COSC451: Artificial Intelligence

Lecture 13: A sensorimotor interpretation of clause syntax

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Recap

My example sentence: **The man grabbed a cup**.

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2. This sequence is initially retained in working memory as a sequence plan, which can then be covertly replayed.

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1. The sensorimotor processes involved in 'experiencing' the action of grabbing a cup have the form of a sequence.
2. This sequence is initially retained in working memory as a sequence plan, which can then be covertly replayed.
3. The 'deep' syntactic structure of the sentence can be read as a description of the process of replaying the working memory sequence (to long-term memory).

Replay of the WM sequence: timecourse of signals

Sustained signals	Transient signals		
	Context signals	Action signals	Reafferent signals
$plan_{attend\_agent/attend\_cup/grasp}$ ↓ ↓	C_1	*attend_agent*	*attending_agent*
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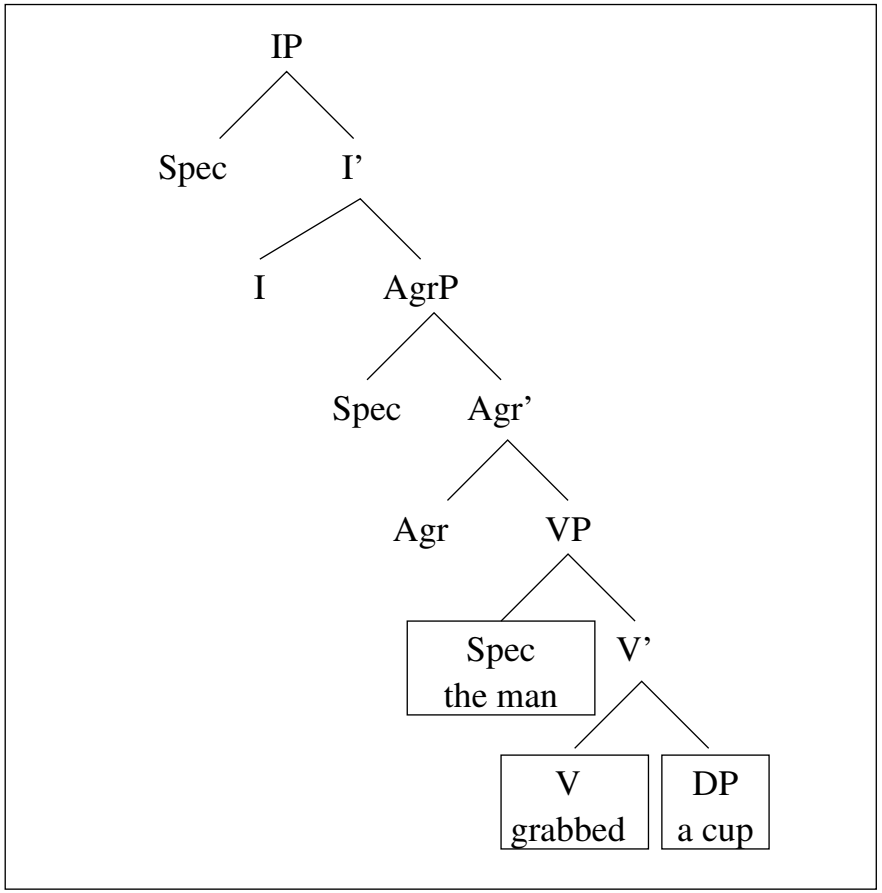
$plan_{attend\_agent/attend\_cup/grasp}$ ↓ ↓	C_3	*grasp*	*attending_agent*
$plan_{attend\_agent/attend\_cup/grasp}$ ↓ ↓	C_4		*attending_cup*

The LF of *The man grabbed a cup*

The verb and its arguments originate in the VP.



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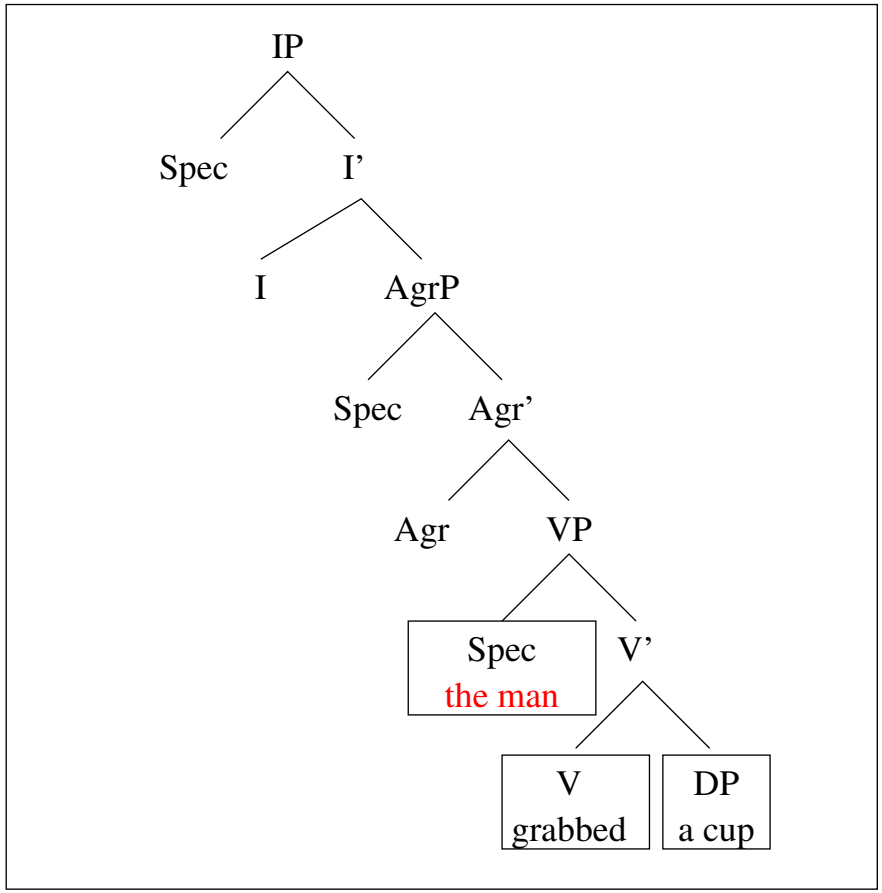

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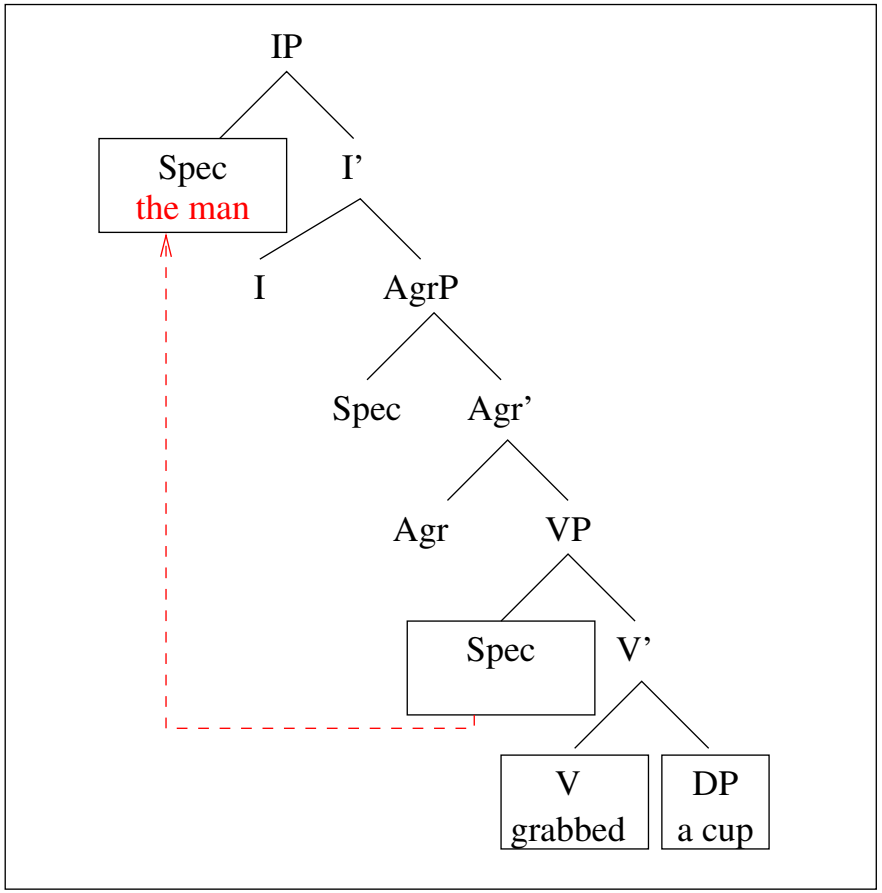

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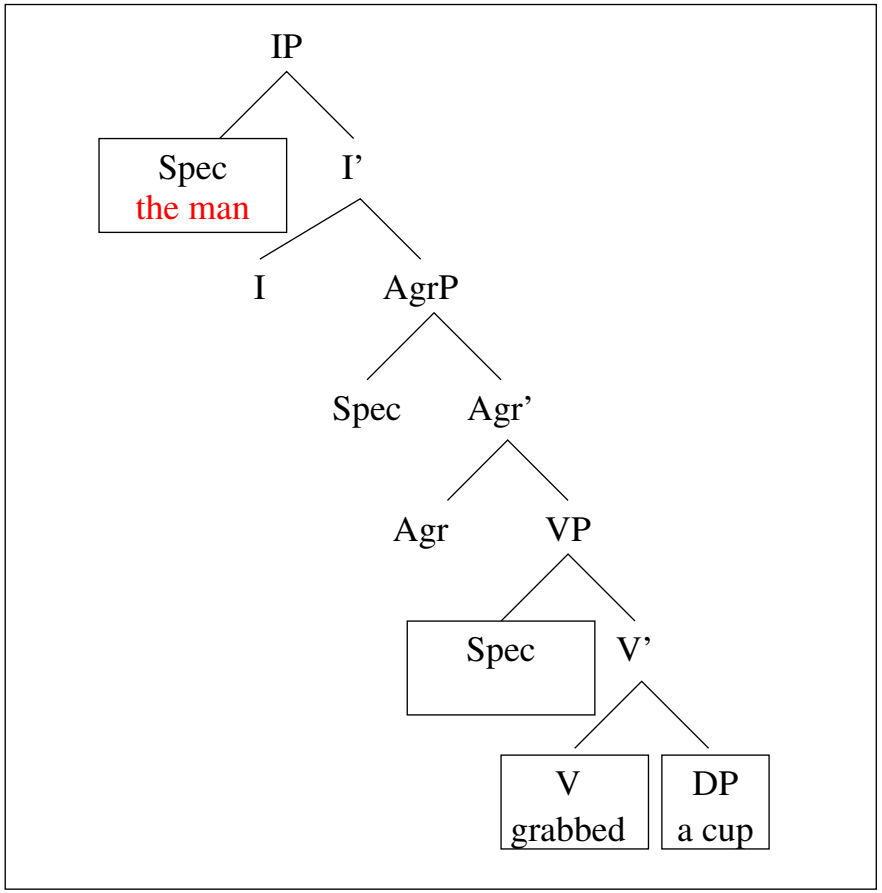

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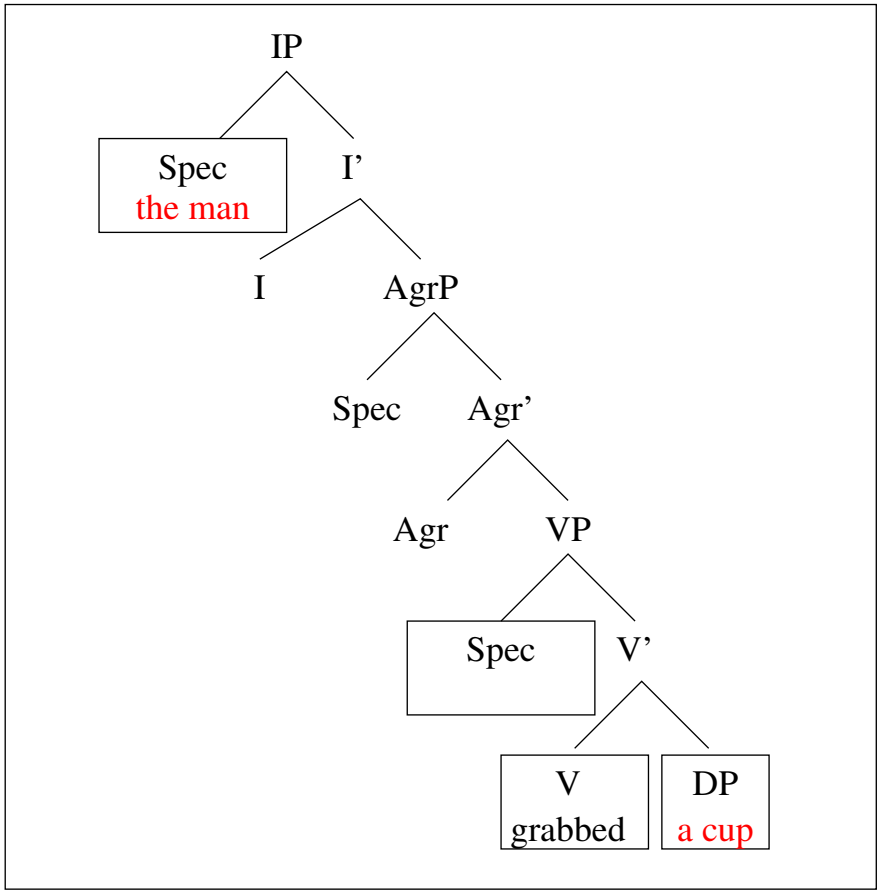

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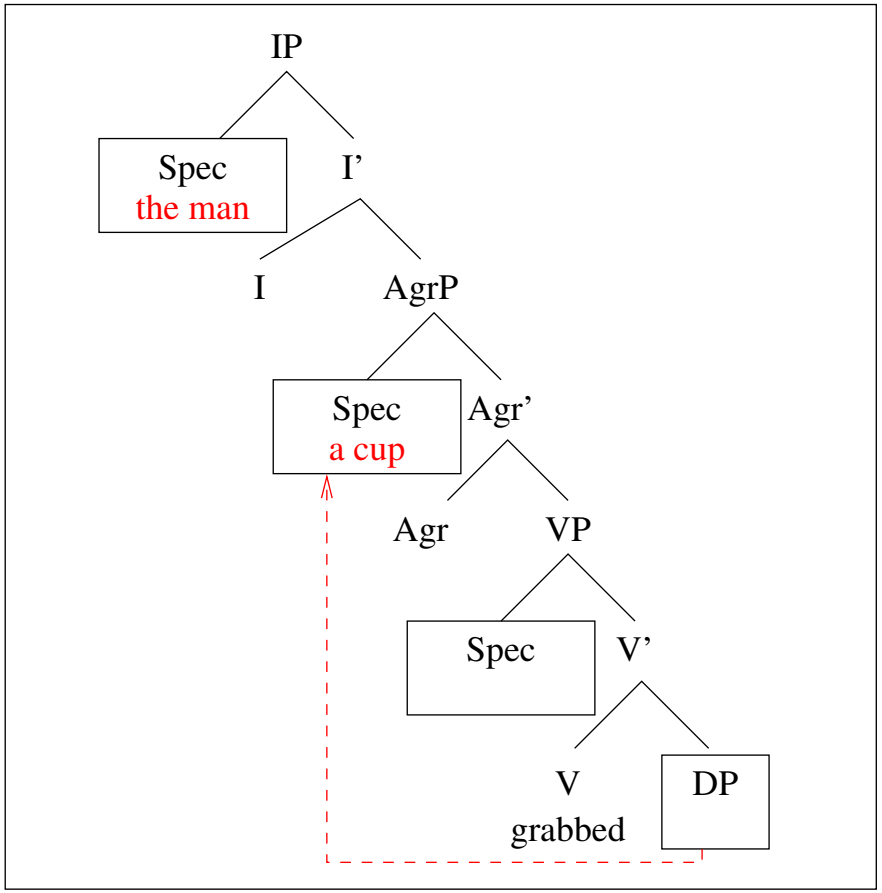

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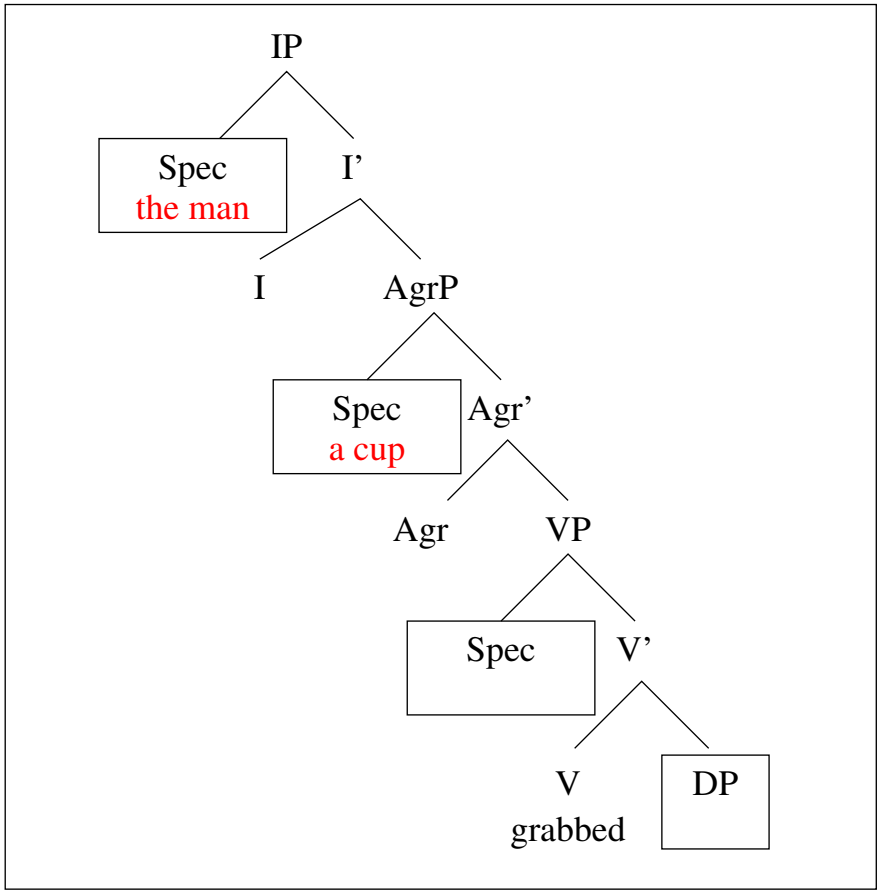

