabs a cup*



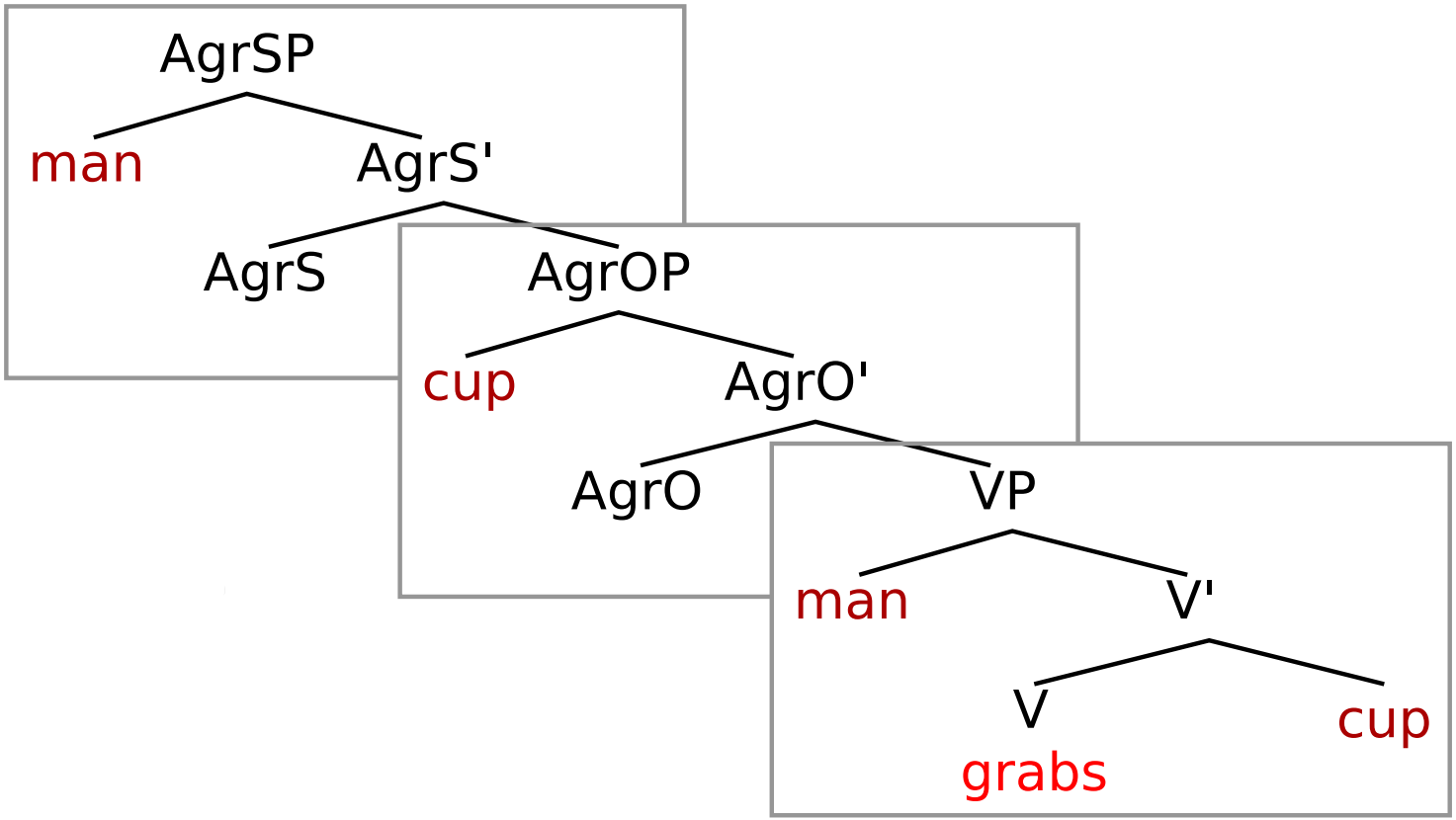
The LF structure of *The man grabs a cup*



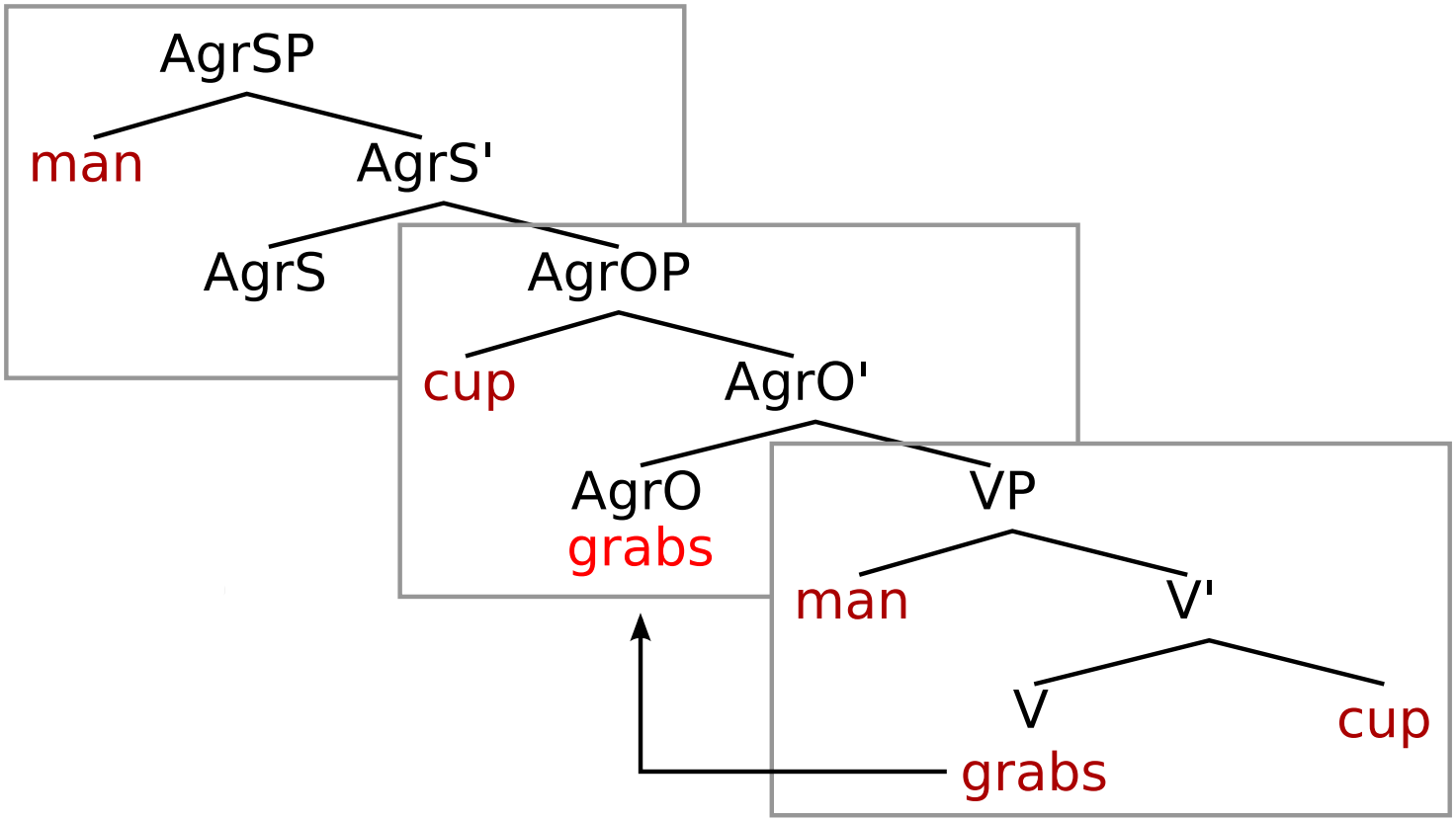
The LF structure of *The man grabs a cup*



