

LIN 313 Class 4: Productivity in Morphology and Syntax

Prof Kanishka Misra

(some material from Prof. Kyle Mahowald)

Hw: Due Next Week (sept 10)!

- Come to office hour chit chat (worth 10% of grade!)

Phonemes are cognitively useful

- They turn continuous information discrete
- But real time lexical processing is still continuous!
- Babies are sensitive to statistical patterns in their audio input!
 - Statistical Learning might be one way how we *learn to* chop up our input.

Today: Morphology and Grammar

- Hockett Design Feature: Productivity

Morphology

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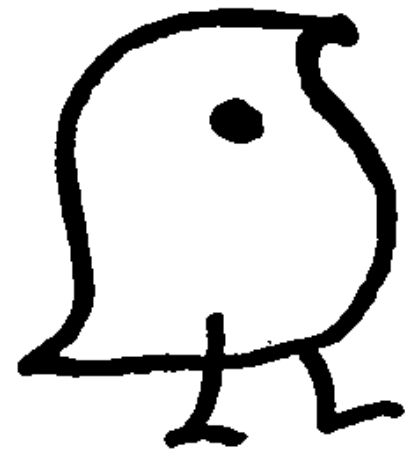
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The wug test!

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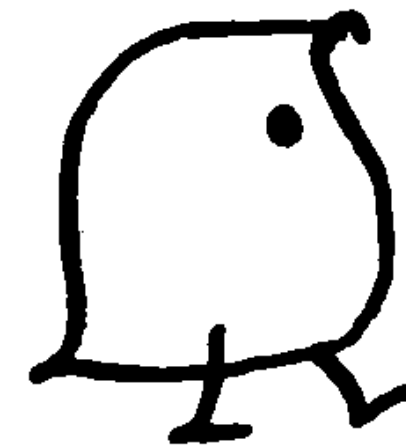


THIS IS A WUG.

The wug test!



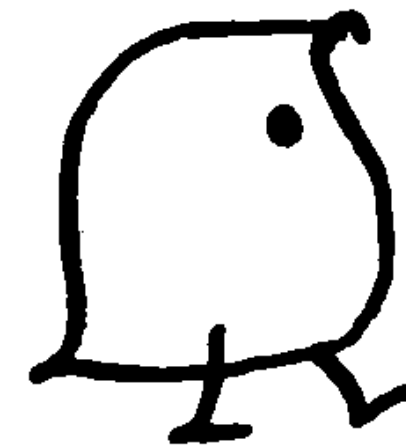
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THIS IS A WUG.



NOW THERE IS ANOTHER ONE.

THERE ARE TWO OF THEM.

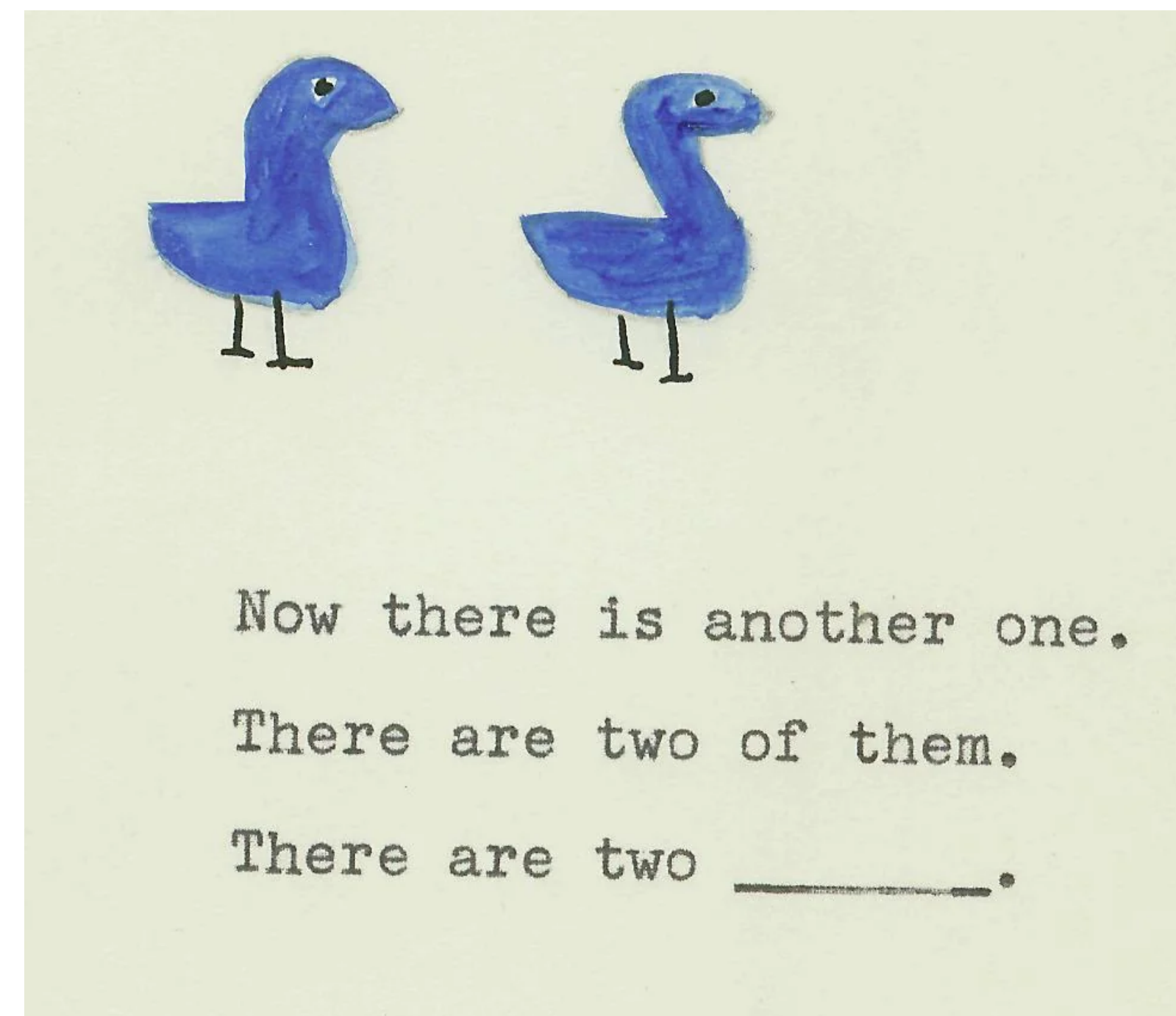
THERE ARE TWO ____.