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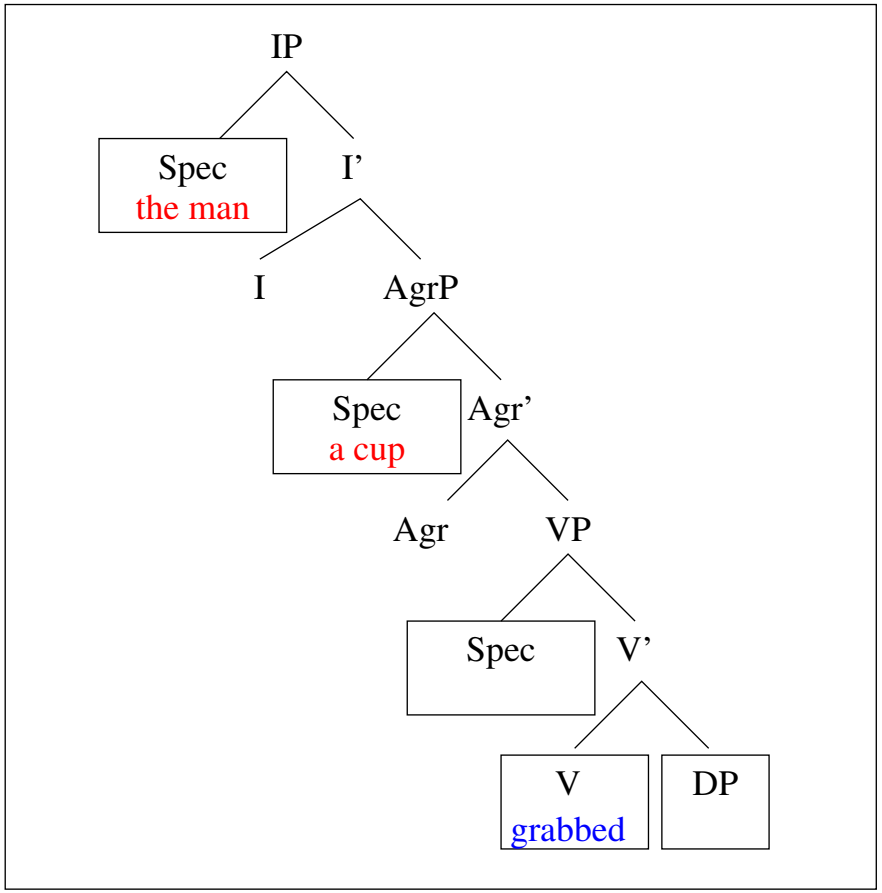

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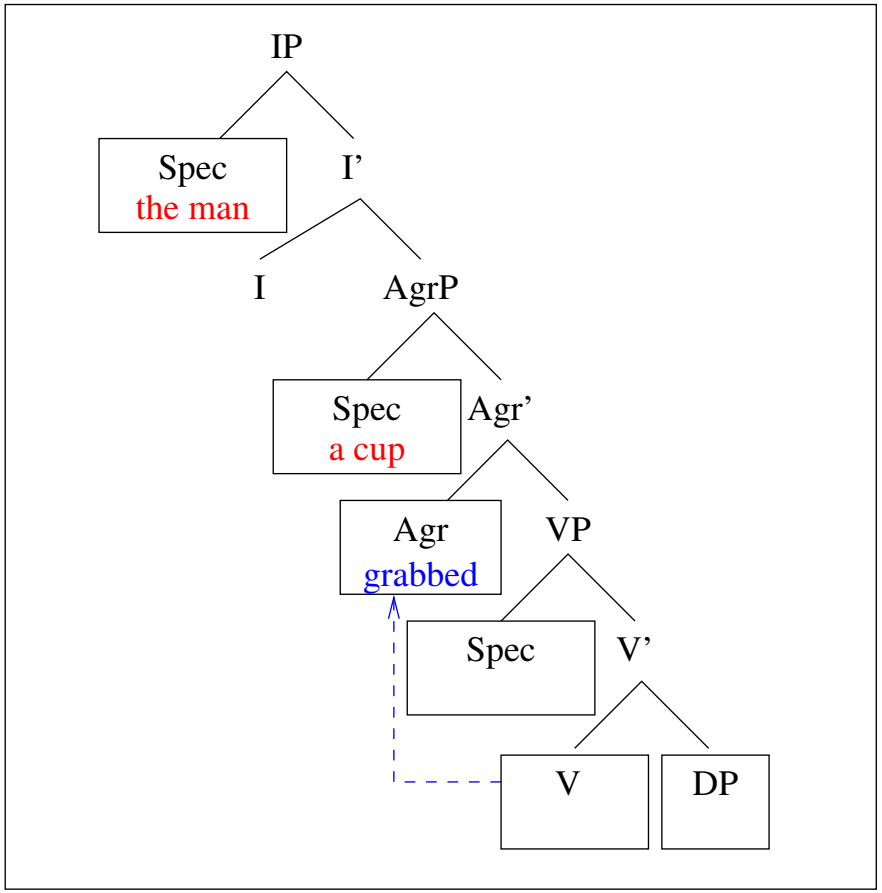

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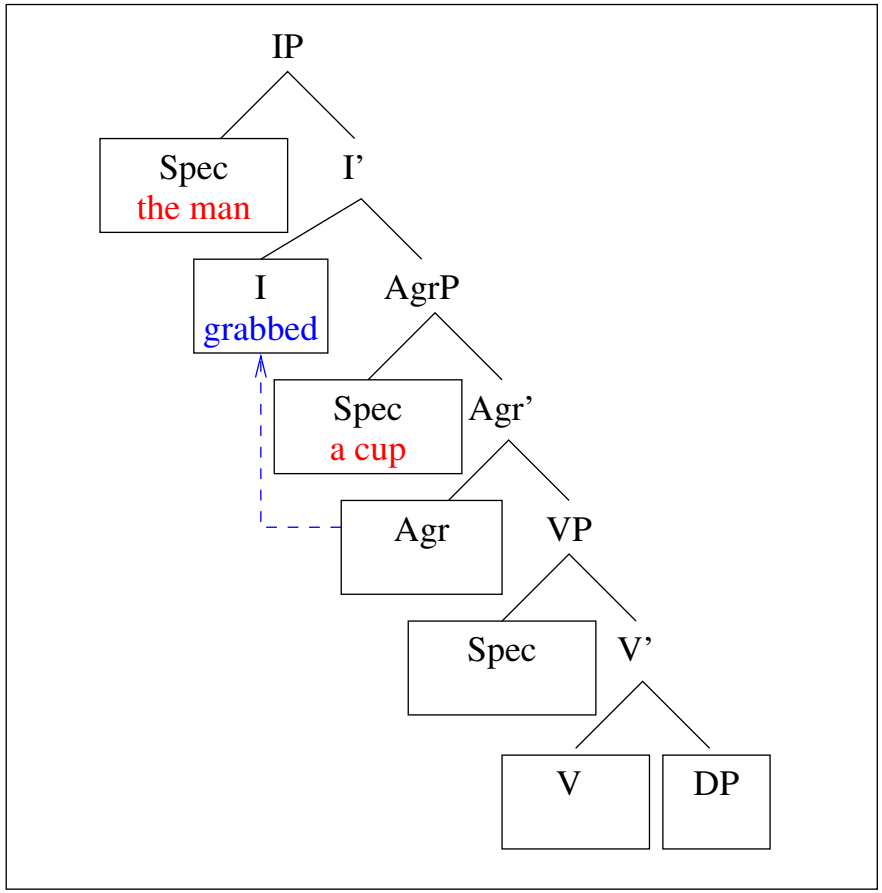

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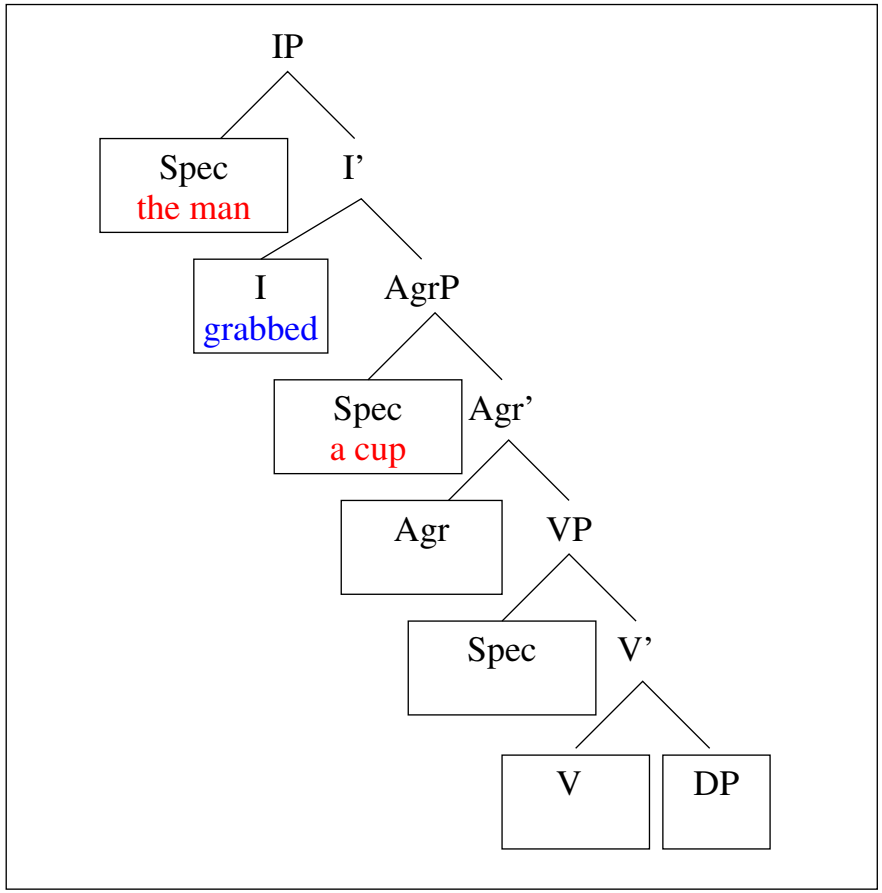
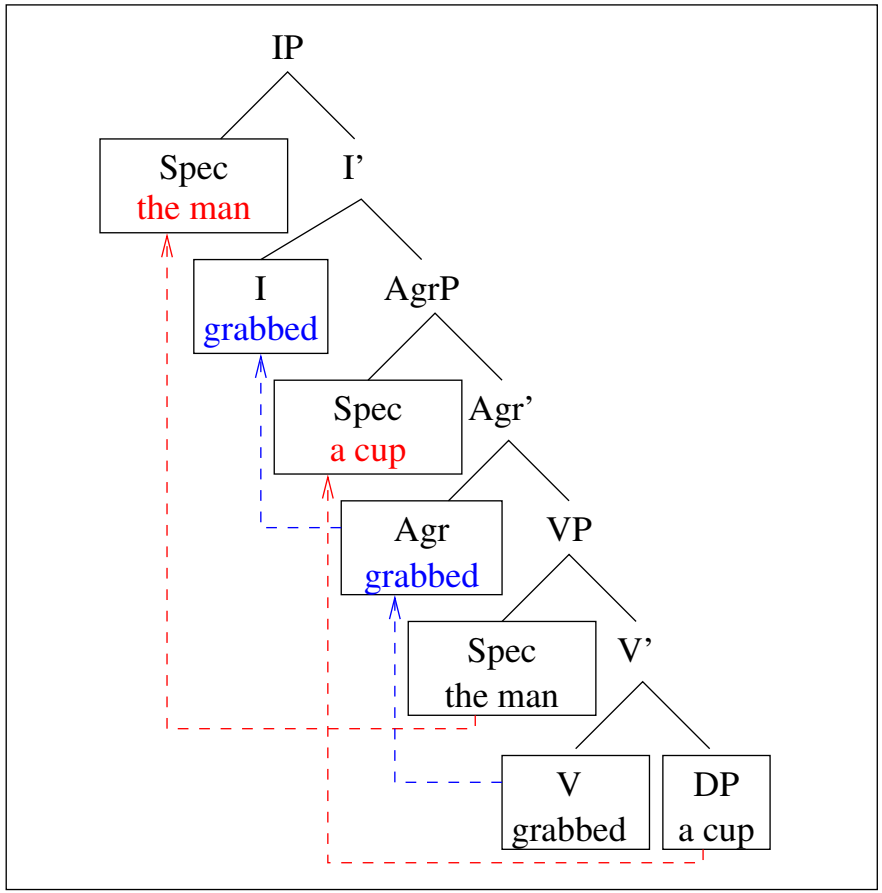


The LF of *The man grabbed a cup*

Moved elements leave traces.



Outline of today's lecture

- The idea of a SM characterisation of LF.
- Proposal: a SM interpretation of LF.

The idea of a SM characterisation of LF

My hypothesis:

'An LF structure describes a sensorimotor process.'

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What does that mean?

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What does that mean?

Consider the LF structure of *The man grabbed a cup*.

What is this, for a syntactician?

- It's a structure from which the 'meaning' of the sentence can be extracted.

The idea of a SM characterisation of LF

My hypothesis:

> *'An LF structure describes a sensorimotor process.'*

What does that mean?

Consider the LF structure of *The man grabbed a cup*.

What is this, for a syntactician?

- It's also a description of how the mechanism which generates *all sentences* generated *this particular sentence*.

The idea of a SM characterisation of LF

My hypothesis:

> *'An LF structure describes a sensorimotor process.'*

What does that mean?

Consider the LF structure of *The man grabbed a cup*.

What is this, for a syntactician?

- It also expresses a hypothesis about 'universal grammar': the idea that at the level of LF, all languages are the same.

The idea of a SM characterisation of LF

My hypothesis:

> *'An LF structure describes a sensorimotor process.'*

What does that mean?

Consider the SM model of the cup-grabbing episode.

What does this provide?

- A model of how the episode is experienced.
  (Key idea: it's a sequence.)

The idea of a SM characterisation of LF

My hypothesis:

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What does that mean?

Consider the SM model of the cup-grabbing episode.

What does this provide?

- A model of how the episode is retained in WM.
  (Key idea: it's stored as a 'replayable' sequence plan.)

The idea of a SM characterisation of LF

My hypothesis (more precisely):

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Proposal:

- We 'entertain the meaning' of the sentence *The man grabbed a cup* by rehearsing its associated SM sequence.

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What has that process got to do with a description of the generative mechanism?

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My hypothesis (more precisely):

> *'An LF structure describes*
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What has that process got to do with a description of the generative mechanism?

Proposal:

- The SM system (and the world) place *constraints* on the SM sequences which can be experienced.
- These constraints *define the generative mechanism*.

The idea of a SM characterisation of LF

My hypothesis (more precisely):

> *'An LF structure describes*
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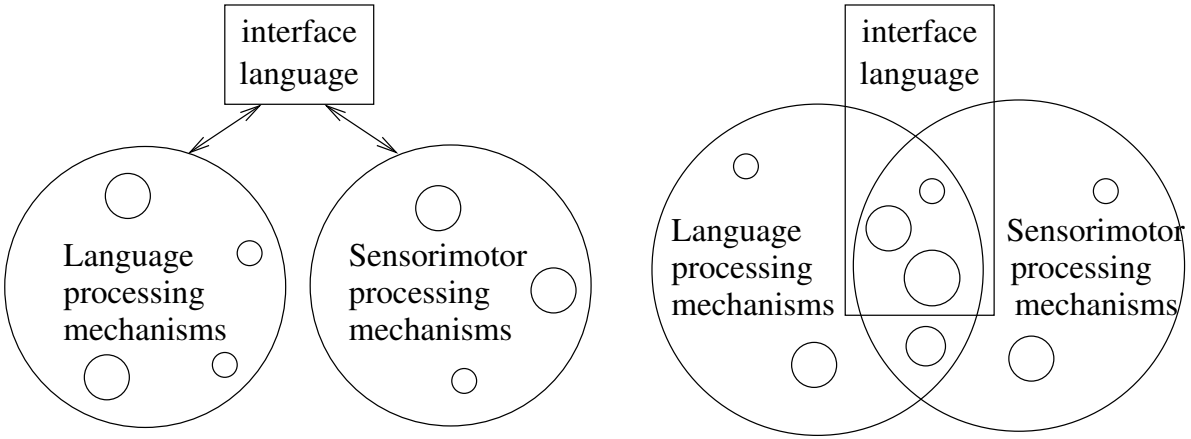
What has that process got to do with universal grammar?

Universal grammar revisited

Linguists tend to think of the 'generative mechanism' as a Fodorian module.



But that's not the only way to think about it.

- My proposal: the generative mechanism overlaps with SM mechanisms.
- Linguistic universals are then explained by the fact that we all have the same SM mechanisms.