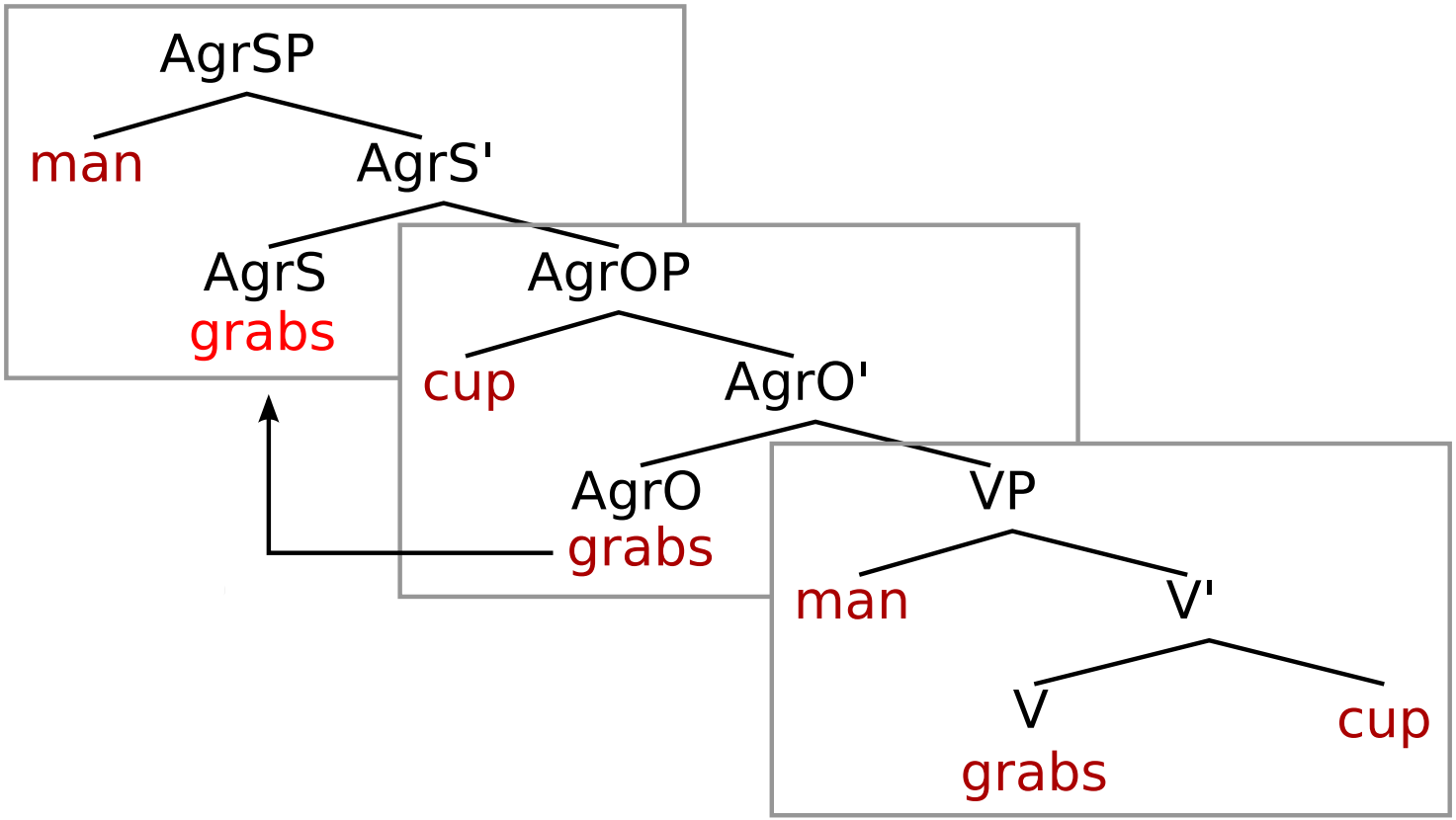
The LF structure of *The man grabs a cup*



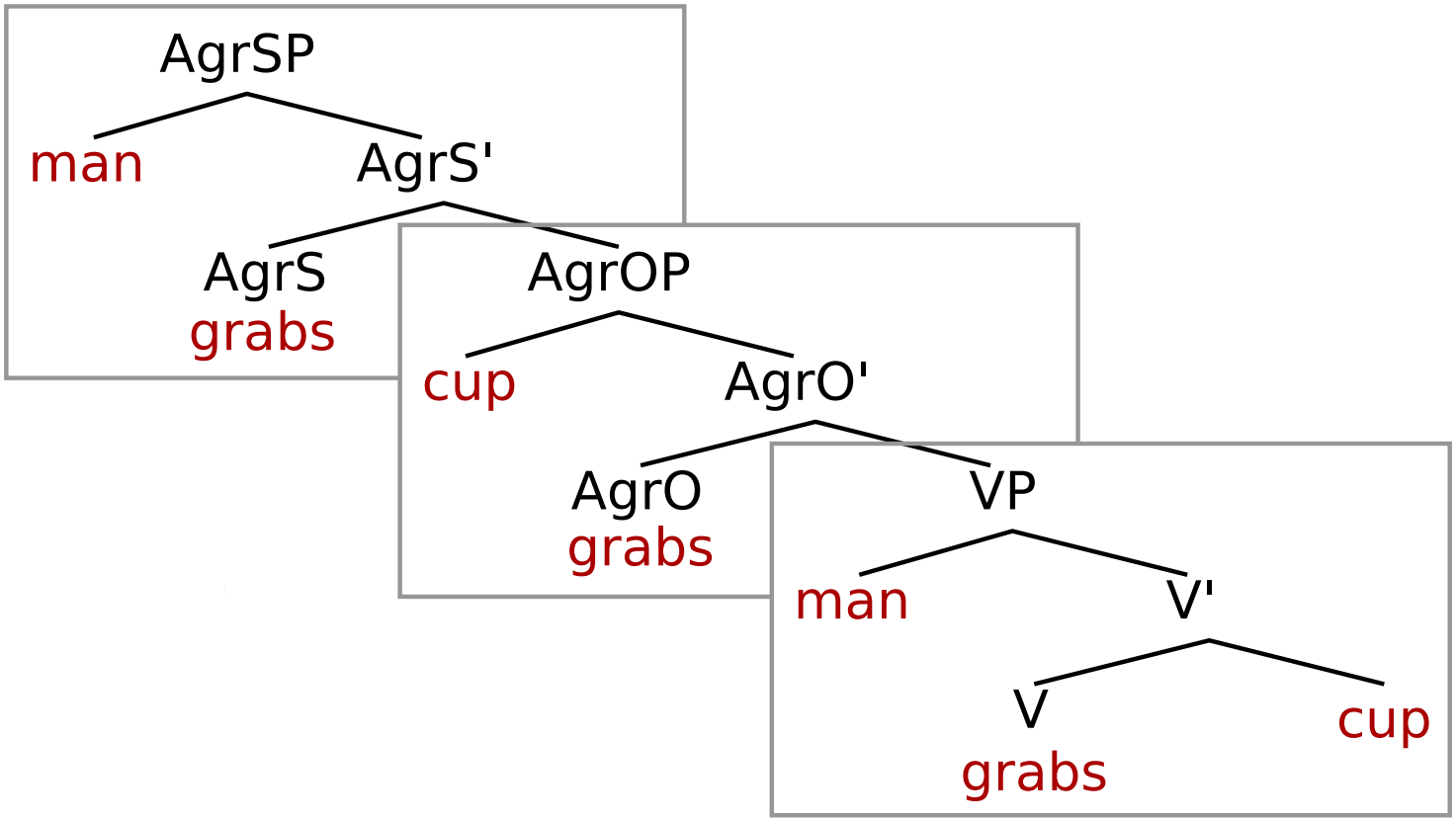
The LF structure of *The man grabs a cup*



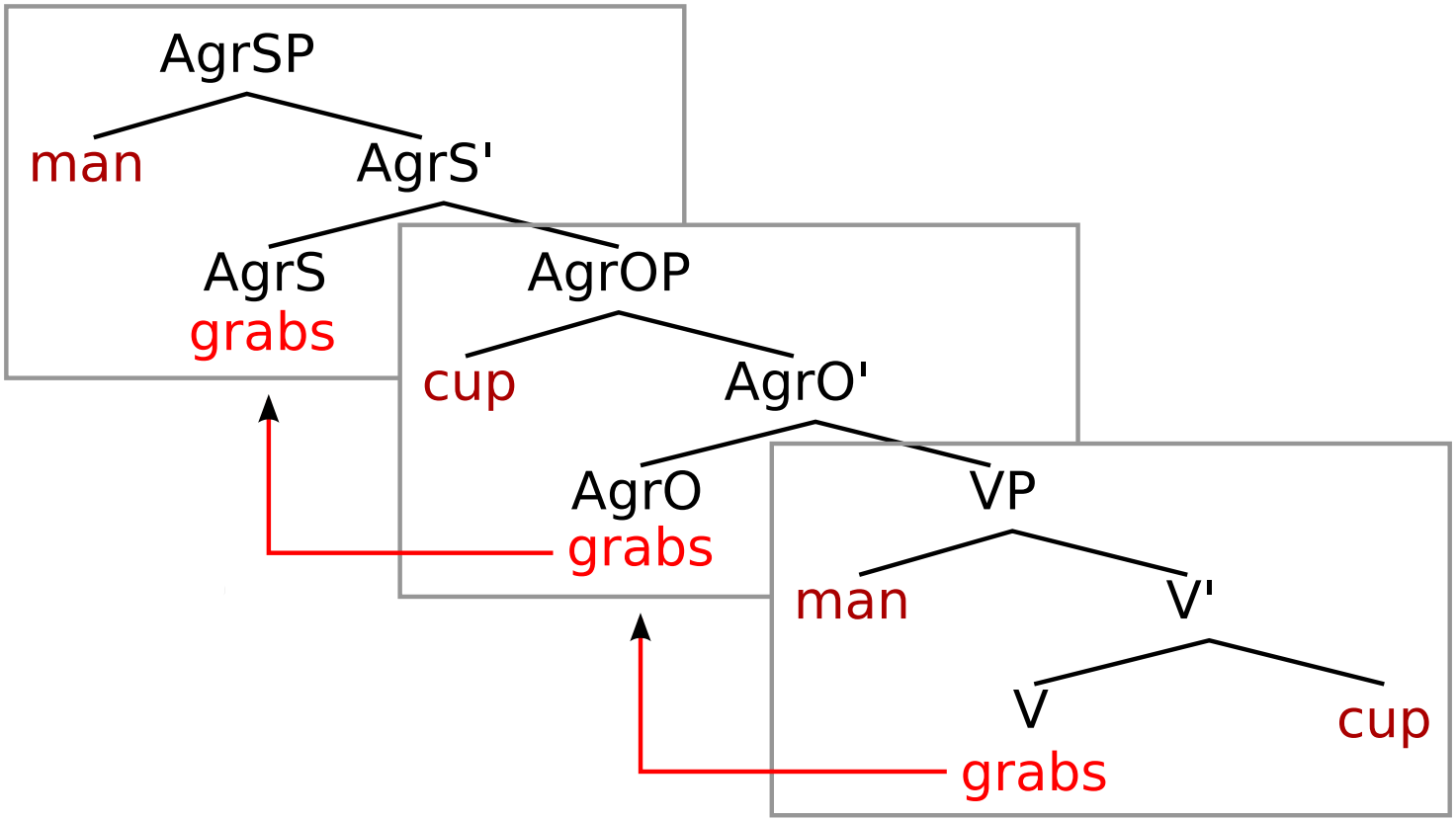
The LF structure of *The man grabs a cup*