The wug test!

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The wug test!



The wug test!

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The wug test!



This is a man who knows how to RICK.
He is Ricking. He did the same thing
yesterday. What did he do yesterday?
Yesterday he _____.

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- We will find out at the end of the lecture!

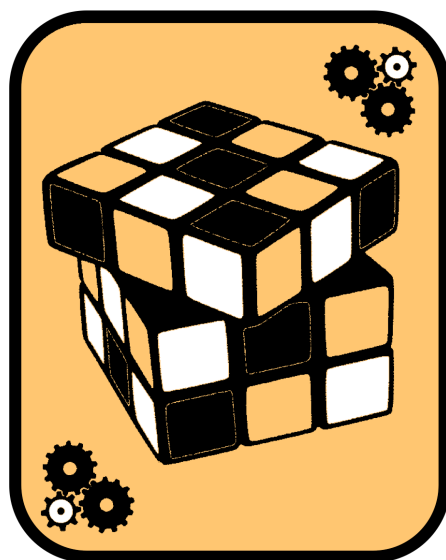
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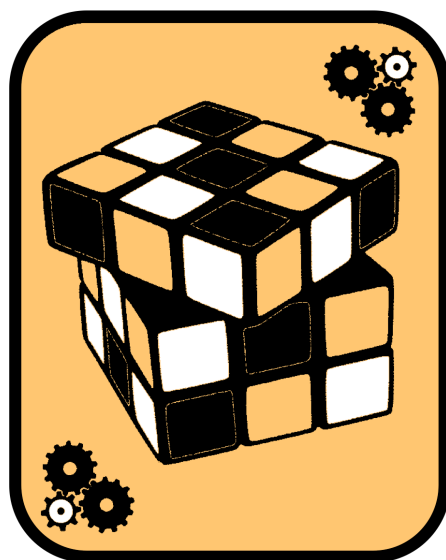
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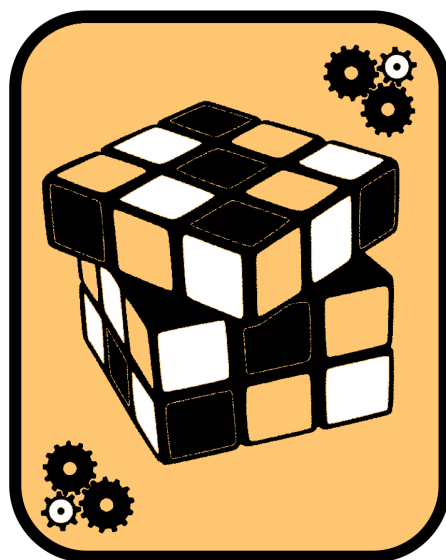


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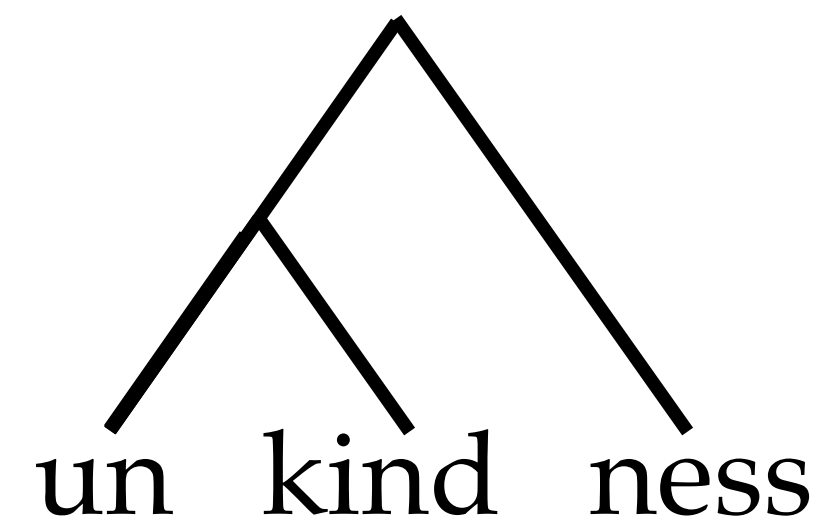
un kind ness