Reading LF as the trace of a replayed sequence

Timecourse of SM signals during the replayed cup-grabbing episode:

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Planned action signals	Context signals	Action signals	Reafferent signals
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A SM interpretation of the X-bar schema

Proposal:

> *An XP schema describes a single iteration within a replayed SM sequence.*

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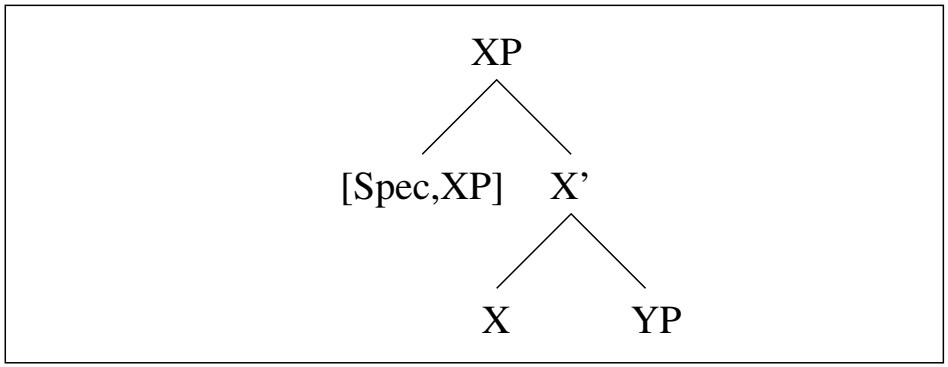
Each item in the XP schema has a SM interpretation.



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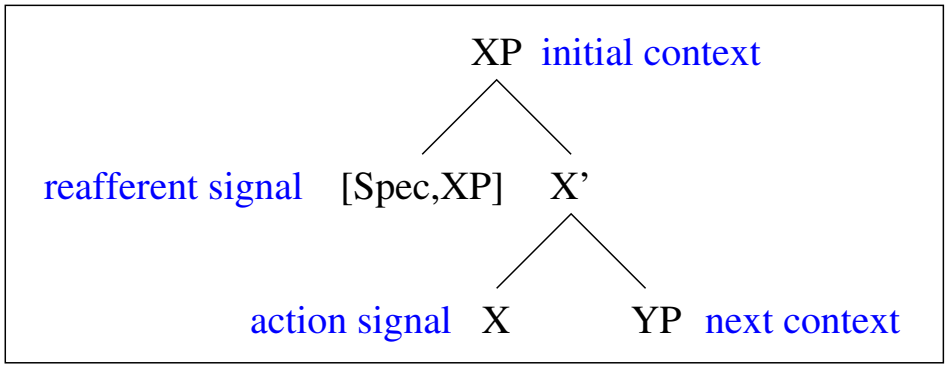

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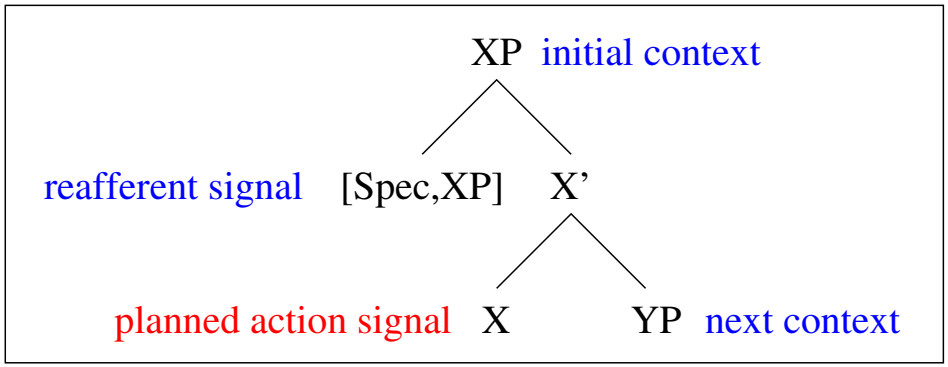
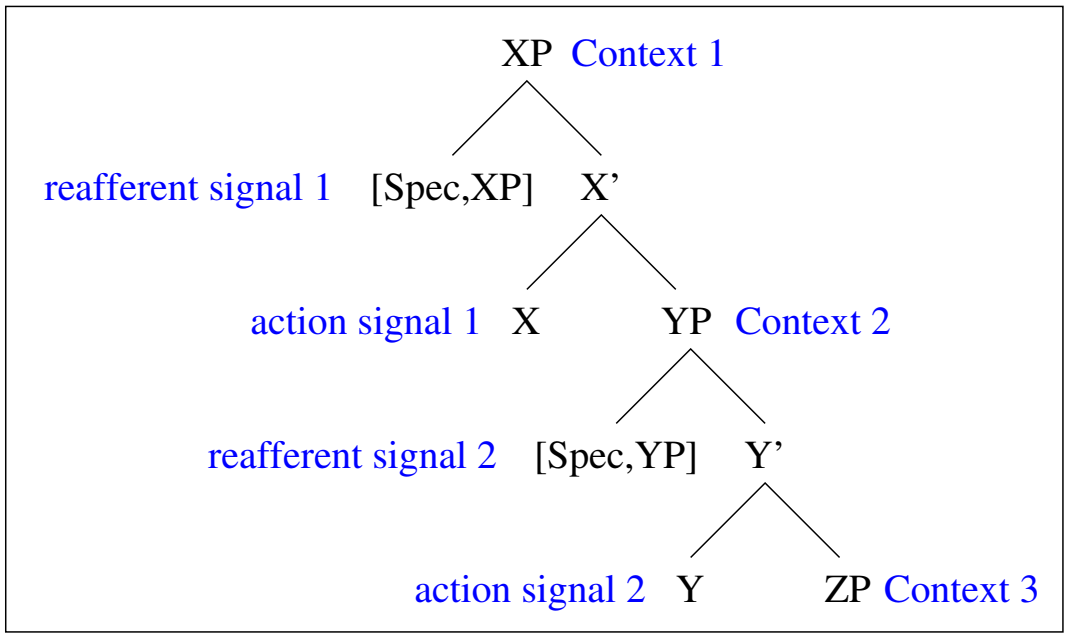


Right-branching structures of X-bar schemas

In a right-branching X-bar structure, the next context of one XP is the initial context of its complement XP.

So a right-branching structure of XPs describes *successive iterations* in the sequence.



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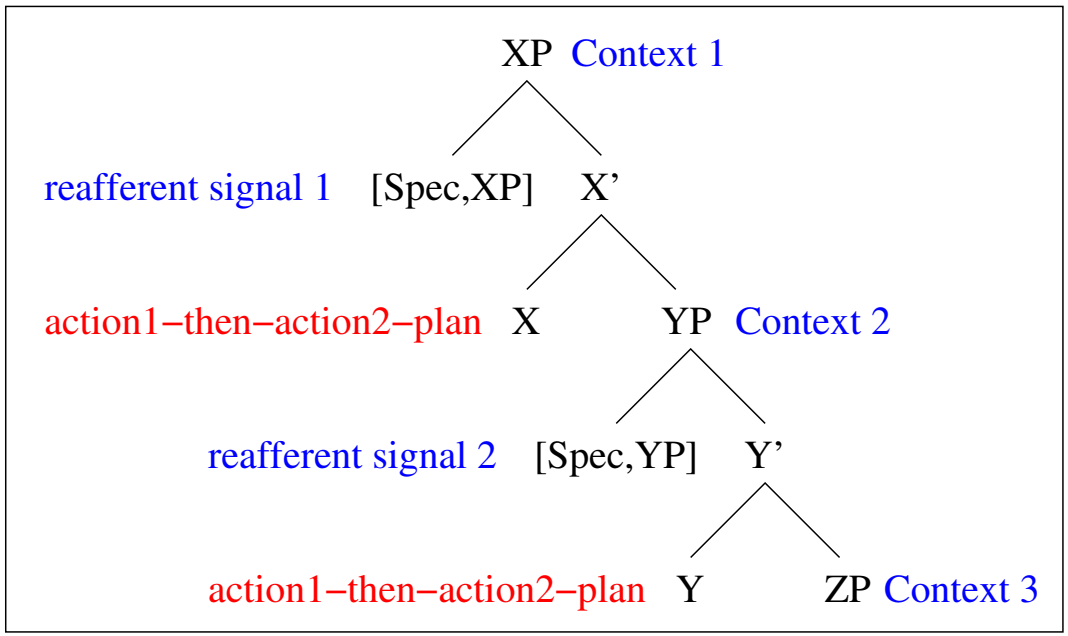
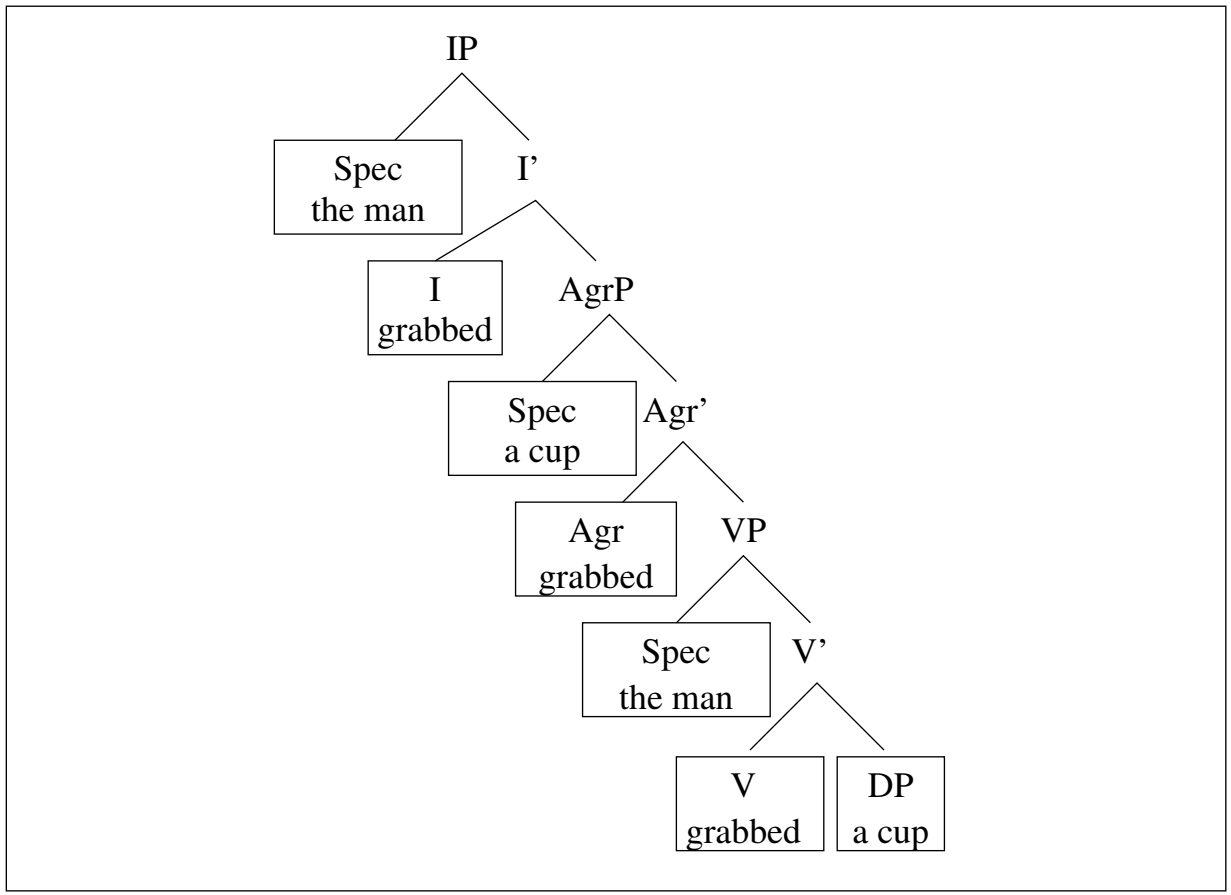


SM interpretation of a transitive clause

The four LF projections map onto the four stages of the SM sequence.



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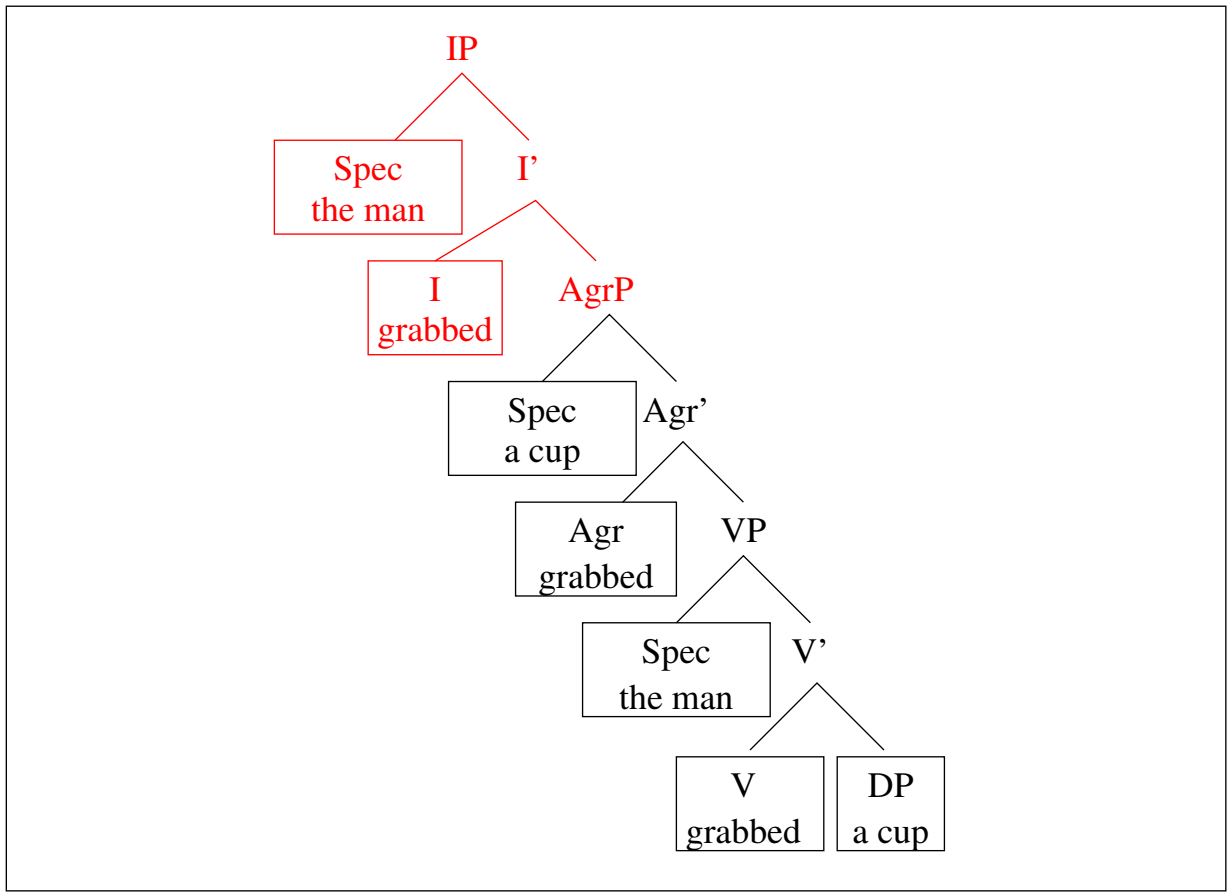

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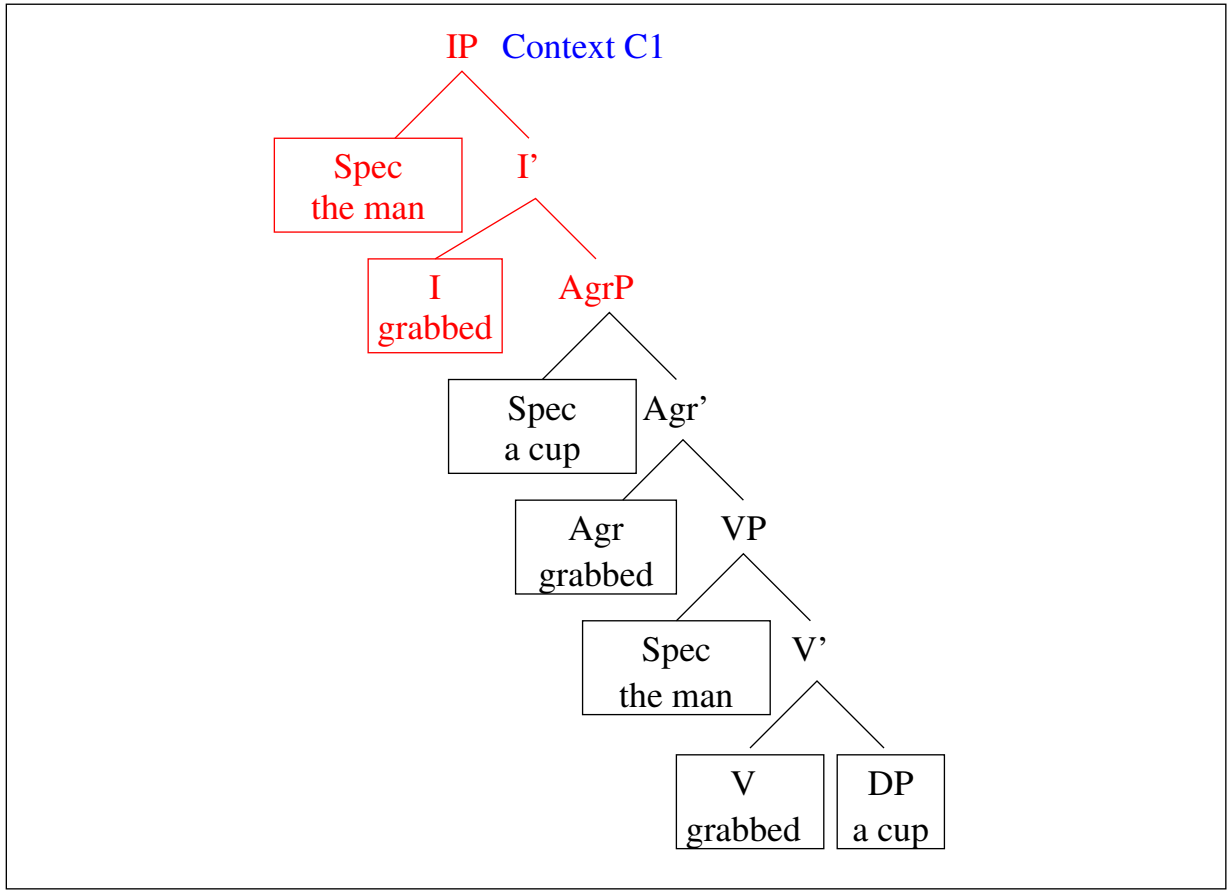