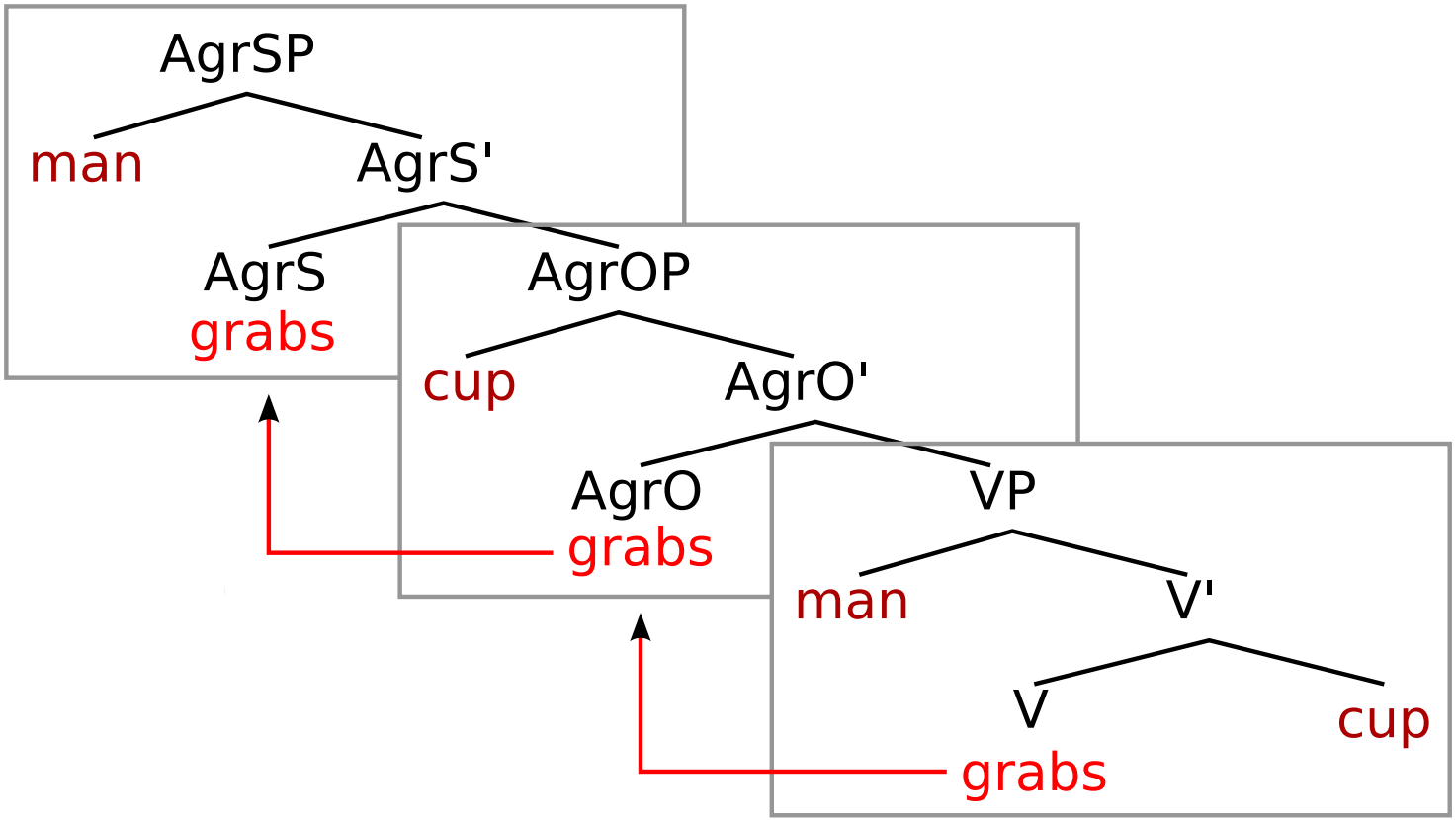
The LF structure of *The man grabs a cup*



The LF structure of *The man grabs a cup*



The LF structure of *The man grabs a cup*



Is there any analogue of the verb's extended syntactic domain in the sensorimotor system?

Embodied accounts of sentence semantics

Embodied linguists often claim that episodes are represented as *simulations* of sensorimotor (SM) experiences (see e.g. Glenberg and Robertson, 1999; Feldman and Narayanan, 2004; Barsalou, 2008).

In a book last year, I proposed that *Minimalist LF structures can be interpreted as descriptions of simulated SM routines* (Knott, 2012).

Embodied accounts of sentence semantics

Embodied linguists often claim that episodes are represented as *simulations* of sensorimotor (SM) experiences (see e.g. Glenberg and Robertson, 1999; Feldman and Narayanan, 2004; Barsalou, 2008).

In a book last year, I proposed that *Minimalist LF structures can be interpreted as descriptions of simulated SM routines* (Knott, 2012).

Episodes are experienced in canonical *sequences of SM operations*:

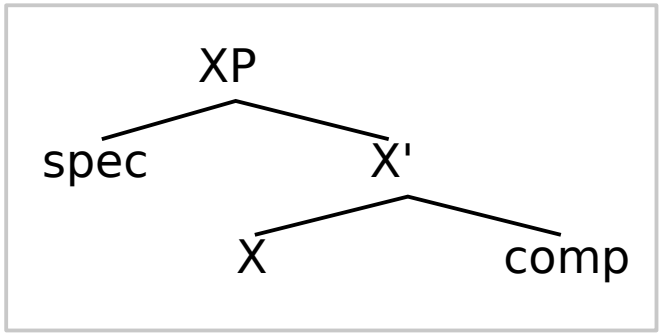
Initial context	SM operation	Reafferent signal	New context
C_1	*attend_man*	*man*	C_2
C_2	*attend_cup*	*cup*	C_3
C_3	*grab*	*man*	C_4 / *cup*

Embodied accounts of sentence semantics

Embodied linguists often claim that episodes are represented as *simulations* of sensorimotor (SM) experiences (see e.g. Glenberg and Robertson, 1999; Feldman and Narayanan, 2004; Barsalou, 2008).

In a book last year, I proposed that *Minimalist LF structures can be interpreted as descriptions of simulated SM routines* (Knott, 2012).

Each XP in an LF denotes a single SM operation:

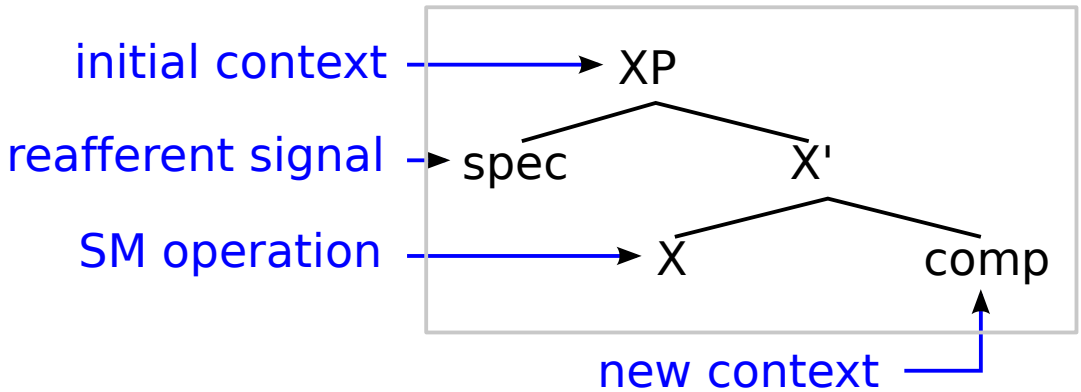


Embodied accounts of sentence semantics

Embodied linguists often claim that episodes are represented as *simulations* of sensorimotor (SM) experiences (see e.g. Glenberg and Robertson, 1999; Feldman and Narayanan, 2004; Barsalou, 2008).

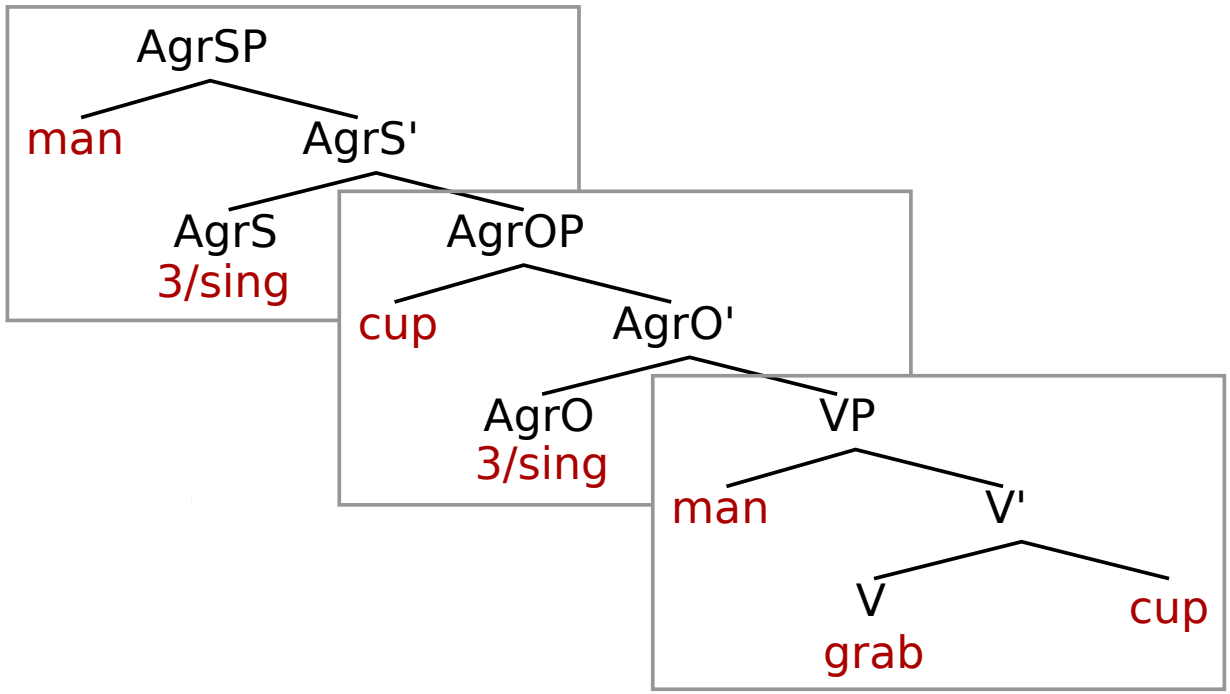
In a book last year, I proposed that *Minimalist LF structures can be interpreted as descriptions of simulated SM routines* (Knott, 2012).