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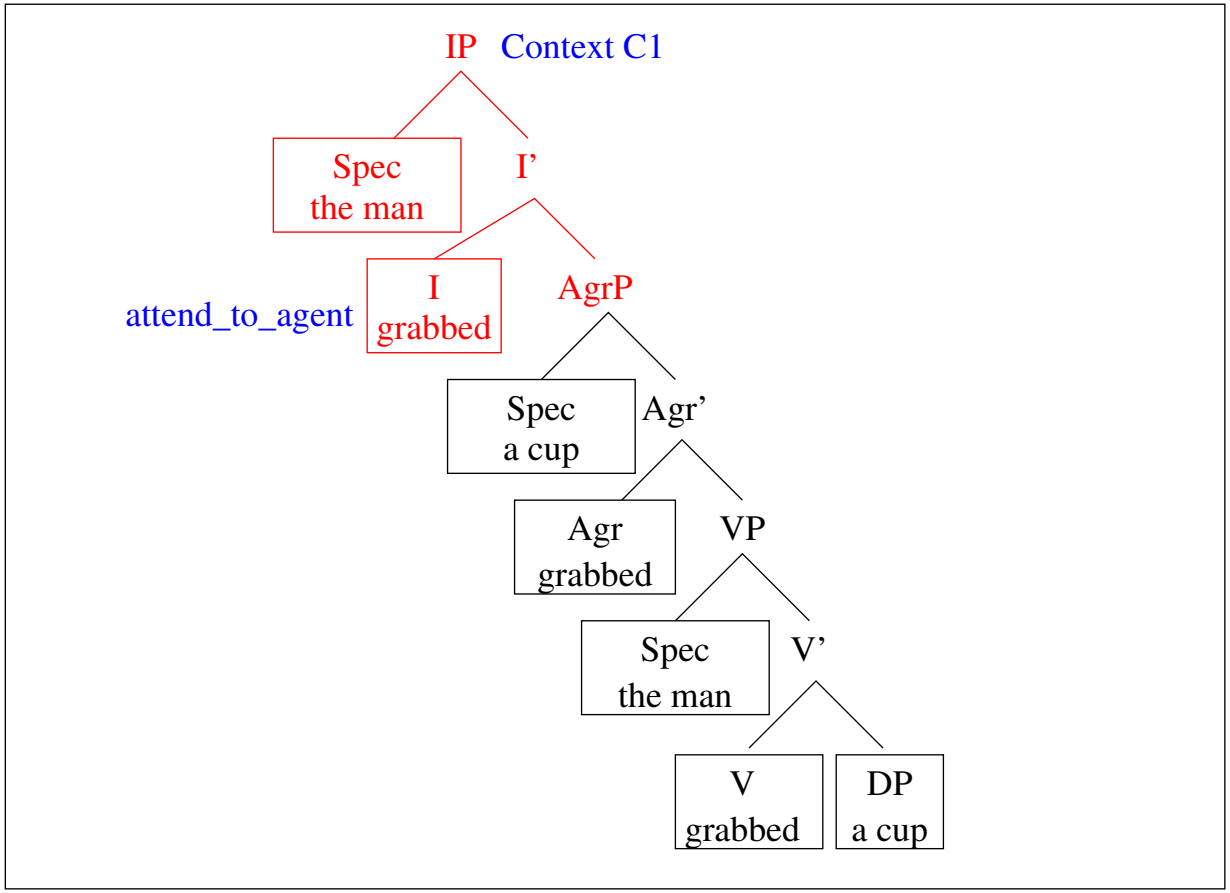

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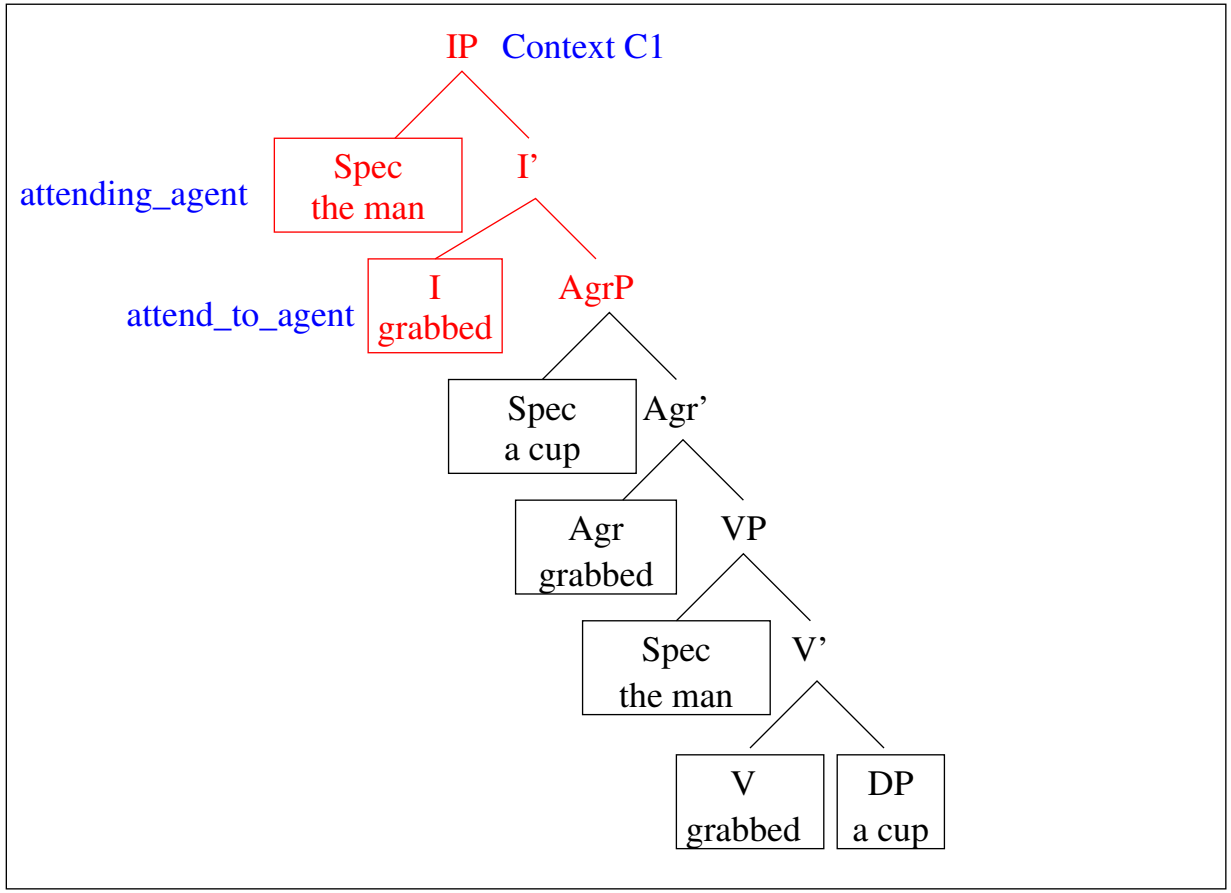

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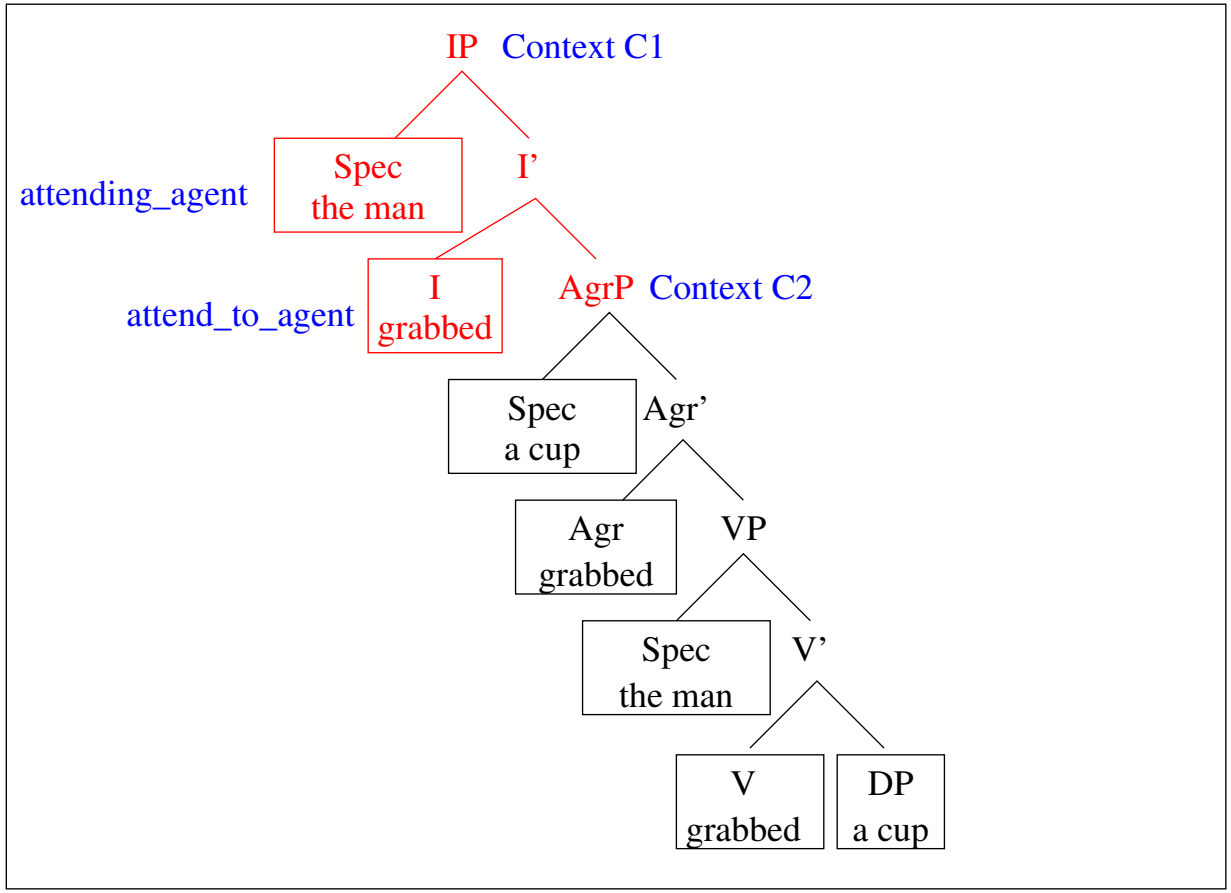

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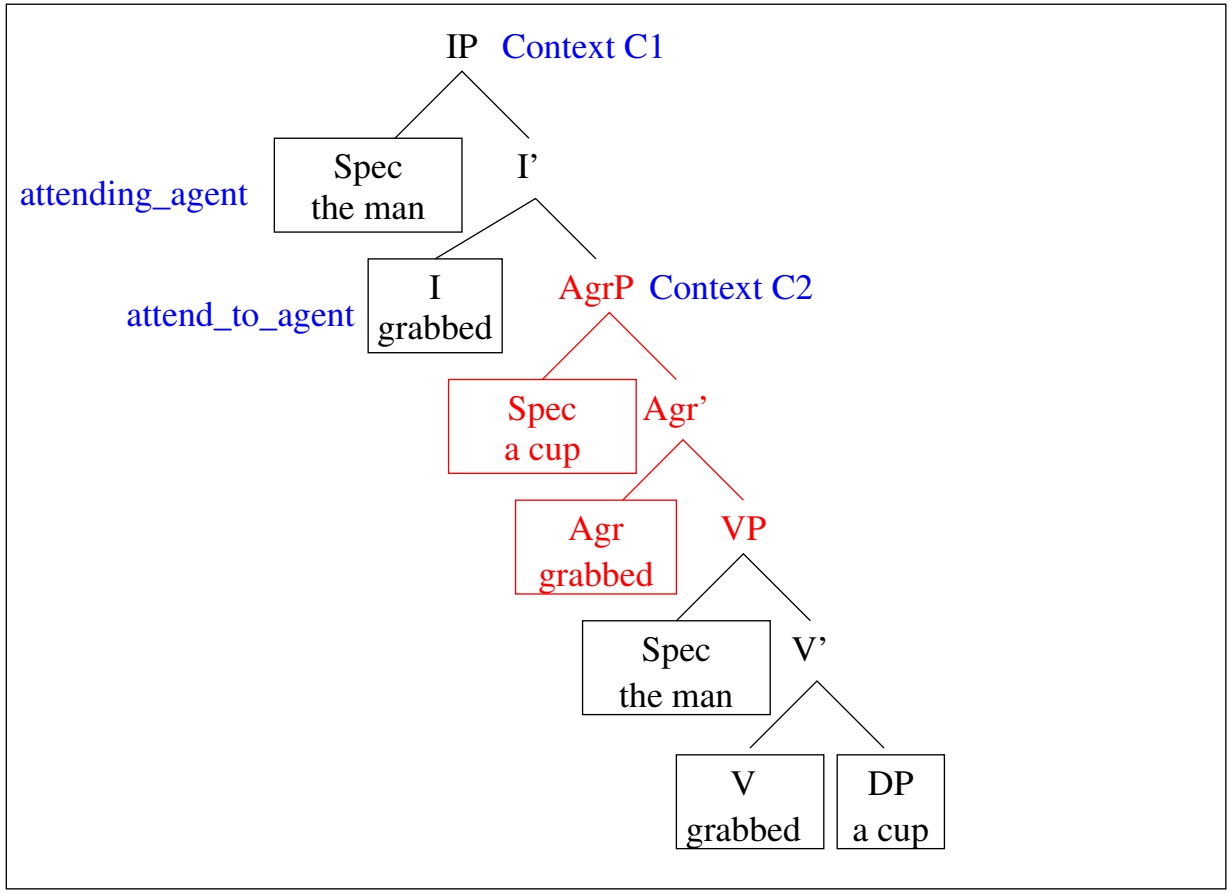

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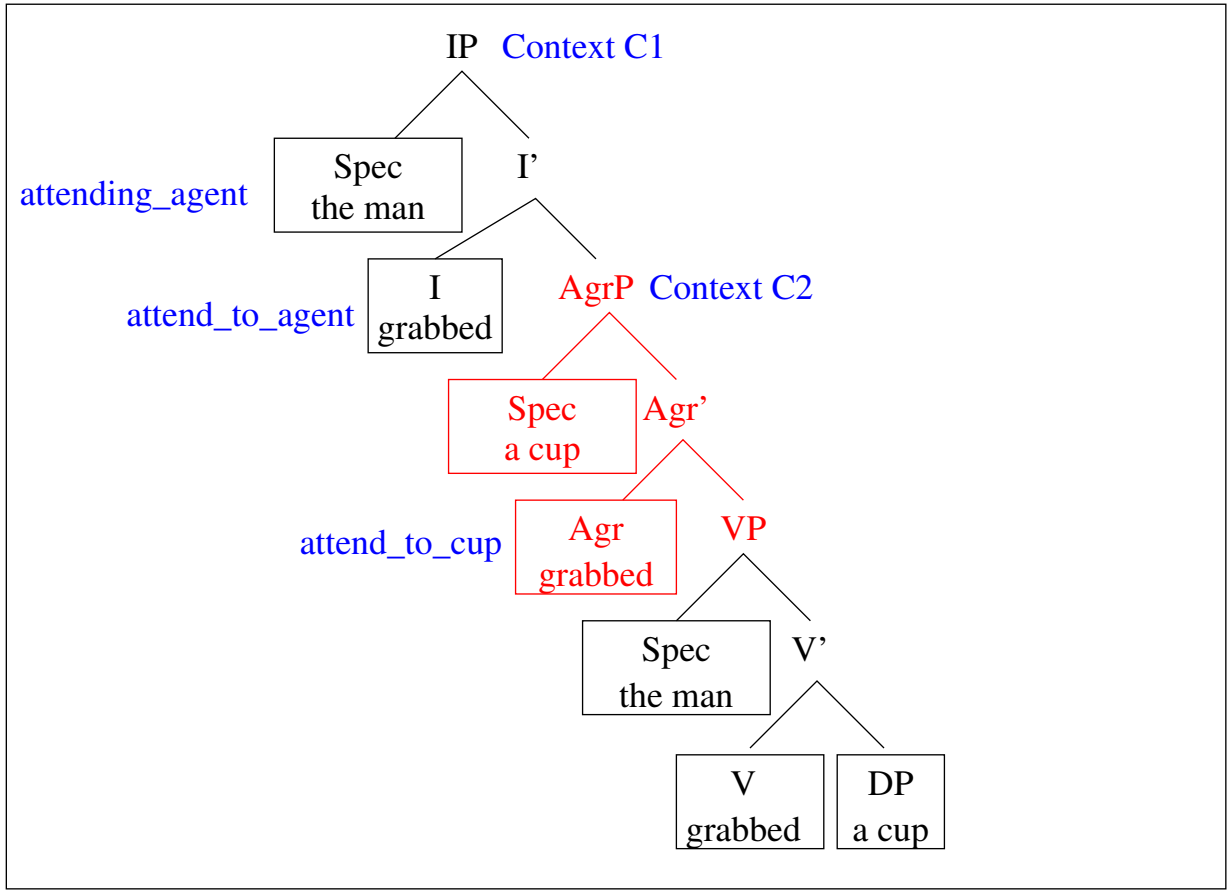