Each XP in an LF denotes a single SM operation:



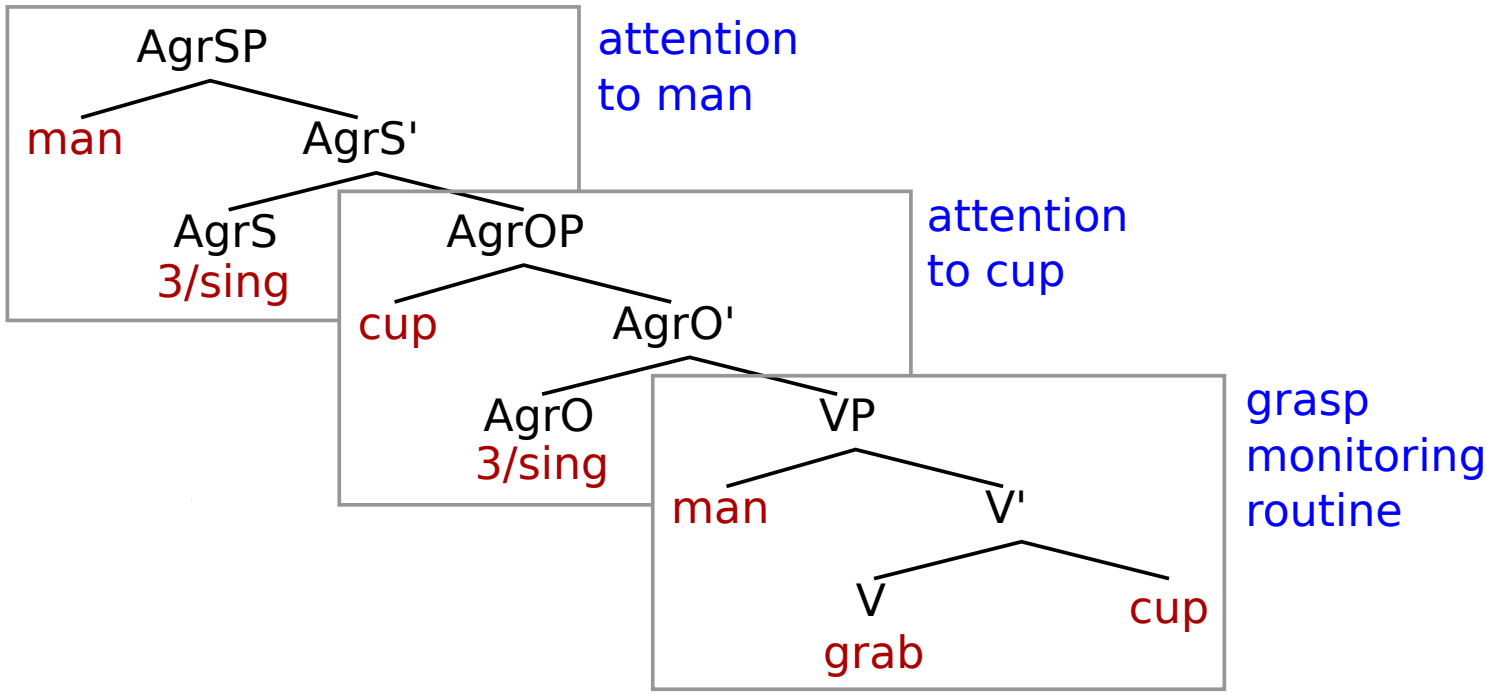
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



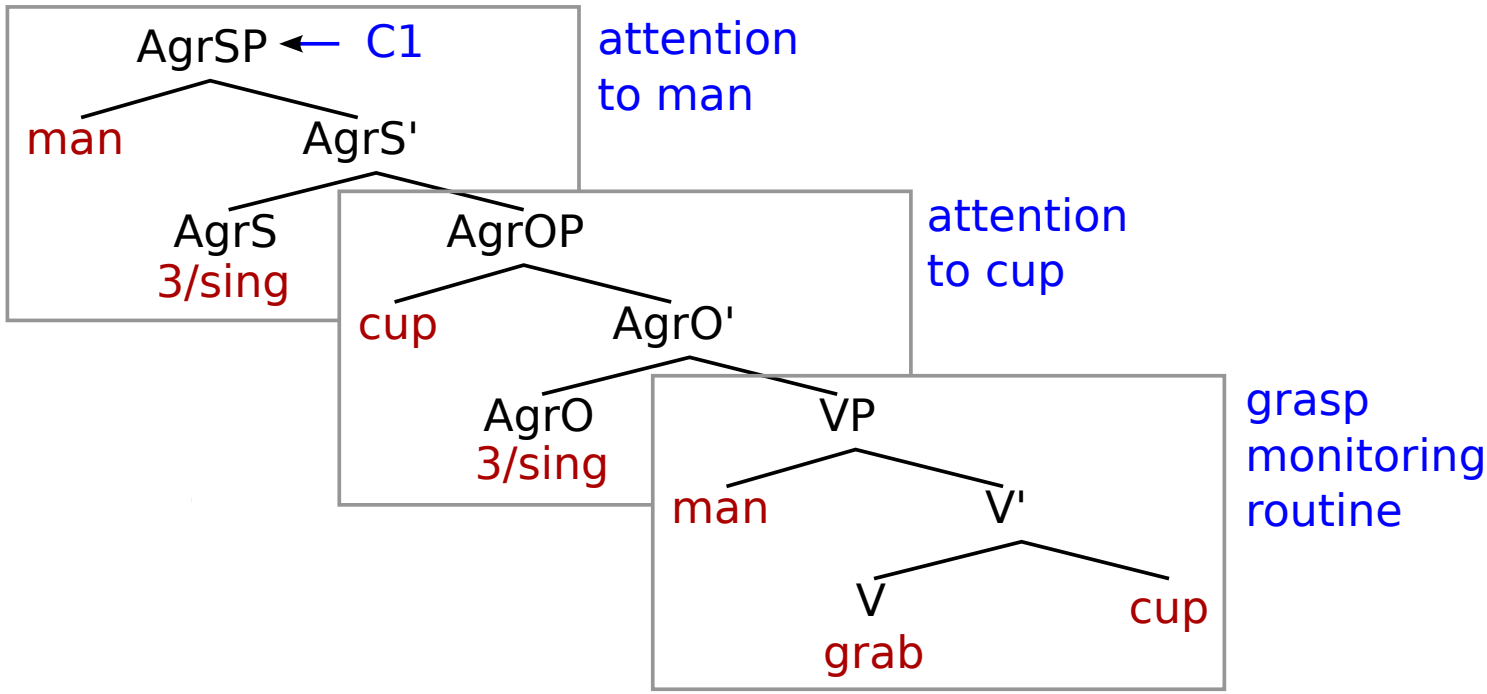
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



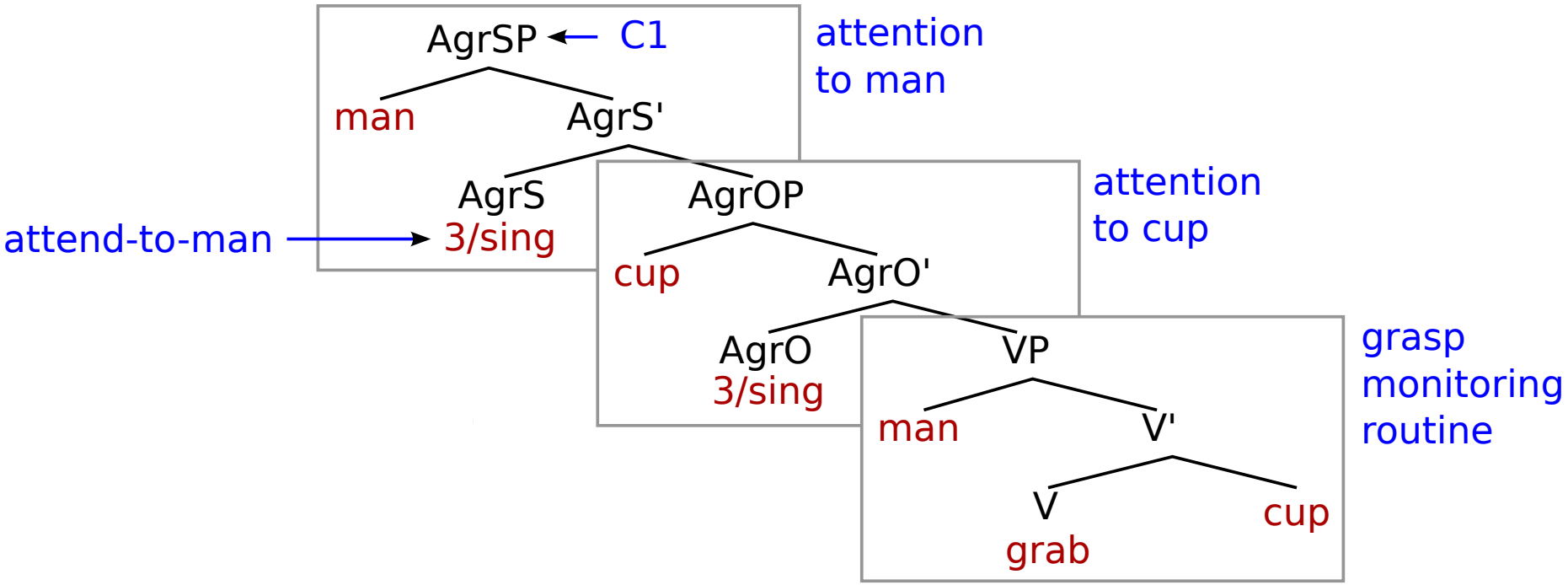
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



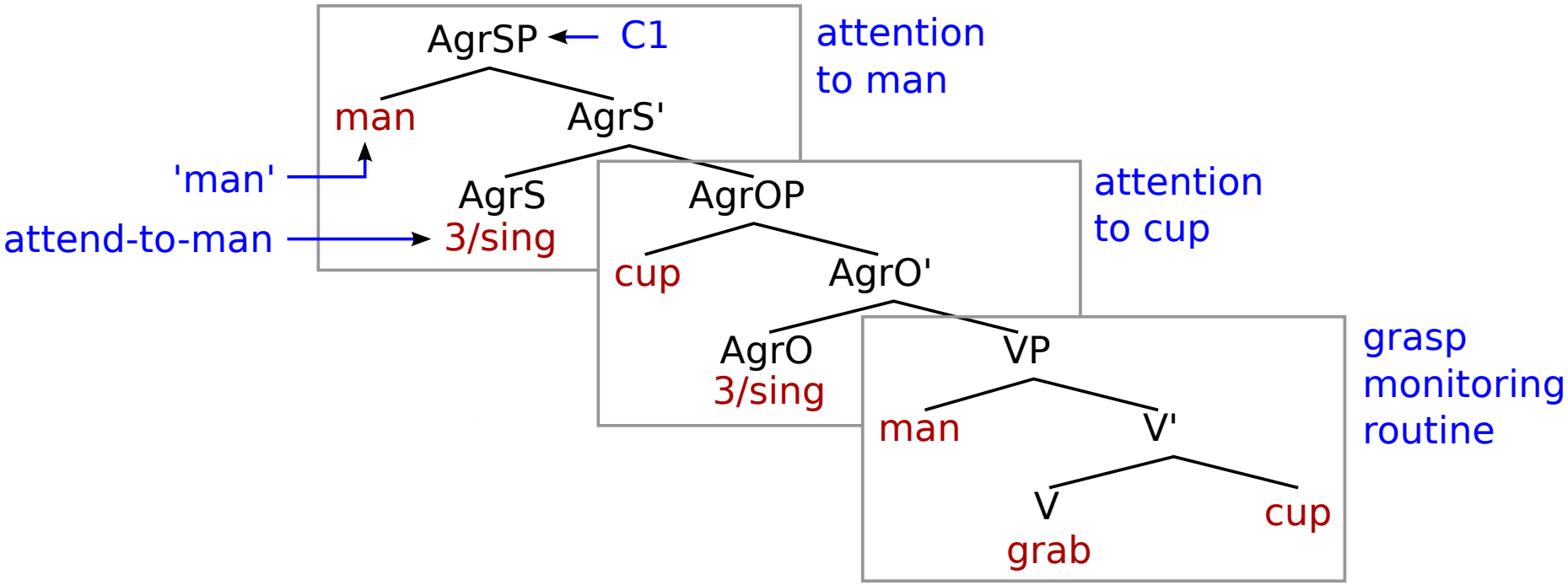
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



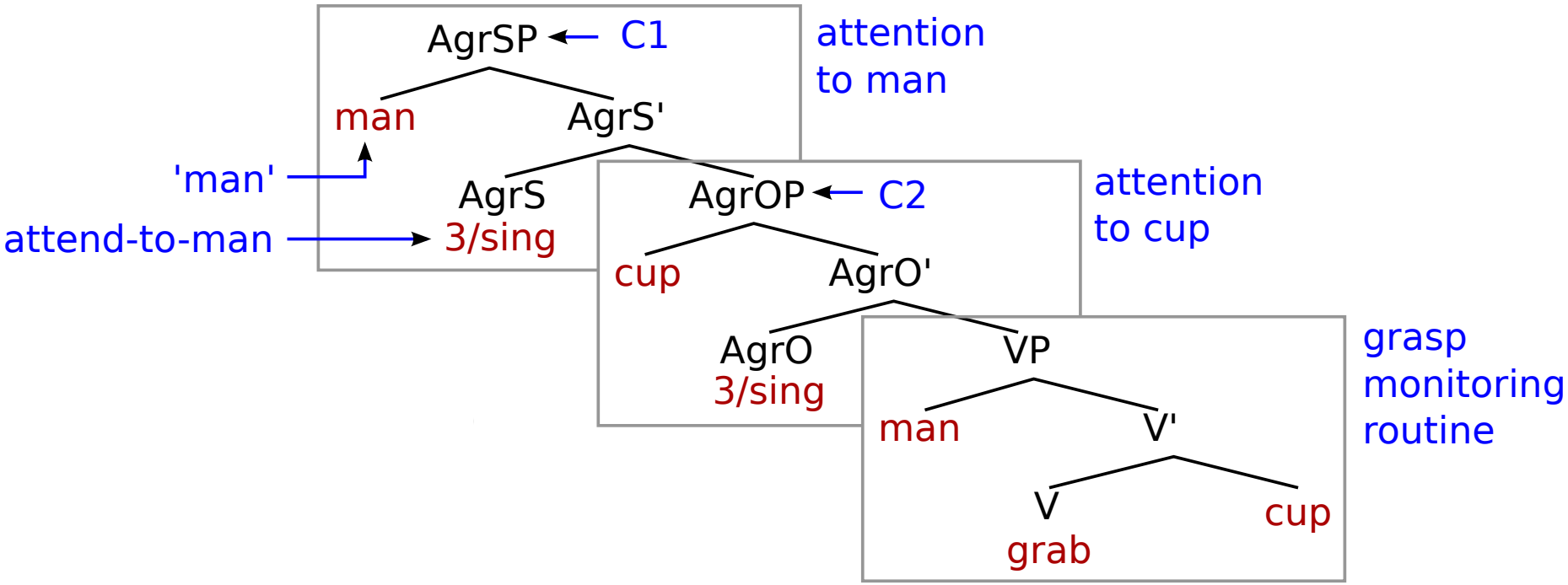
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



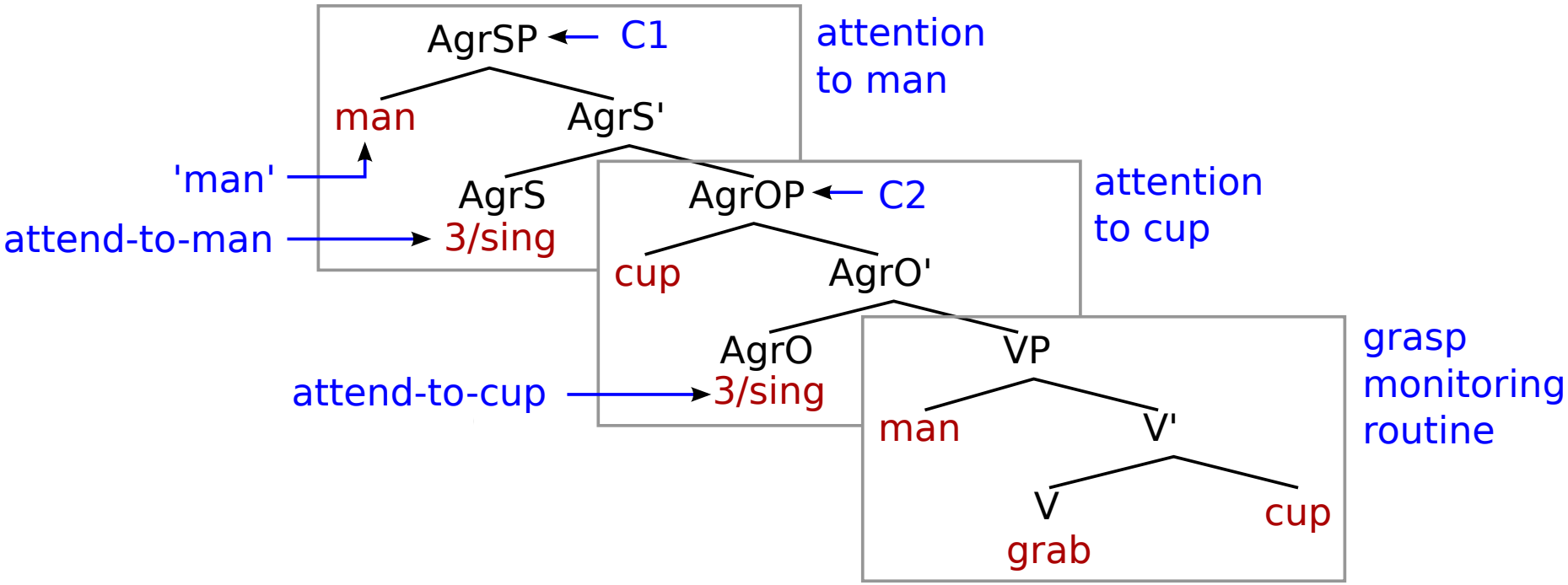
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