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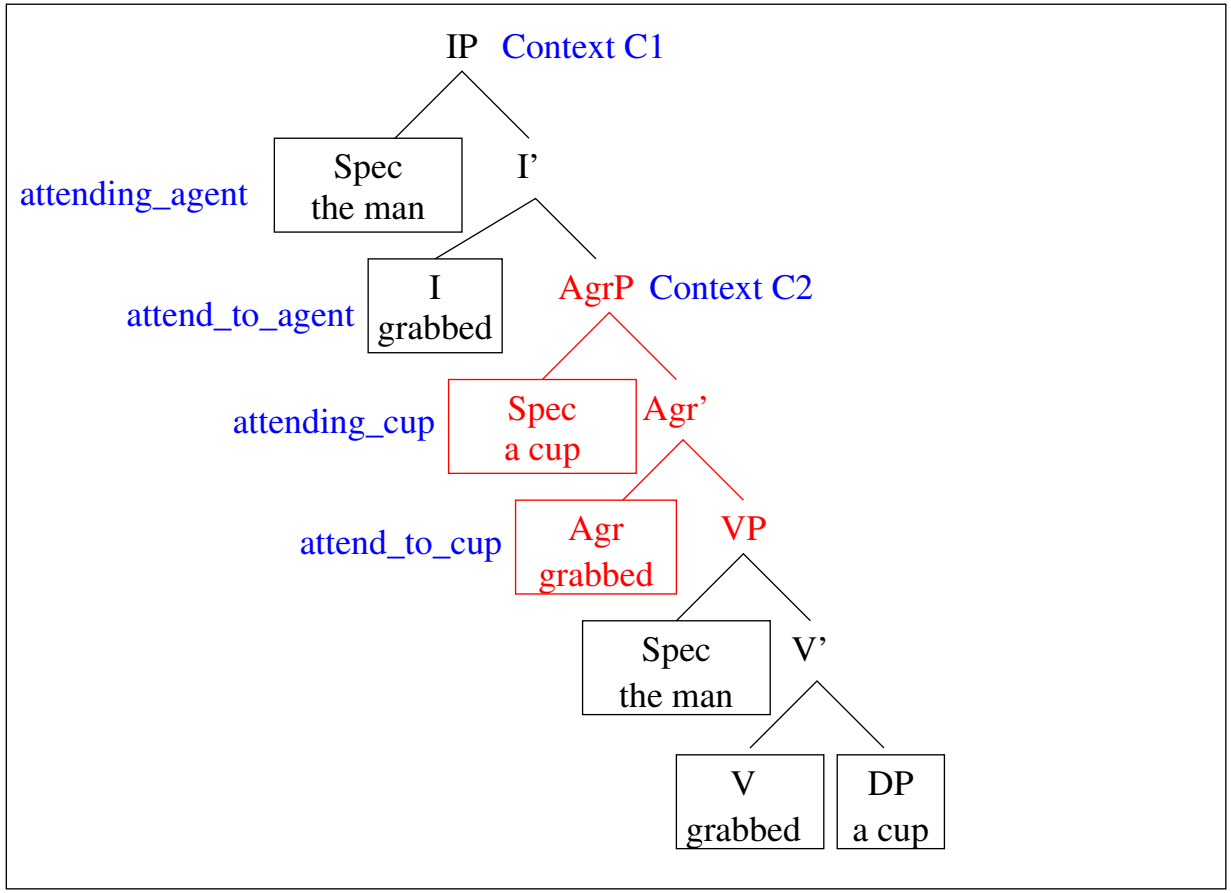

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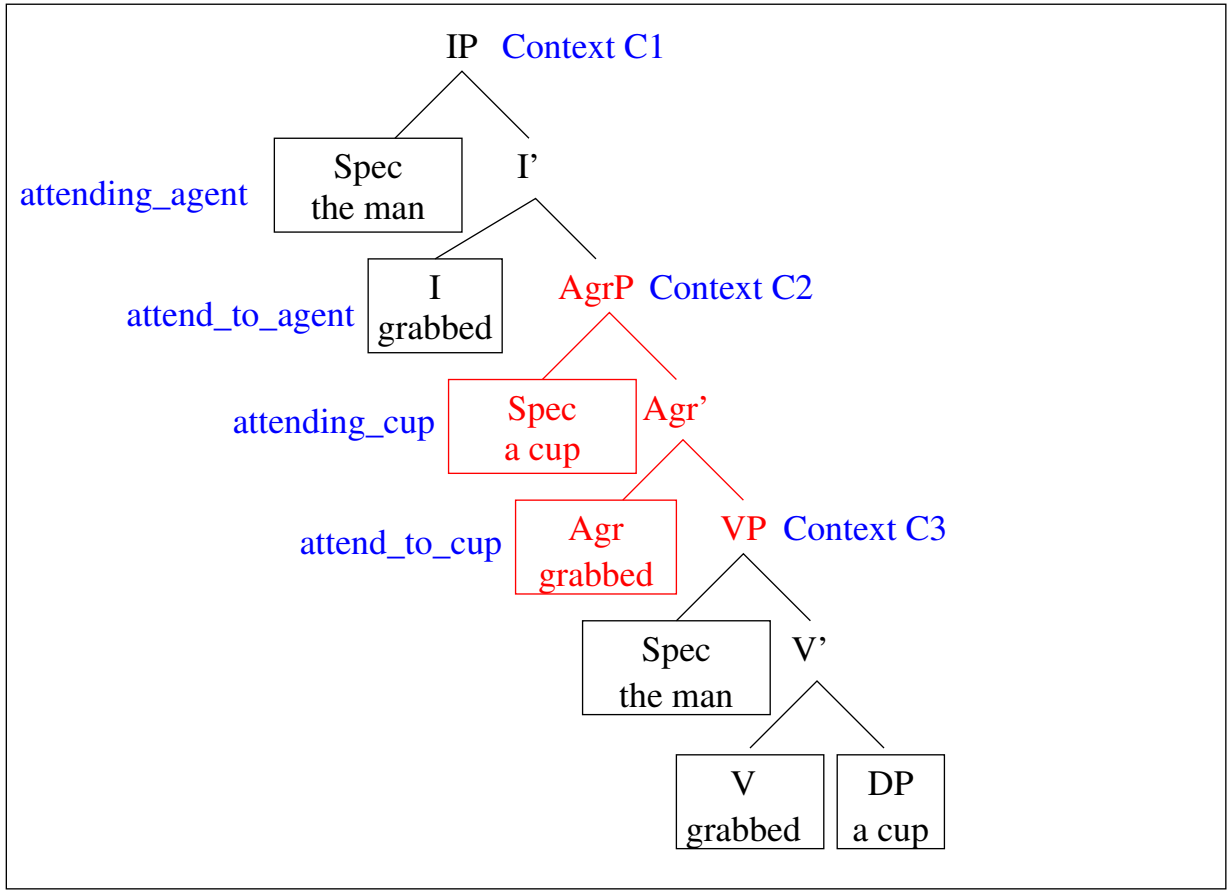

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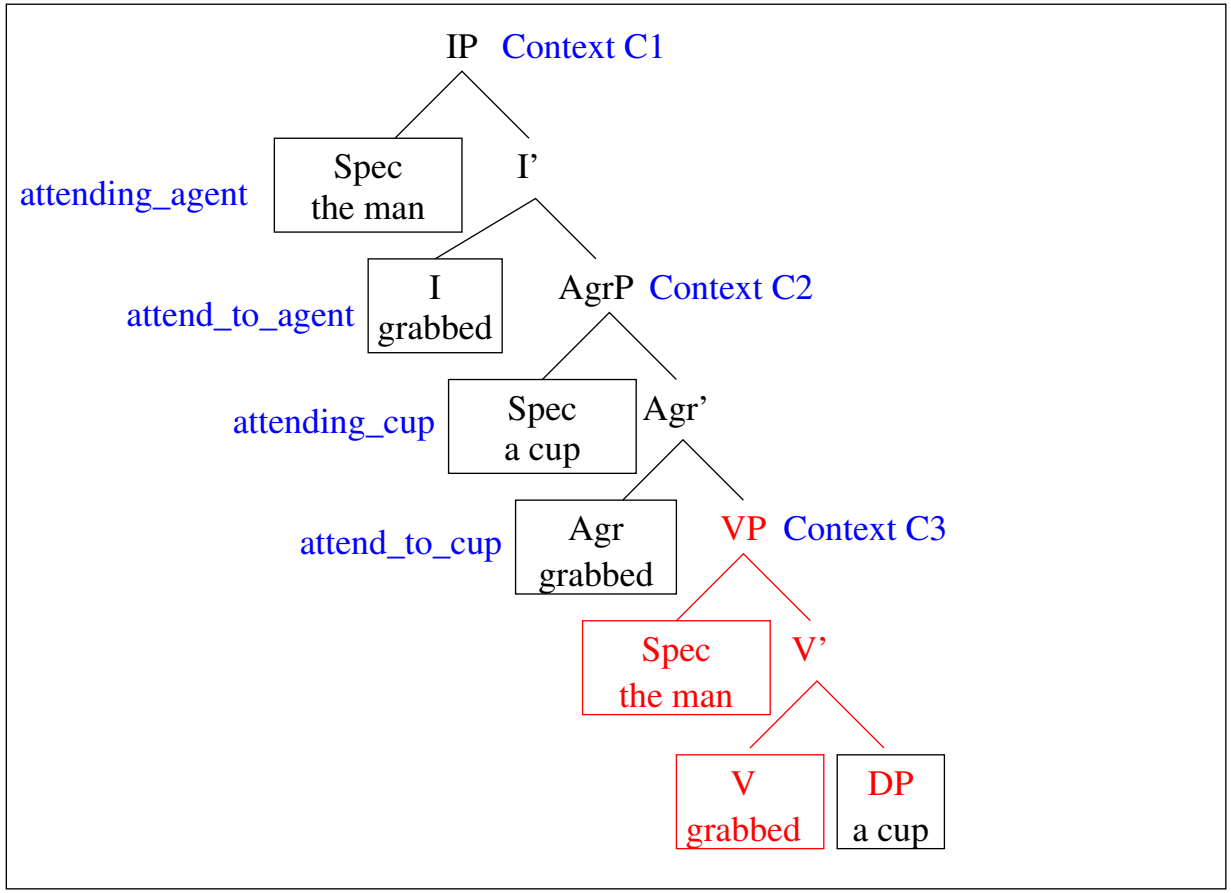

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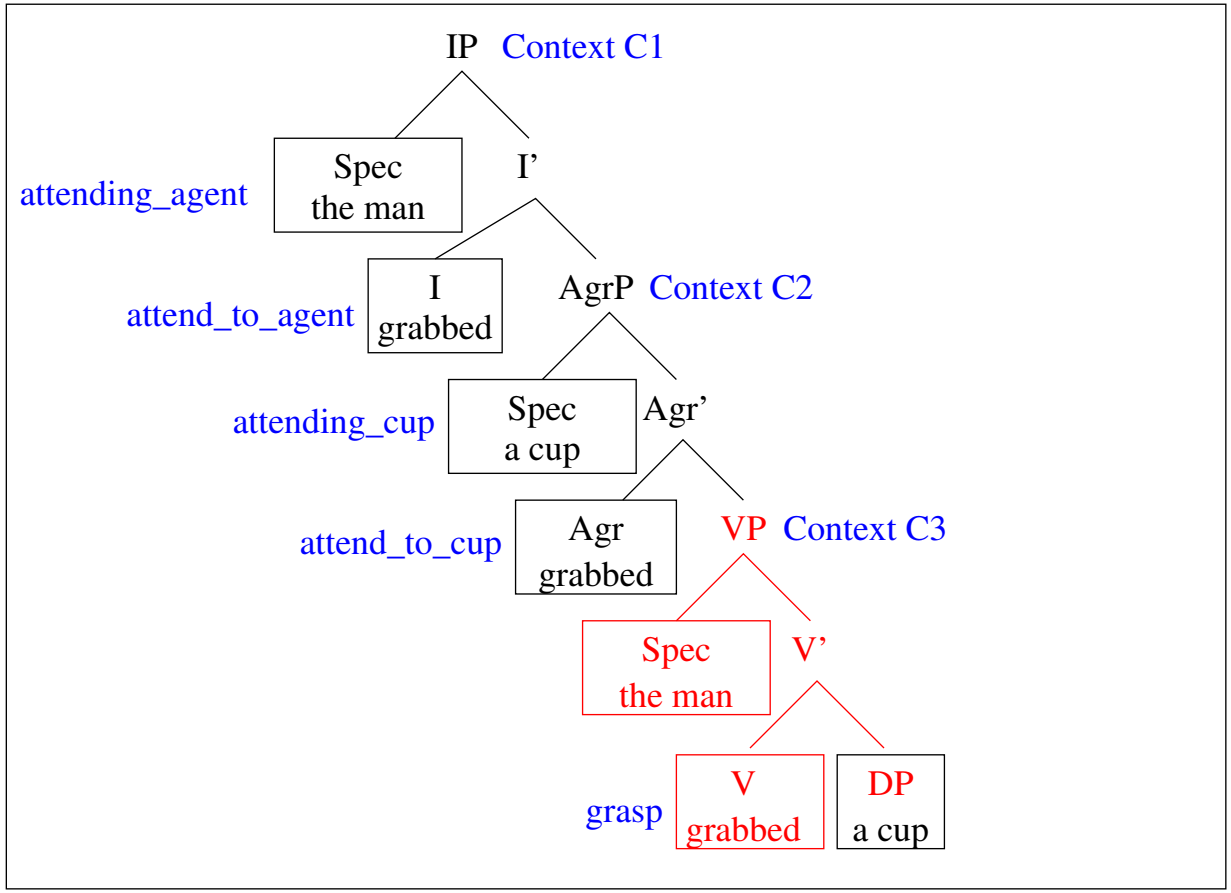

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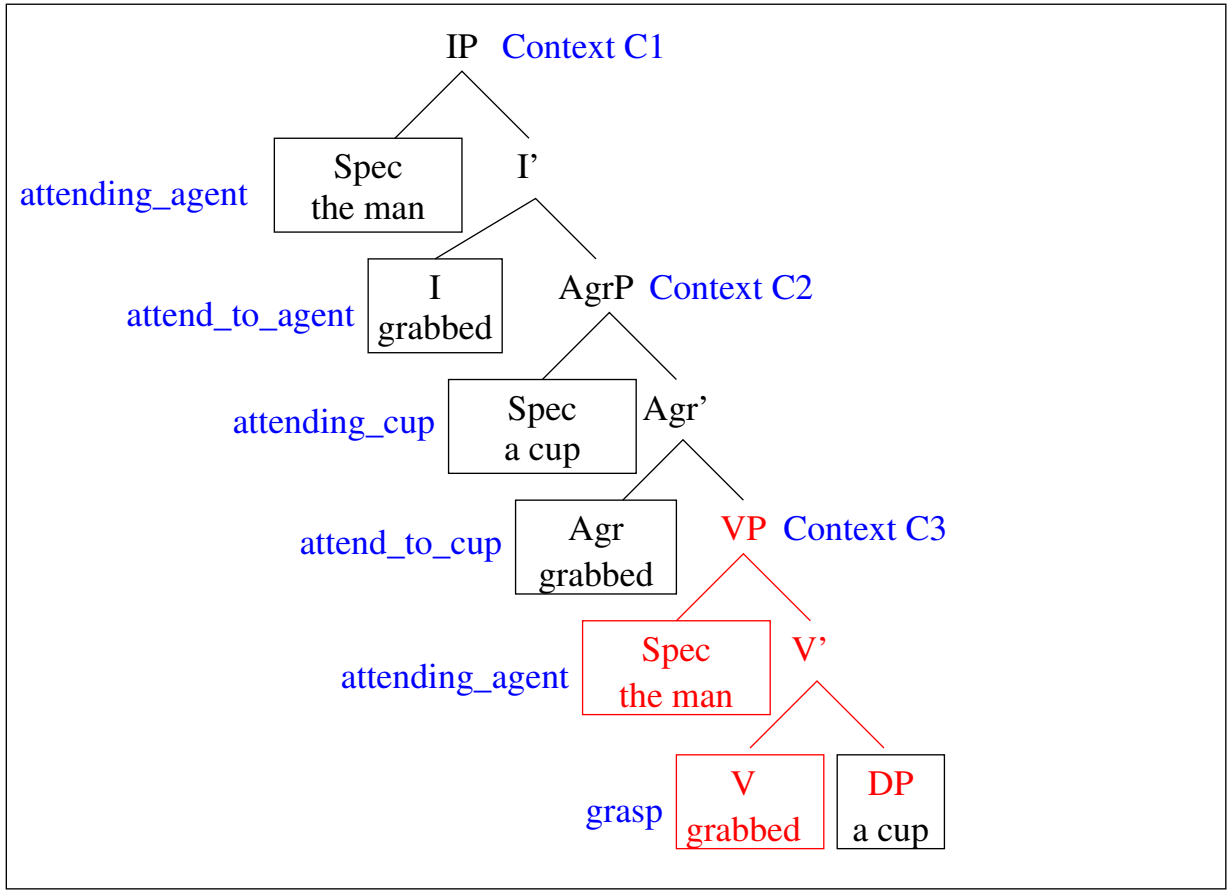