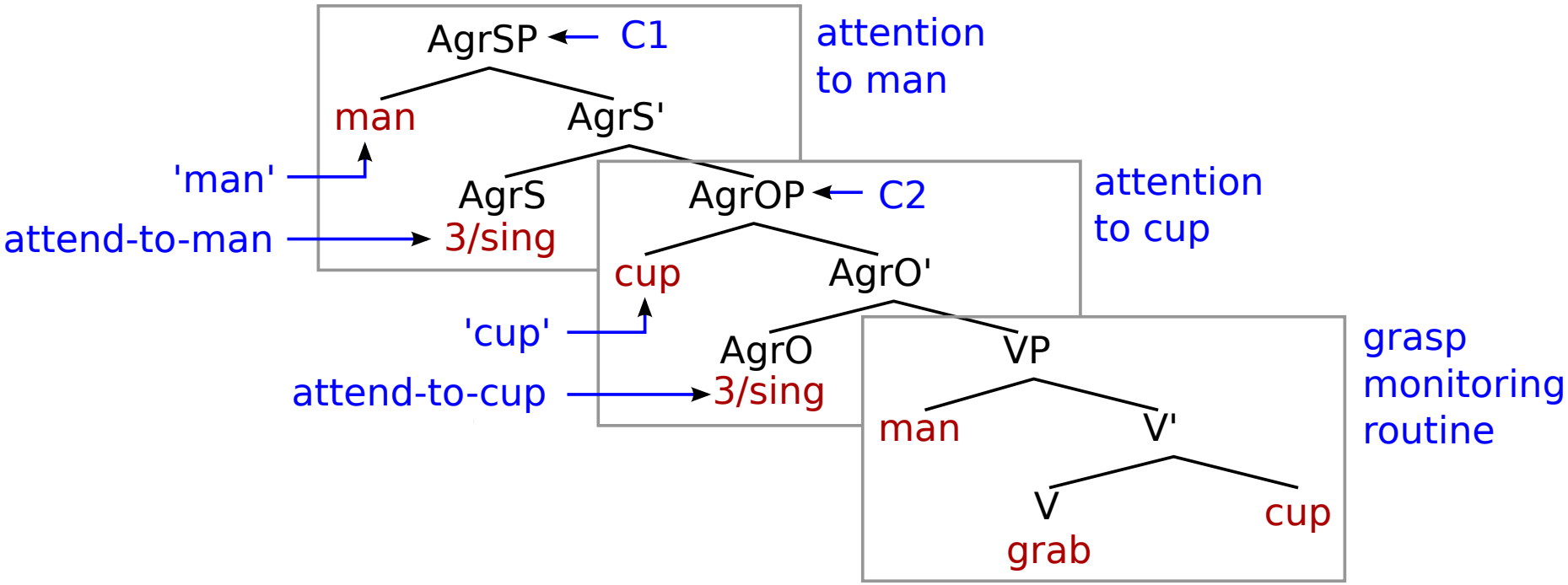
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



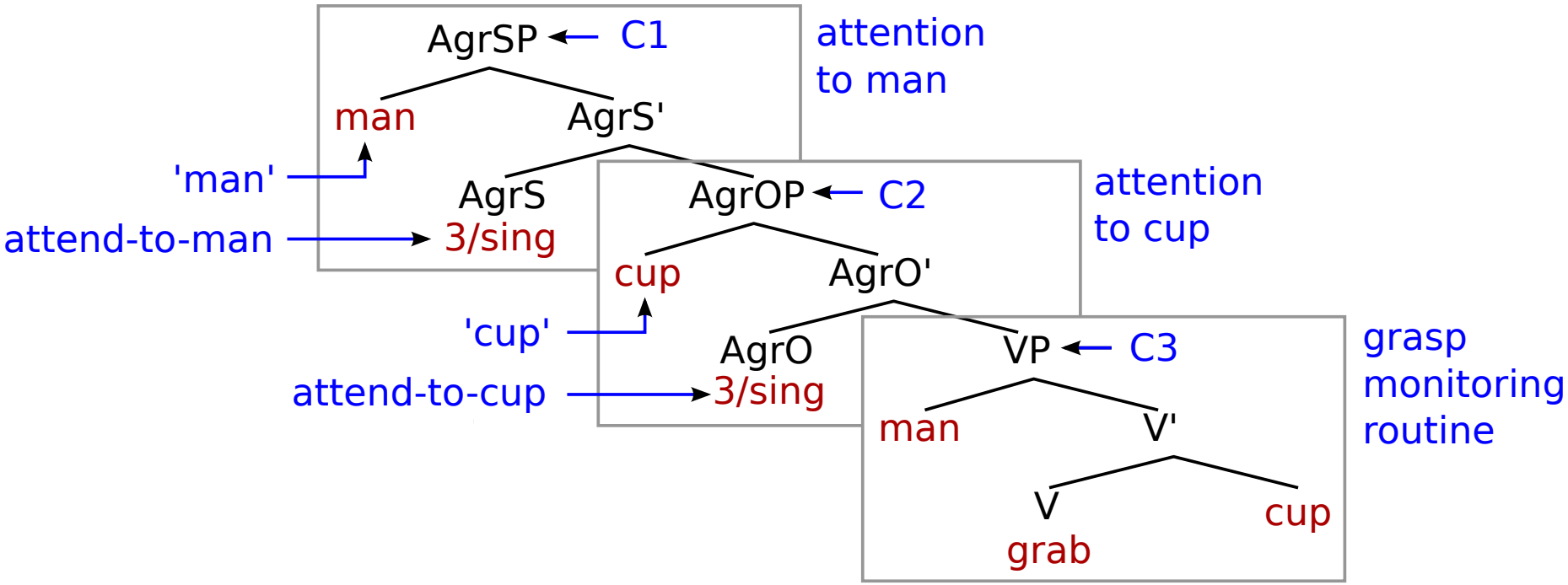
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



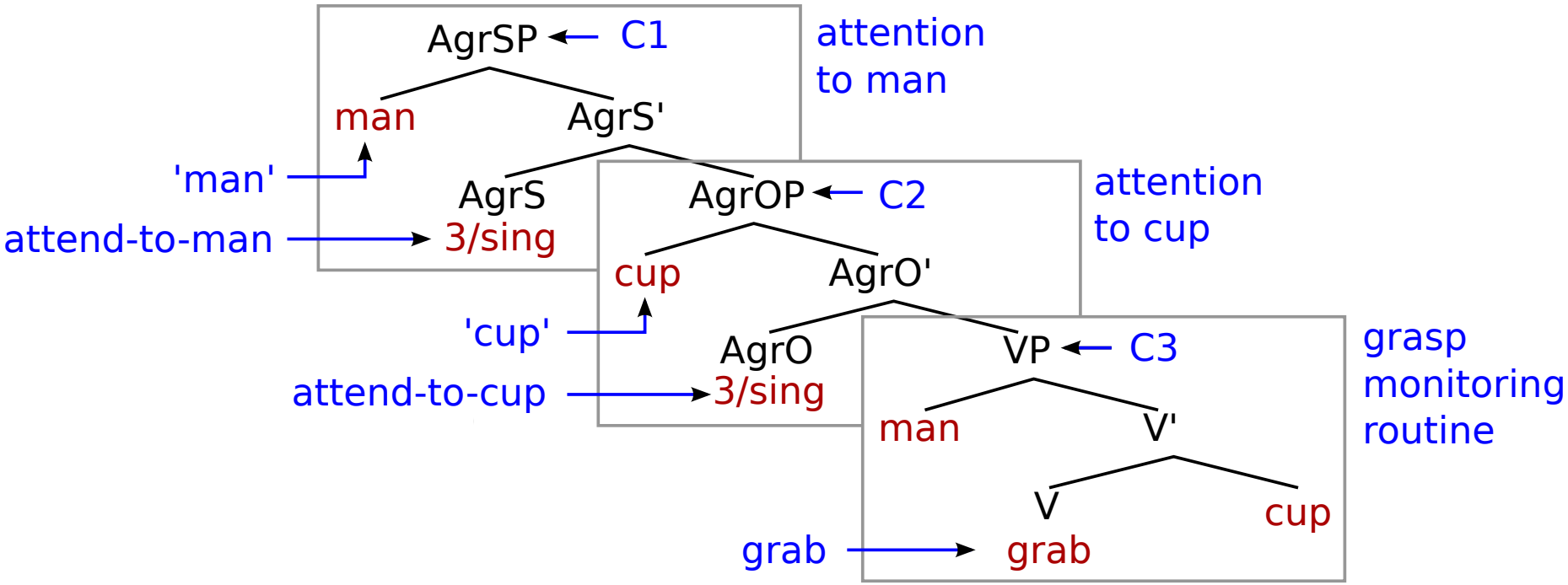
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