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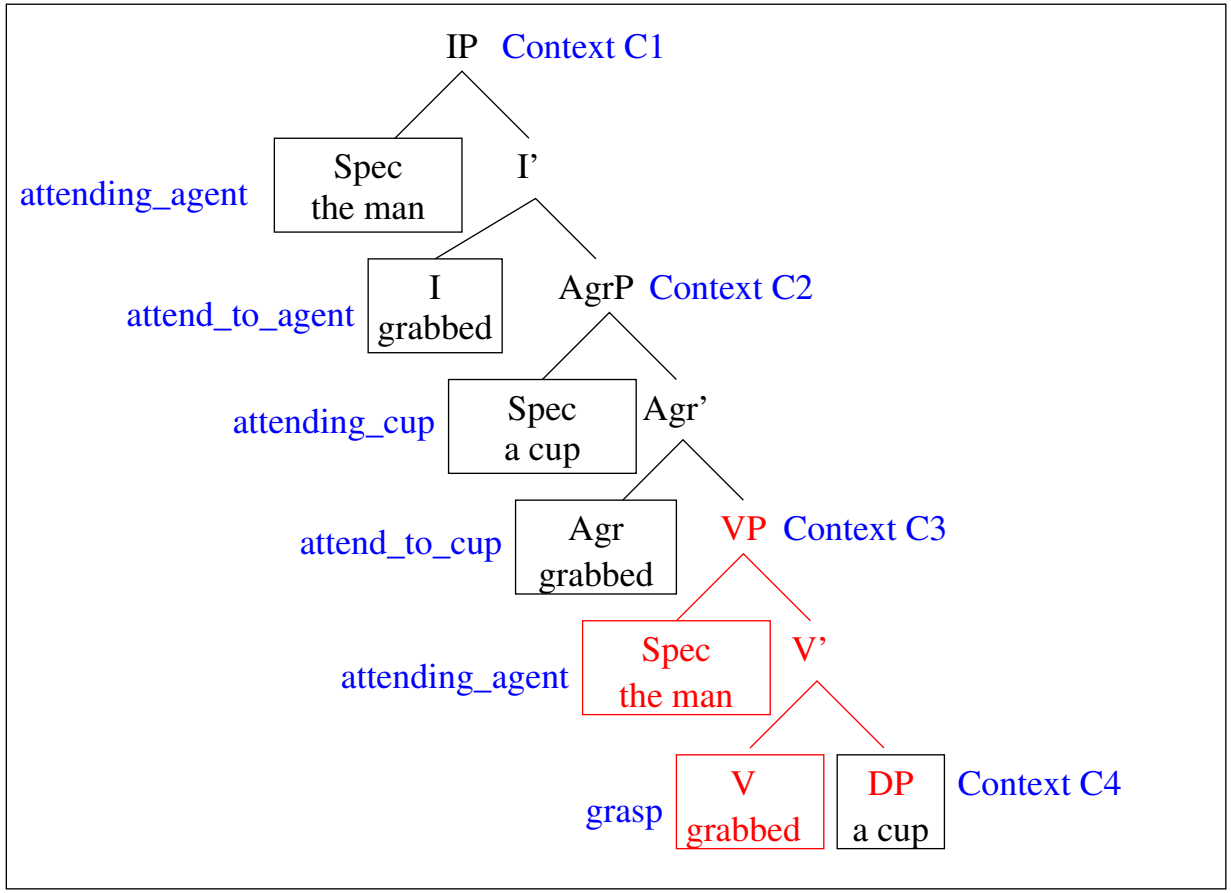

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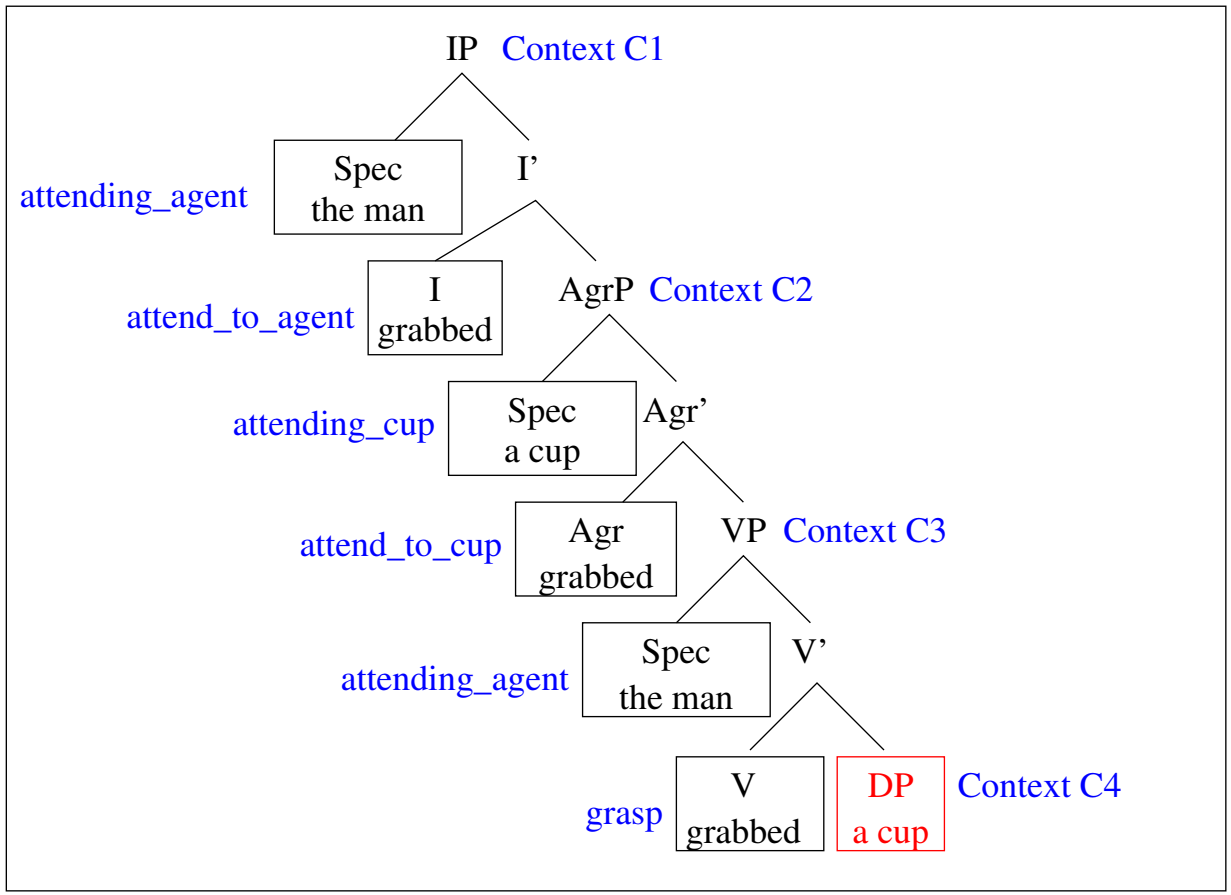

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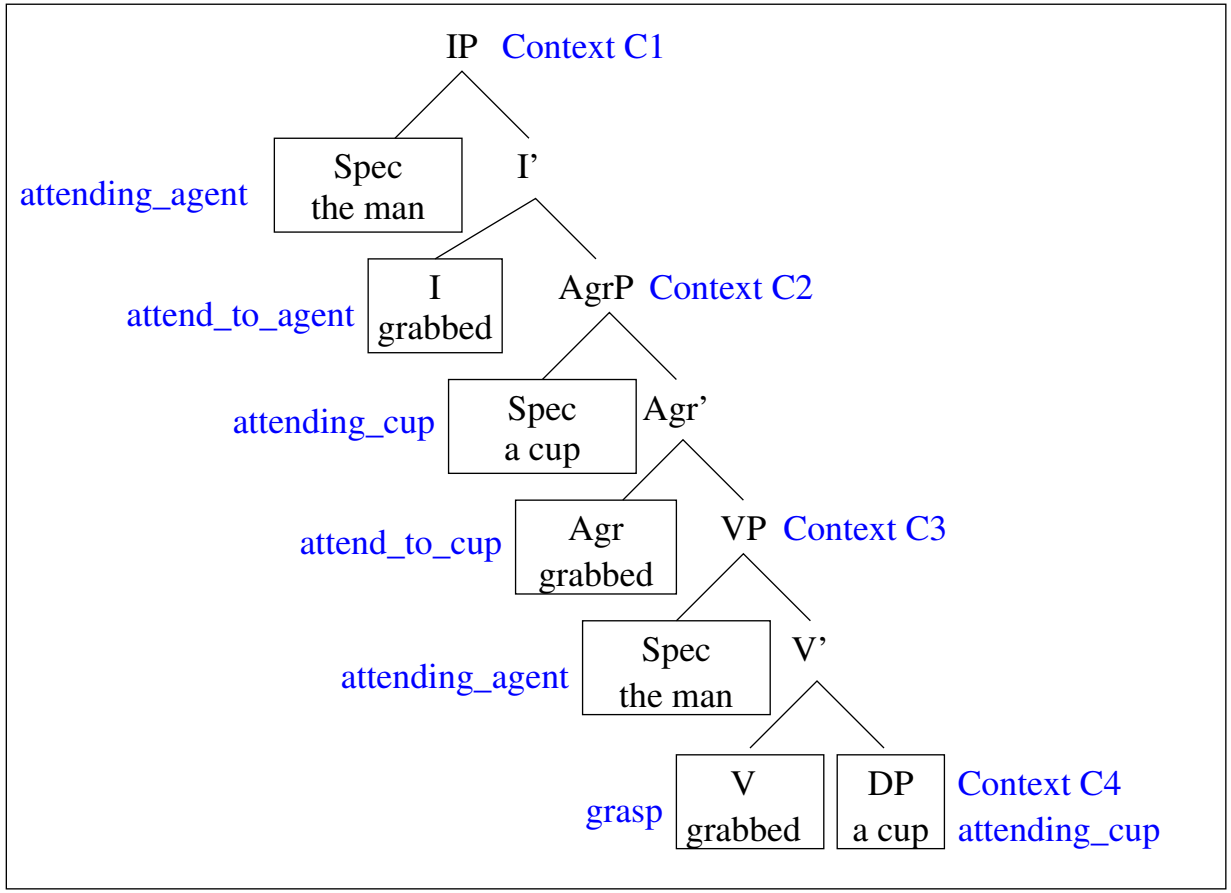
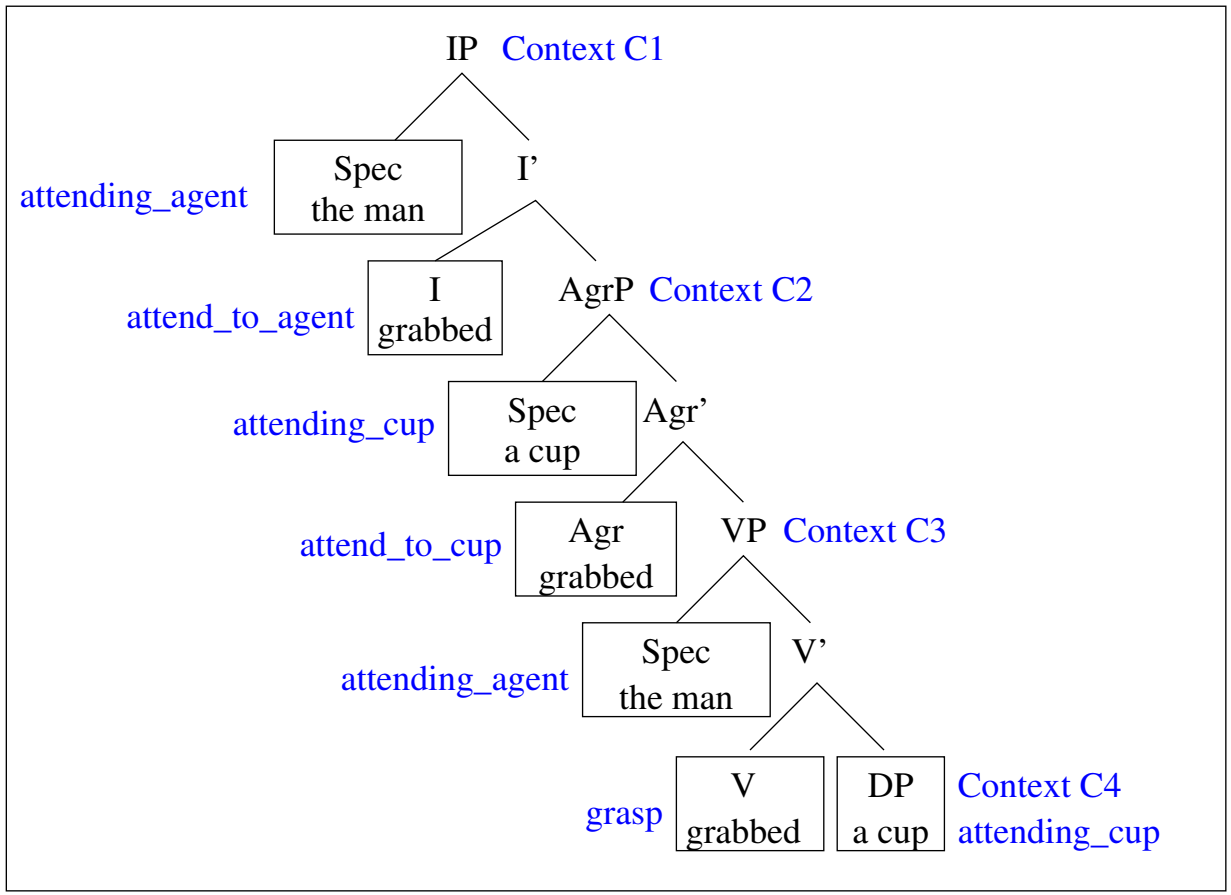


SM interpretation of a transitive clause

DP raising reflects operations of *re-attention to agent and patient*.



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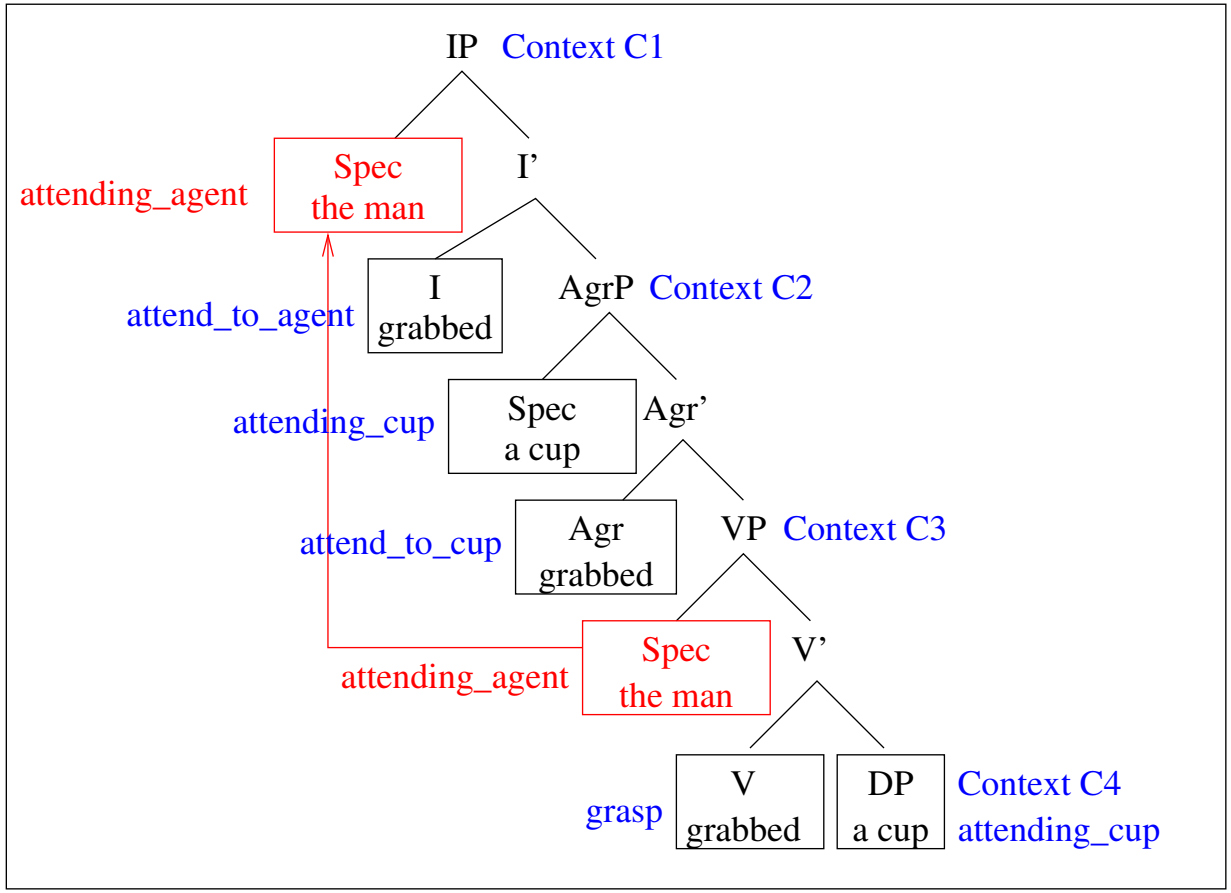