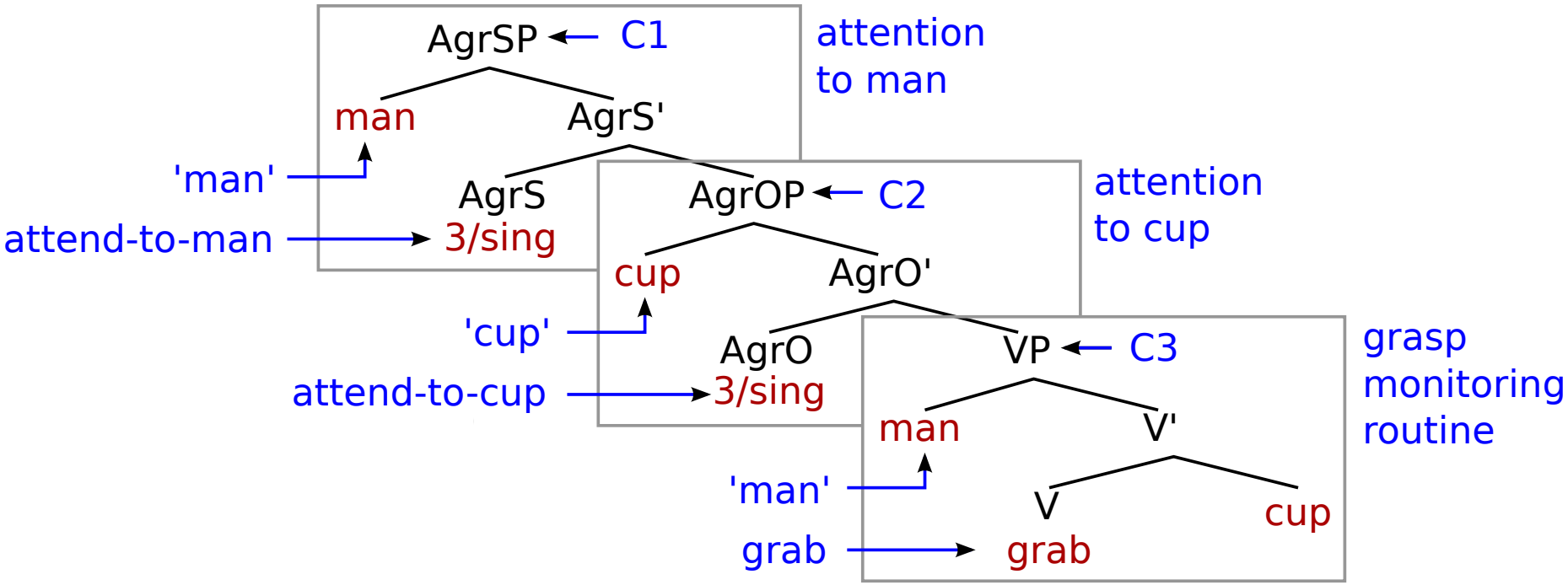
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



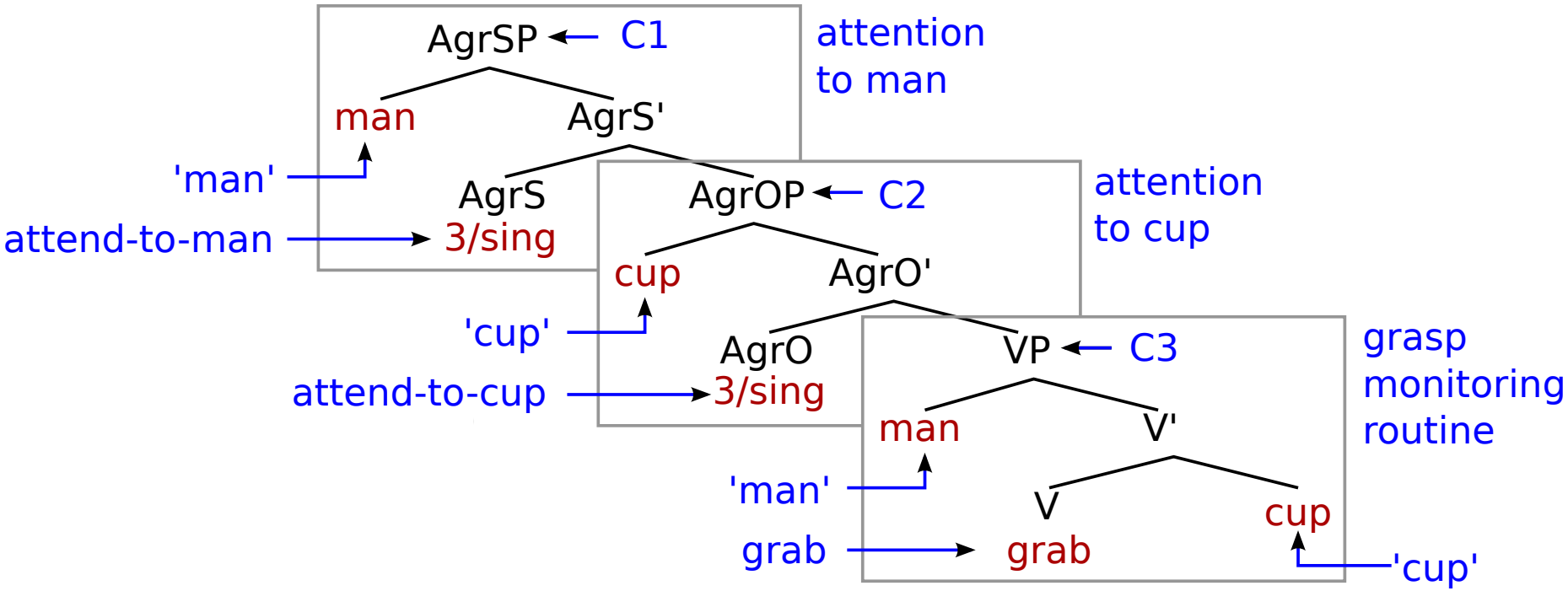
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



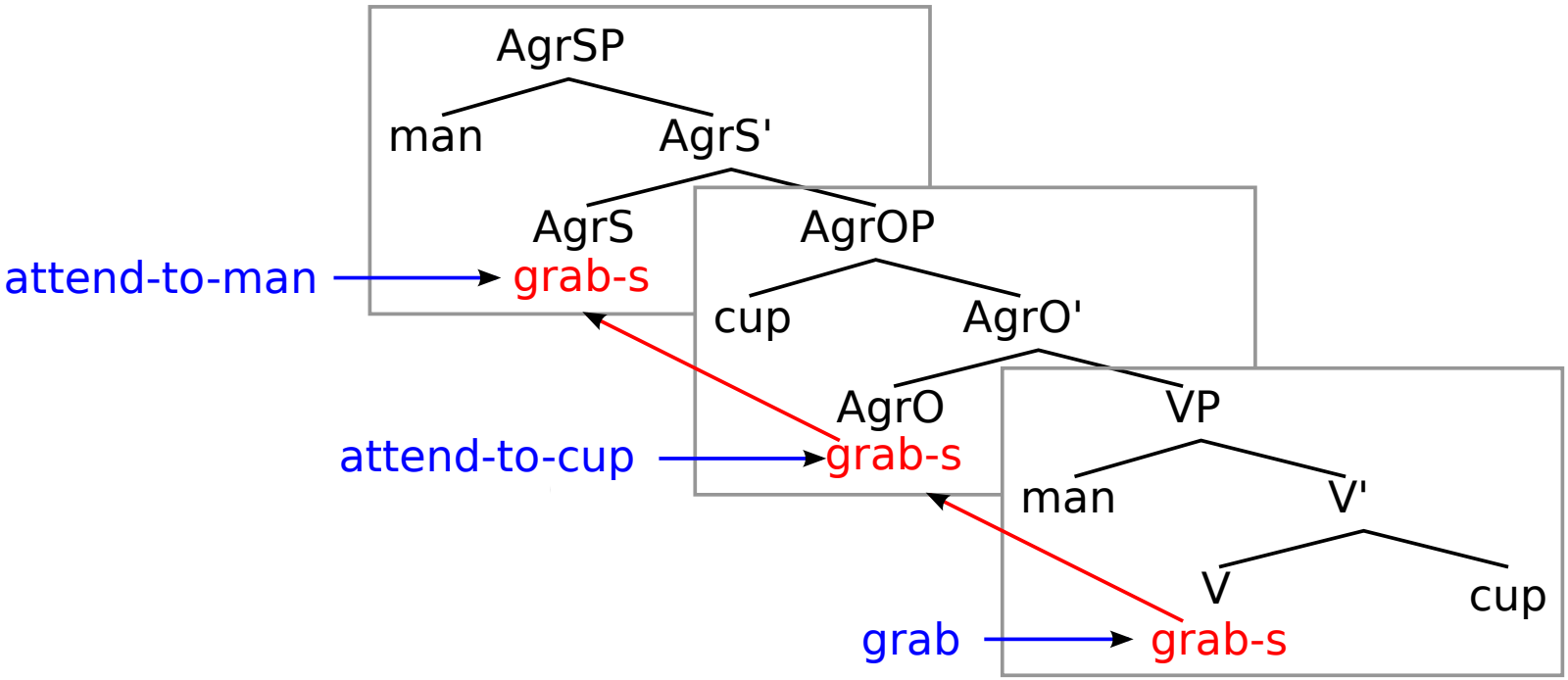
SM interpretation of an LF structure

A right-branching LF structure describes a simulated sequence of SM operations.