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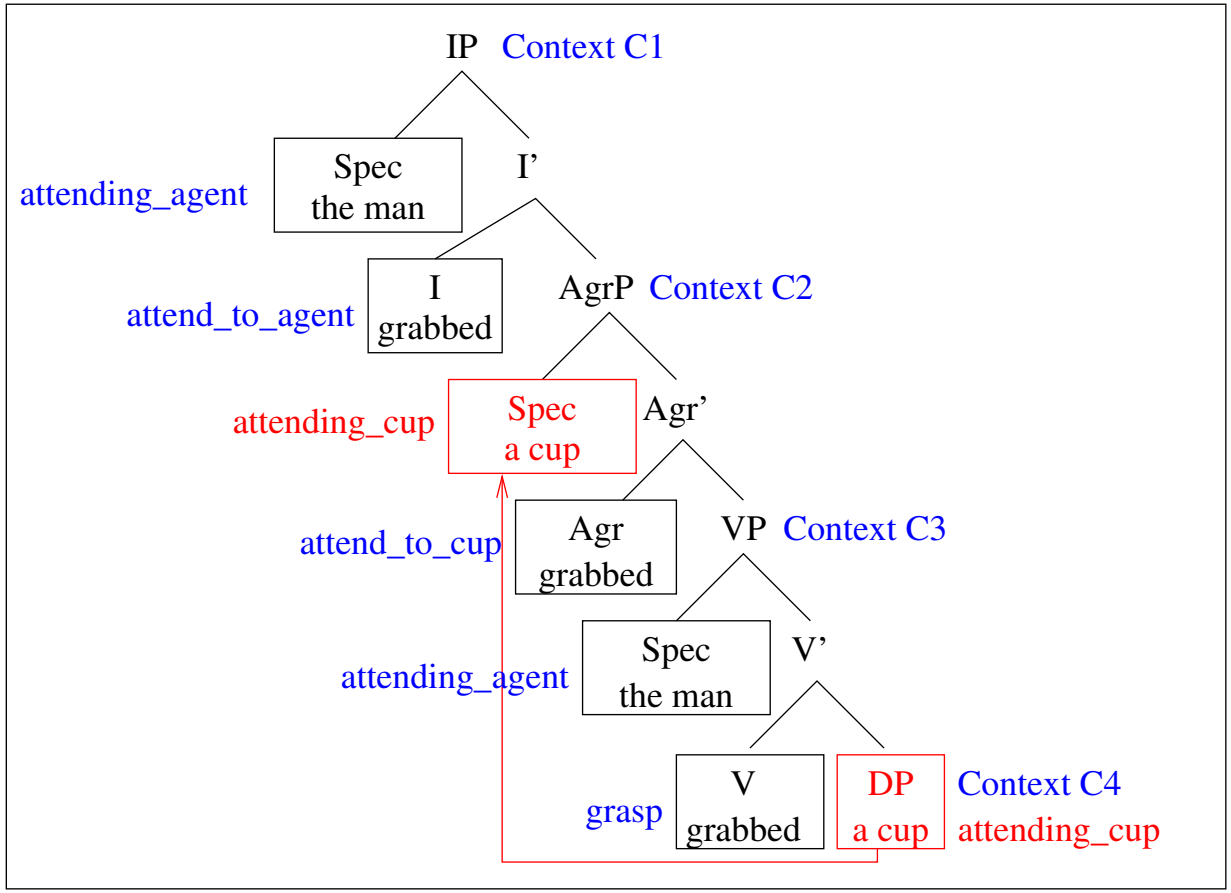
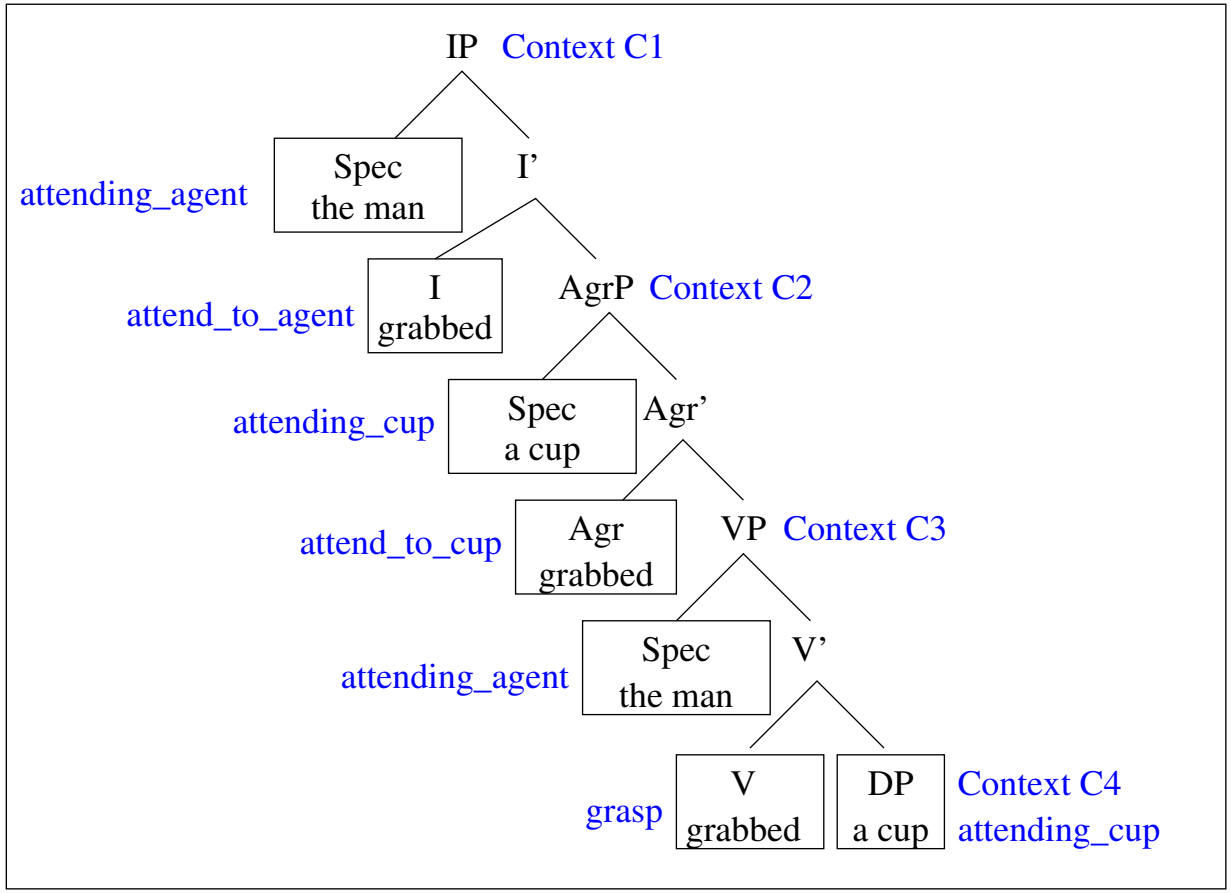


SM interpretation of a transitive clause

V-Agr-I raising reflects *tonically active planned action signals*.



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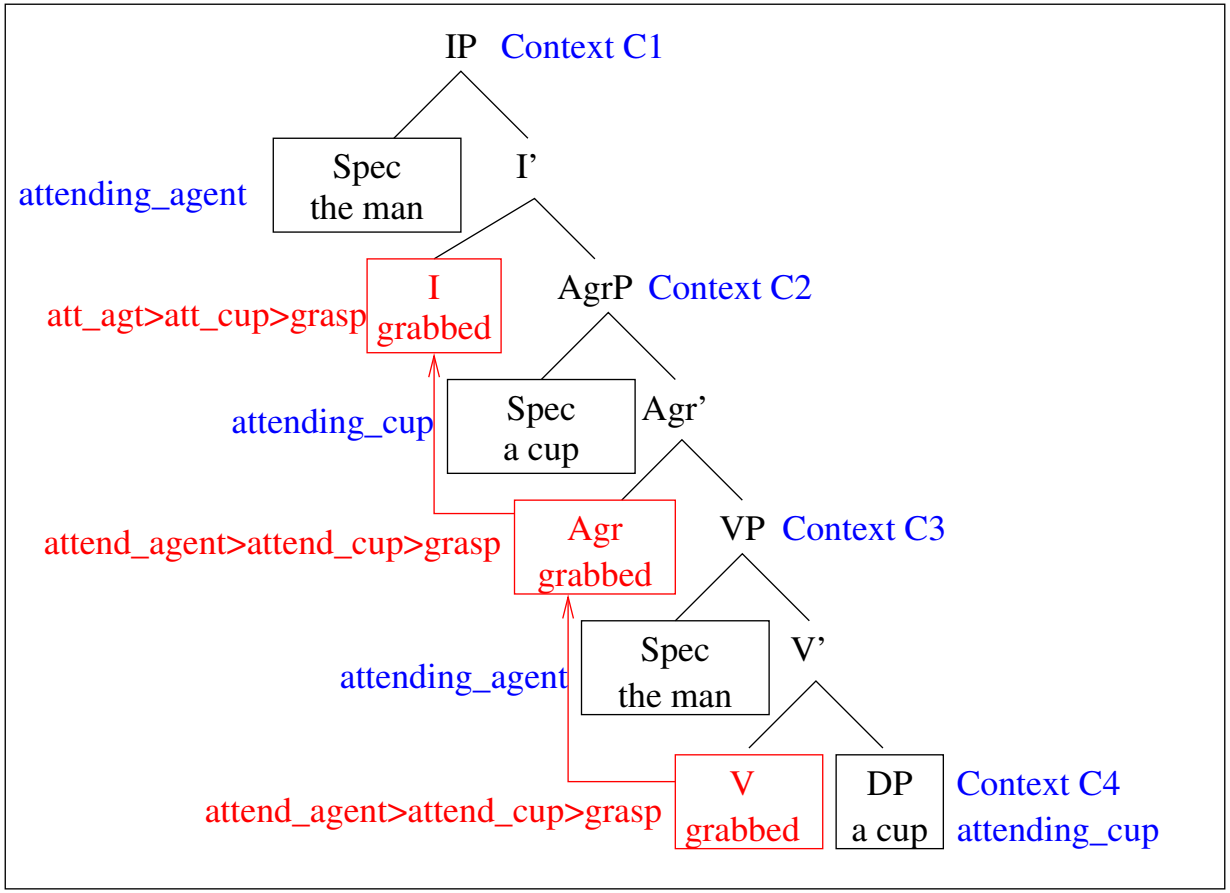


A reality check

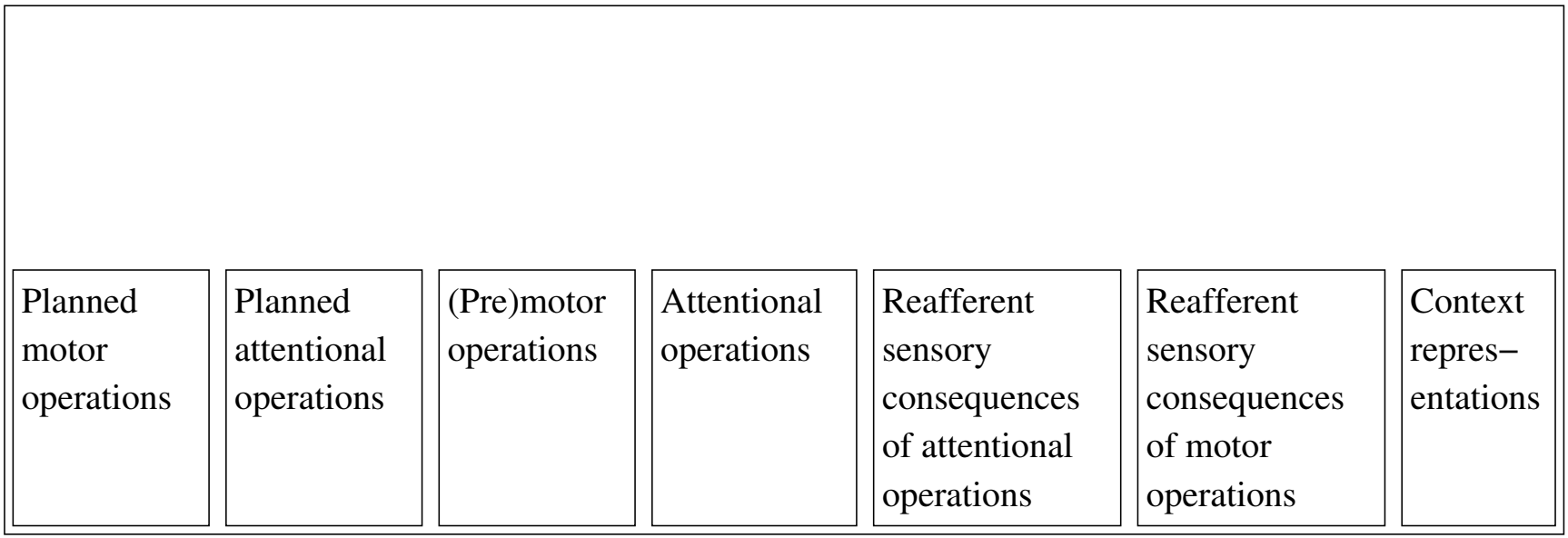
This model makes some concrete proposals about the semantic contributions of different types of lexical/morphological item.

- A verb stem like *grab* contributes a (planned) motor operation.
- An agreement inflection like ‘first person singular’ contributes a (planned) attentional operation.
- A DP contributes the reafferent sensory consequence of an attentional or motor operation. [First approximation.]

Do these make sense?

Some assumptions

These proposals can be thought of as hypotheses about connections between SM/WM areas and surface linguistic forms.



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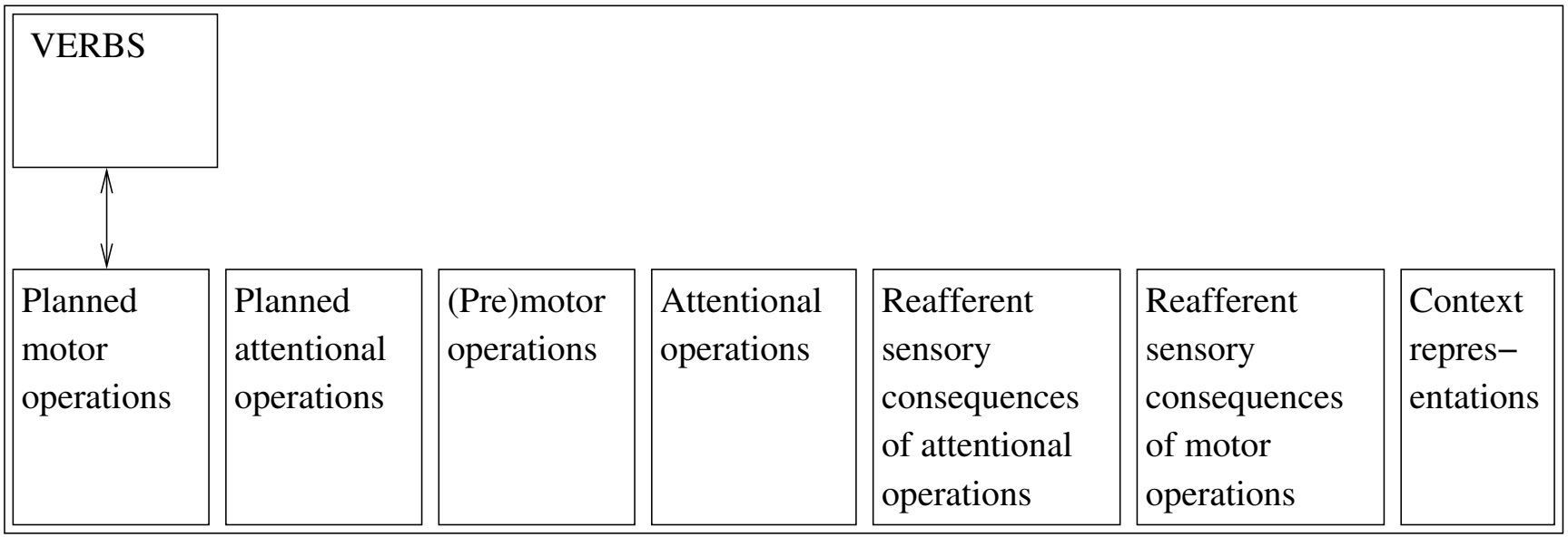

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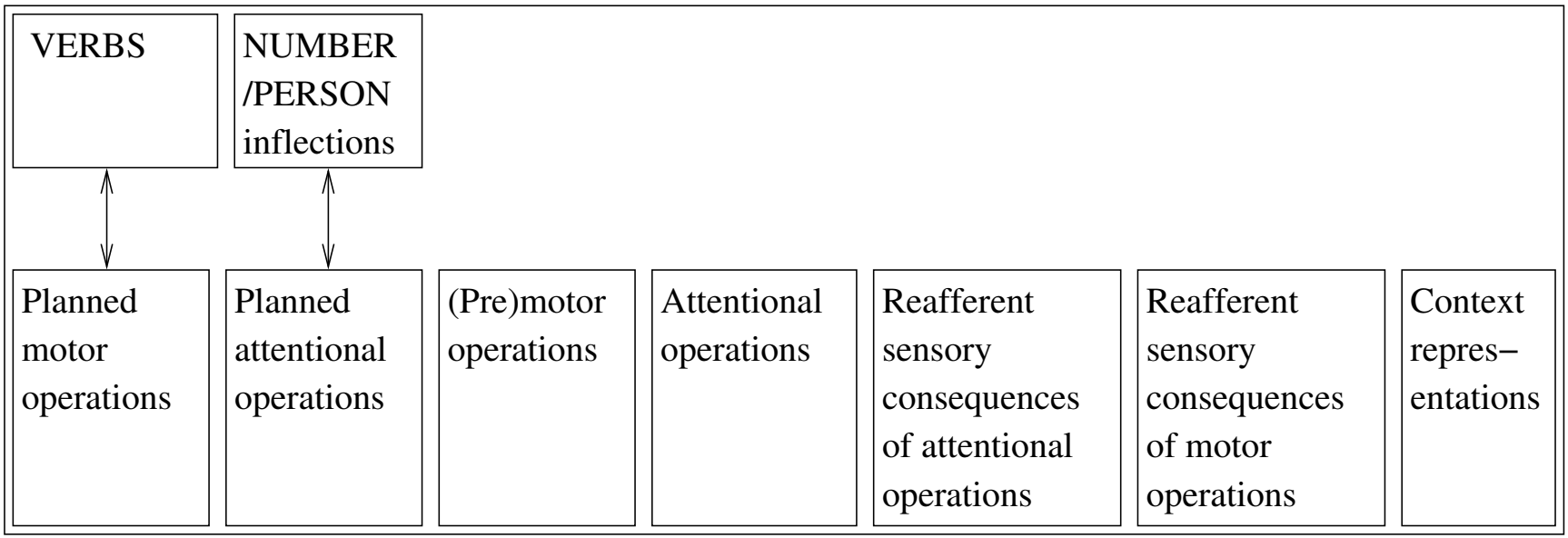

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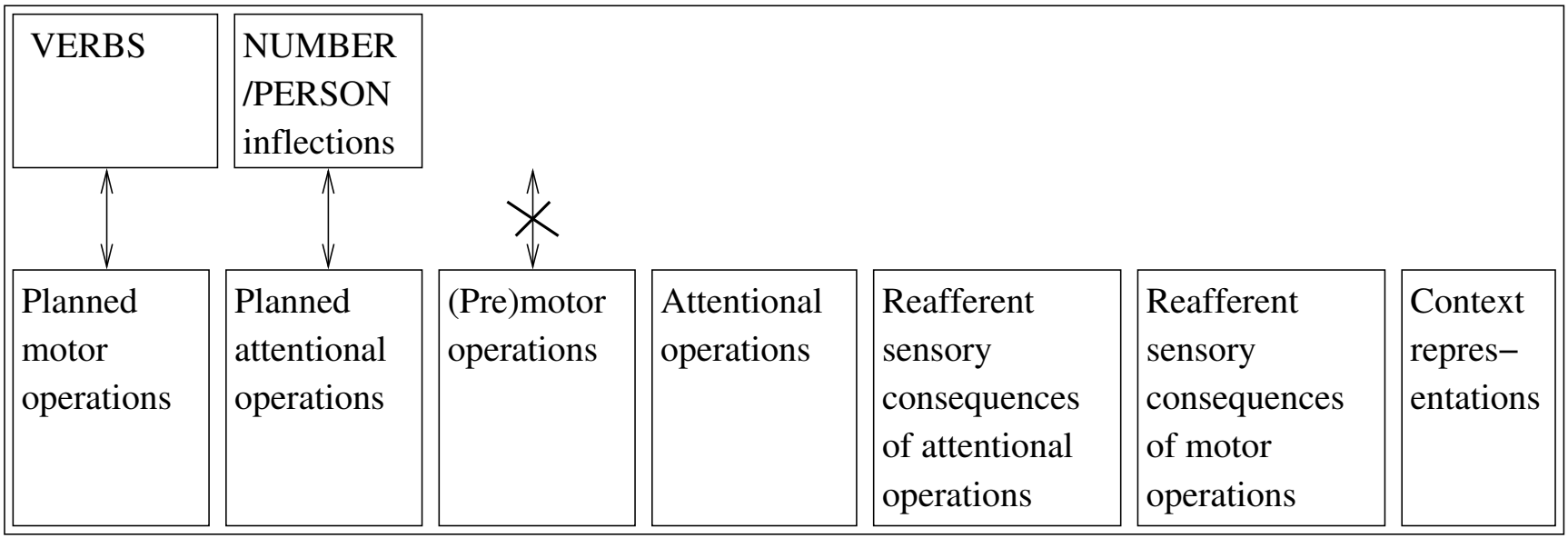

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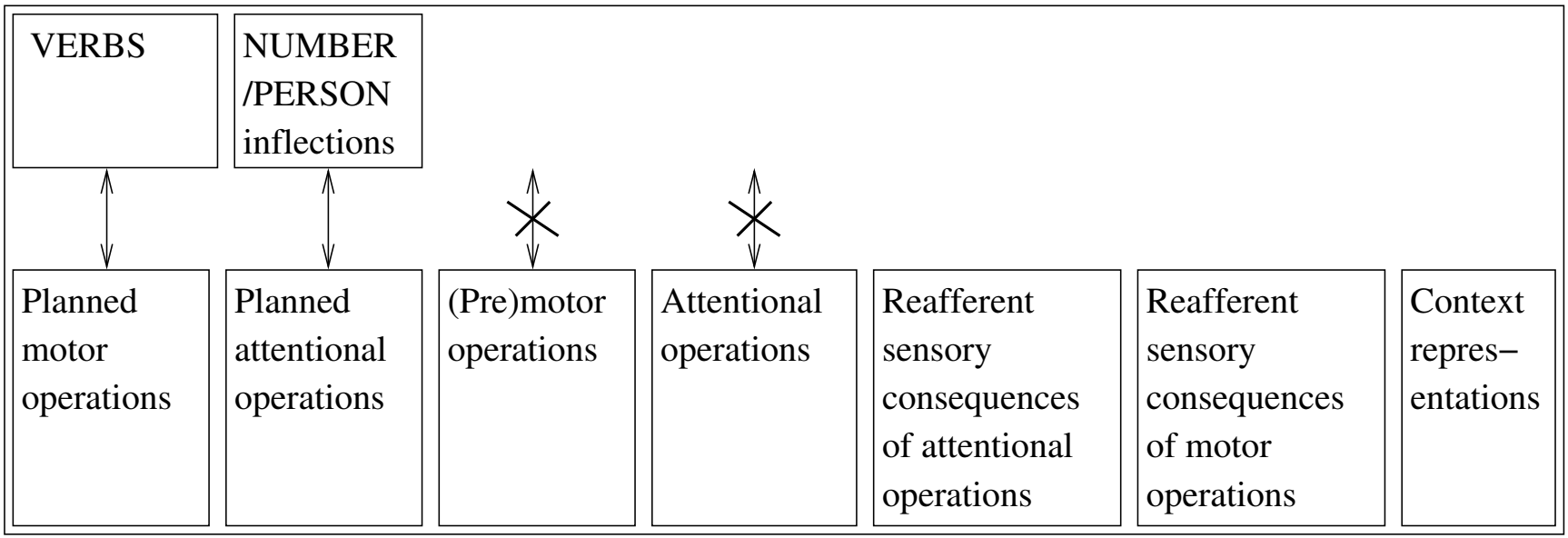

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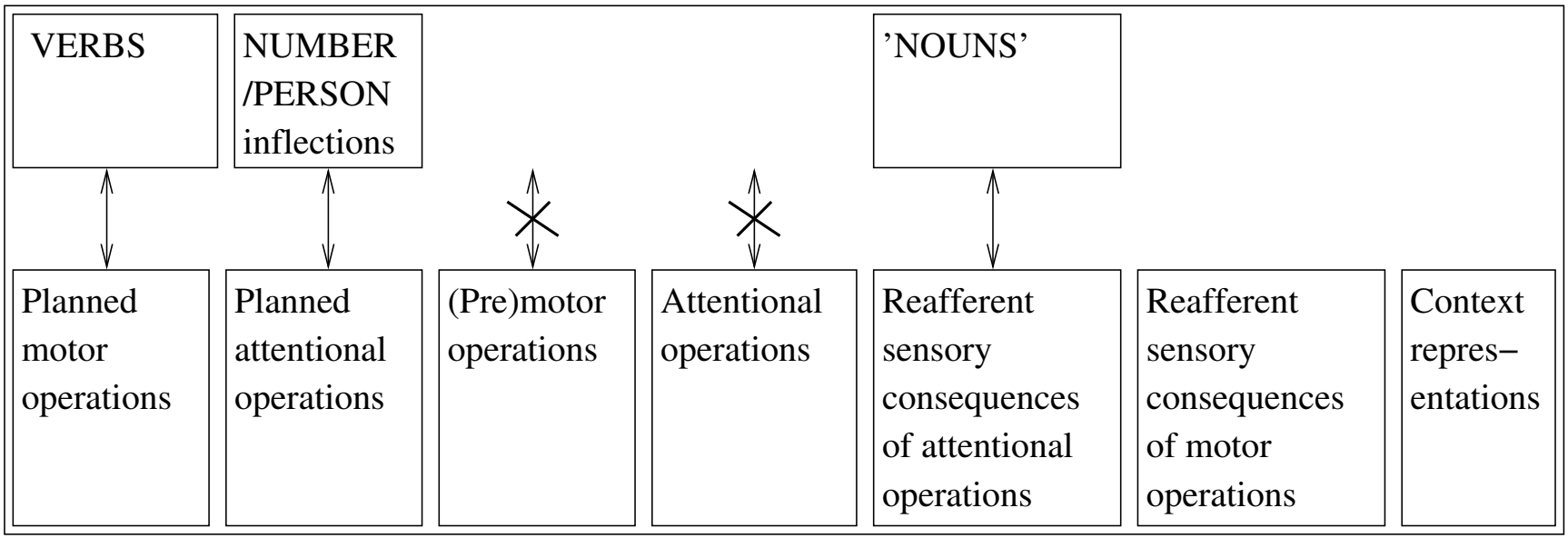

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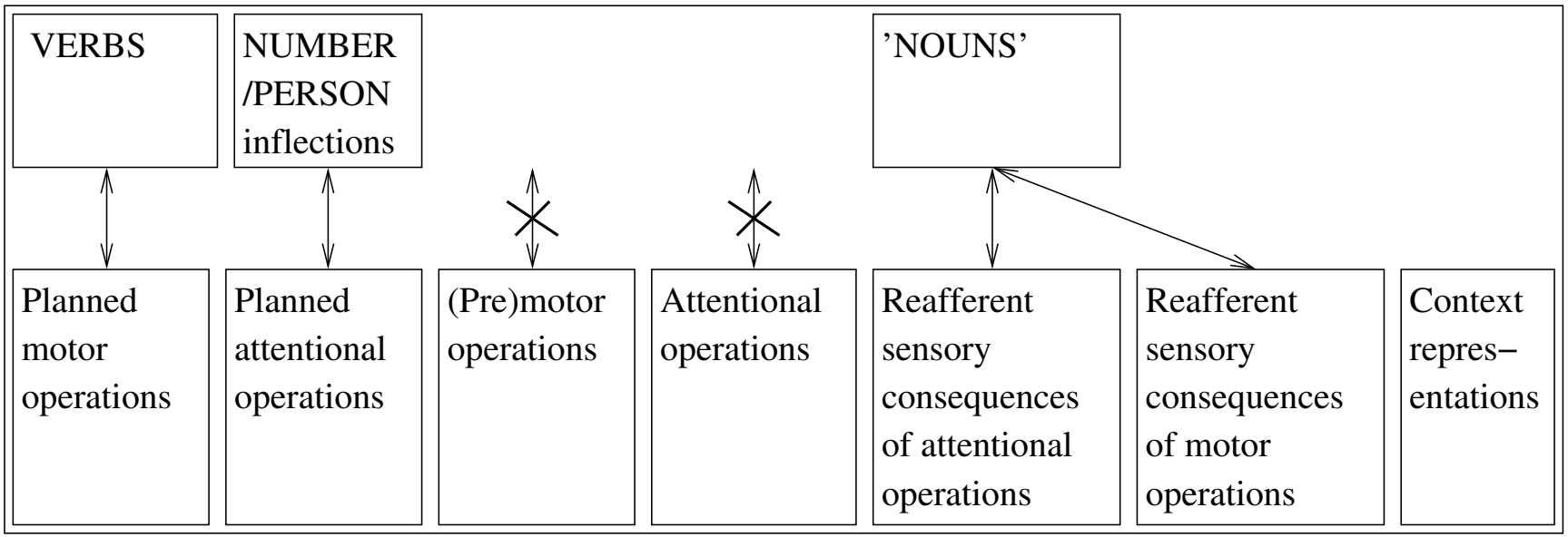

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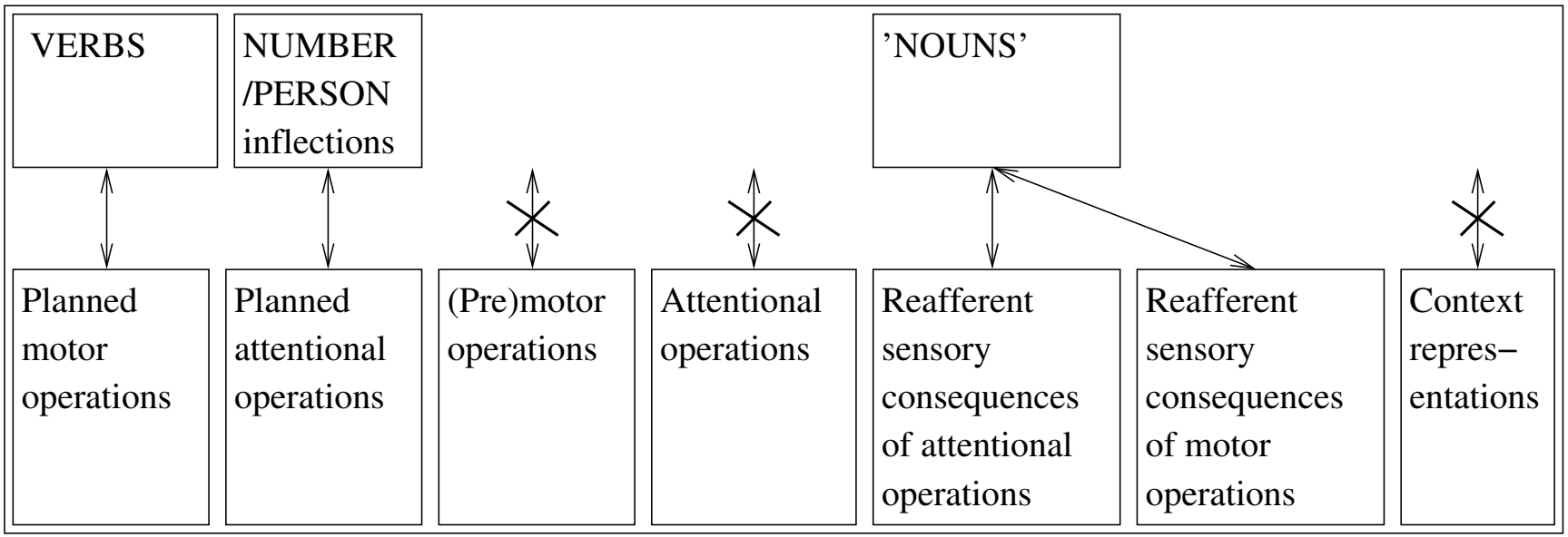

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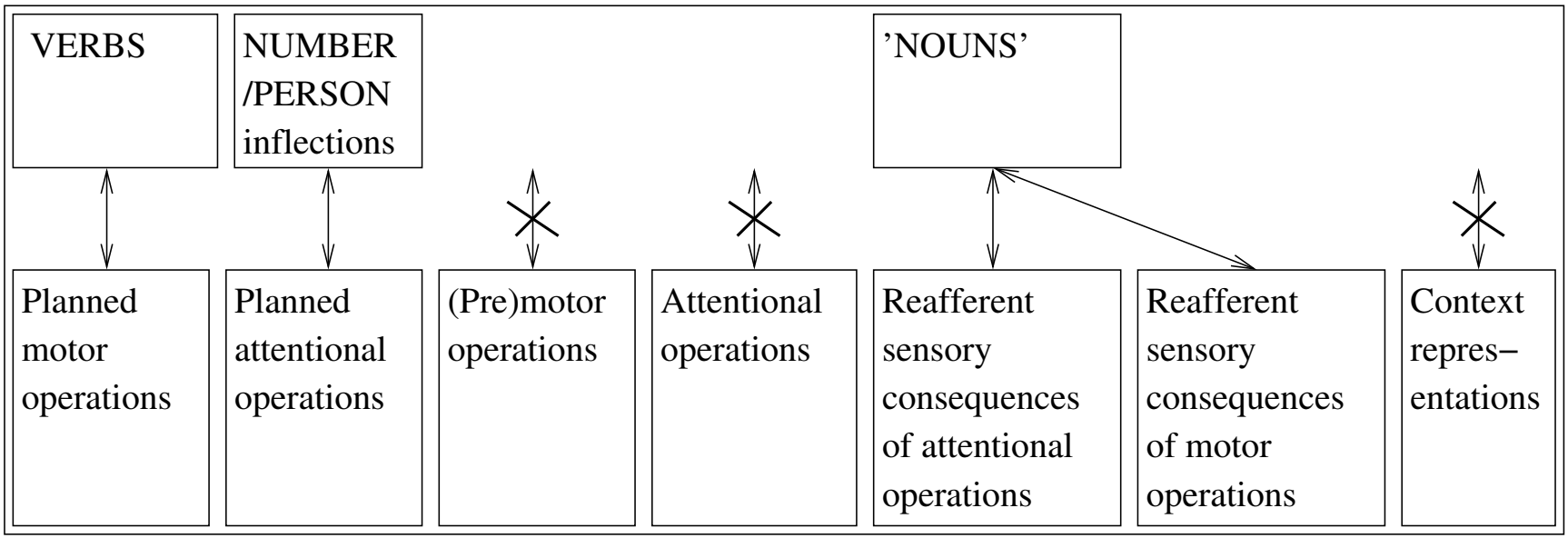

Idea: these are the basic interfaces which evolution happened to find.

Outline of the rest of the course

L15	How 'surface language' is represented in the brain: neural and developmental models of language
L16	A neural network for learning words
L17	A neural network for learning clause syntax (the LF-PF mapping)
L18	SM and syntactic representations of objects
L19	SM and syntactic representations of predicates and quantified propositions
L20	Revision