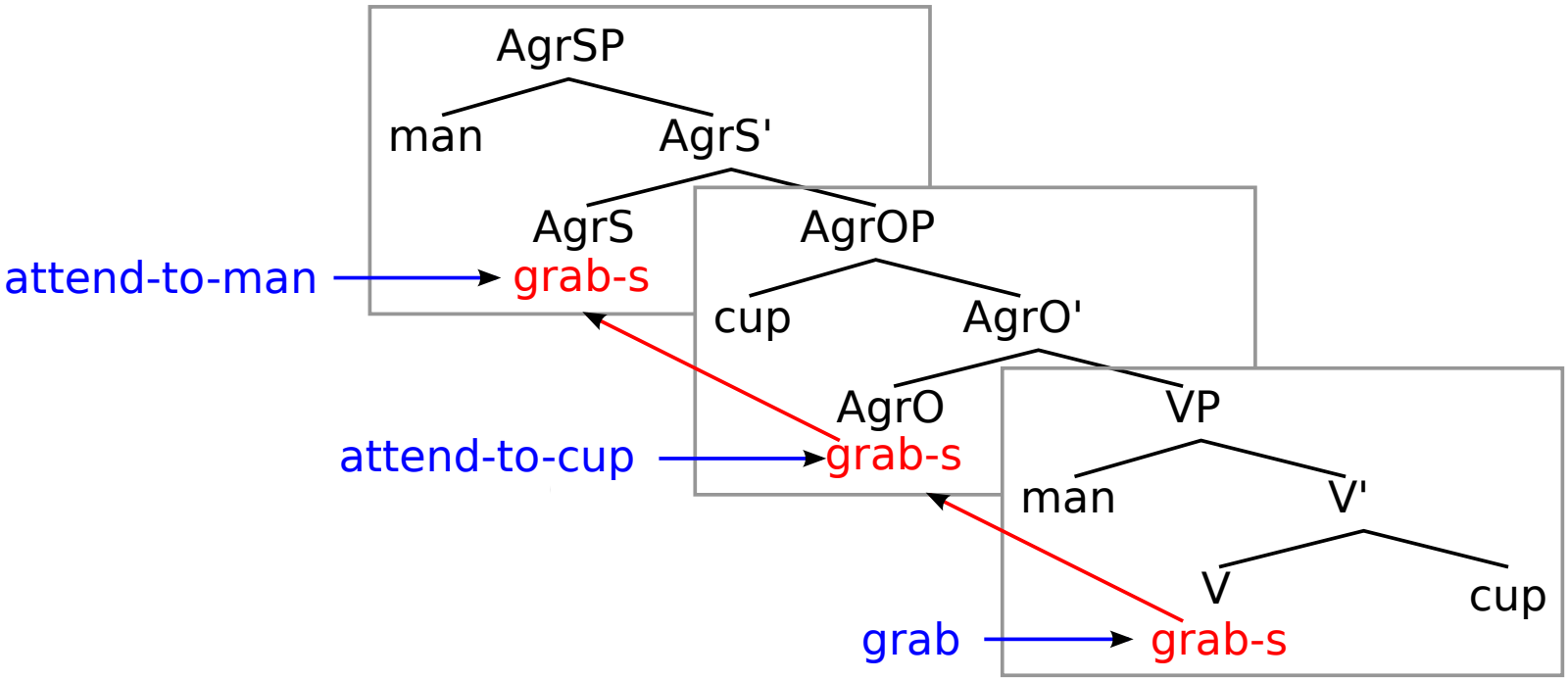
SM interpretation of an LF structure

Why can the verb and its inflections appear at every head position?



SM interpretation of an LF structure

Why can the verb and its inflections appear at every head position?



If LF encodes a simulated sequence, the SM operations in this sequence must be active *throughout the simulation*.

How are SM routines simulated?

My model of simulation starts from the premise that episodes are apprehended in canonical sequences of SM operations.

How are SM routines simulated?

My model of simulation starts from the premise that episodes are apprehended in canonical sequences of SM operations.

Proposal: episodes are stored in working memory as *prepared* sequences of discrete SM operations.

- Since they're prepared SM sequences, they're naturally replayable.

How are SM routines simulated?

My model of simulation starts from the premise that episodes are apprehended in canonical sequences of SM operations.

Proposal: episodes are stored in working memory as *prepared* sequences of discrete SM operations.

- Since they're prepared SM sequences, they're naturally replayable.

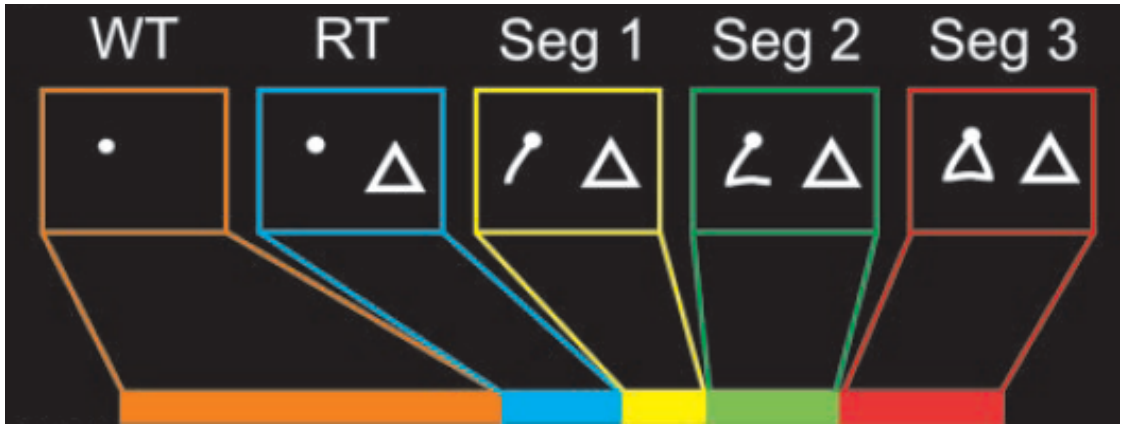
We know a lot about how sequences of attentional/motor operations are stored in the brain.

- For more, come to Takac and Knott, 2:30 Thurs!

Prefrontal representations of prepared SM sequences

Averbeck *et al.* (2002) trained monkeys to draw simple linear shapes.

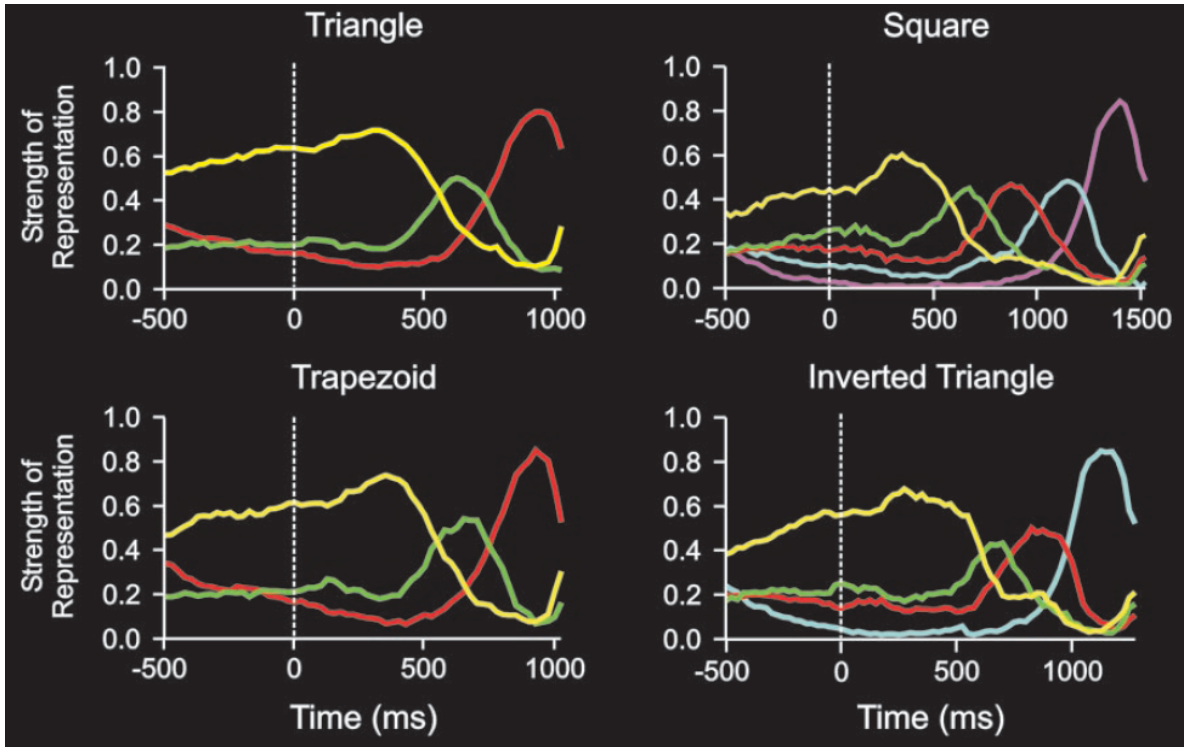
- Drawing each shape involved a sequence of motor movements.
- There was a delay before the monkey began to draw.



- PFC cells were recorded during the delay and drawing periods.

Prefrontal representations of prepared SM sequences

Different PFC cells were sensitive to different movements.



These PFC cells were active *in parallel*.

Why do verbs have an extended syntactic domain?

Why do verbs have an extended syntactic domain?

A model of sentence generation (Takac *et al.*, Cognition 2012):

Why do verbs have an extended syntactic domain?

A model of sentence generation (Takac *et al.*, Cognition 2012):

- A sentence is generated by replaying a SM sequence in a special mode where SM signals can trigger surface words.

Why do verbs have an extended syntactic domain?

A model of sentence generation (Takac *et al.*, Cognition 2012):

- A sentence is generated by replaying a SM sequence in a special mode where SM signals can trigger surface words.
- Heads of XPs (verbs and agreement inflections) 'report' SM operations.

Why do verbs have an extended syntactic domain?

A model of sentence generation (Takac *et al.*, Cognition 2012):

- A sentence is generated by replaying a SM sequence in a special mode where SM signals can trigger surface words.
- Heads of XPs (verbs and agreement inflections) 'report' SM operations.
- Verbs and their inflections are read from representations of SM operations as they are planned, in prefrontal cortex, where they are active in parallel. They can therefore be pronounced at any stage during replay.

Why do verbs have an extended syntactic domain?

A model of sentence generation (Takac *et al.*, Cognition 2012):

- A sentence is generated by replaying a SM sequence in a special mode where SM signals can trigger surface words.
- Heads of XPs (verbs and agreement inflections) 'report' SM operations.
- Verbs and their inflections are read from representations of SM operations as they are planned, in prefrontal cortex, where they are active in parallel. They can therefore be pronounced at any stage during replay.

Processing of verbs and inflections activates prefrontal cortex (Shapiro & Caramazza, 2003; Cappeletti *et al.*, 2008; Shapiro *et al.*, 2012)

Summary

If sentence meanings are simulated SM routines, maybe the verb's extended syntactic domain is because verbs denote SM operations *as they are planned*, in prefrontal cortex, where they are tonically active.