un avoid able

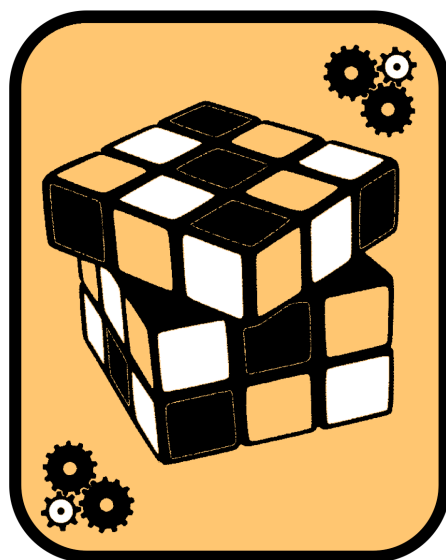


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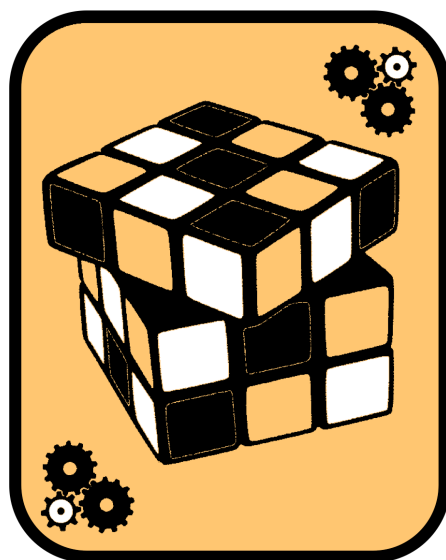
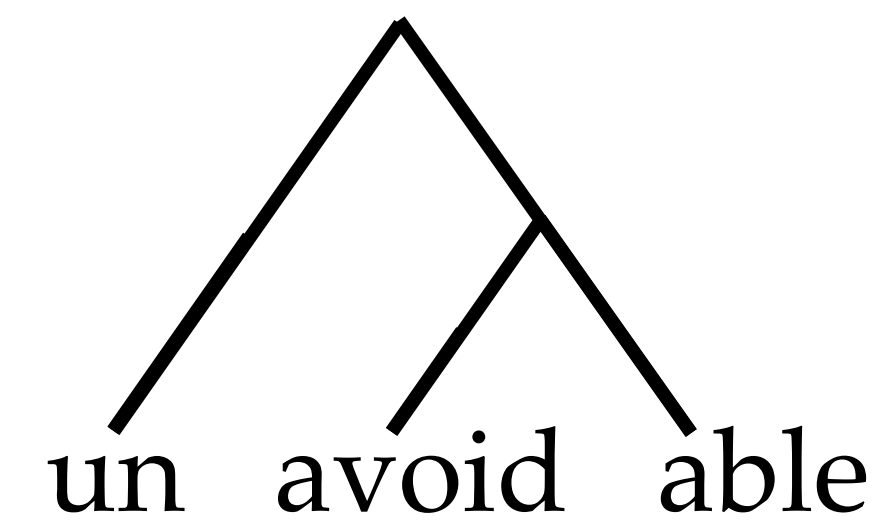
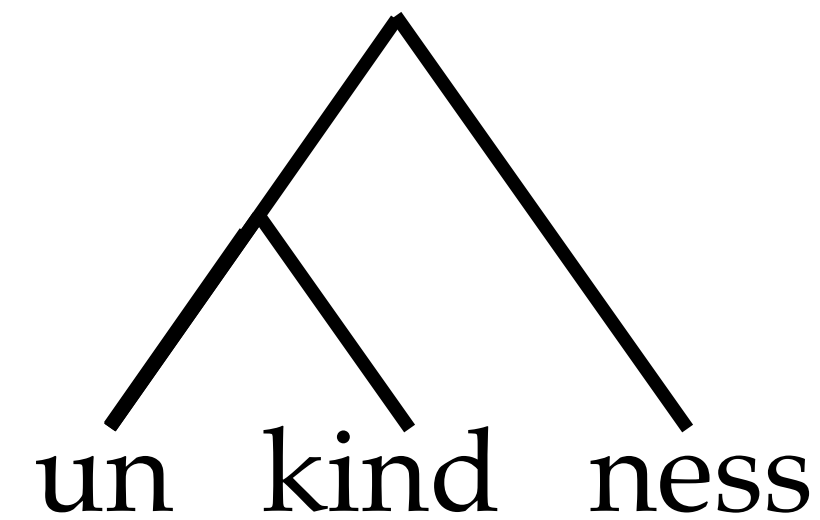


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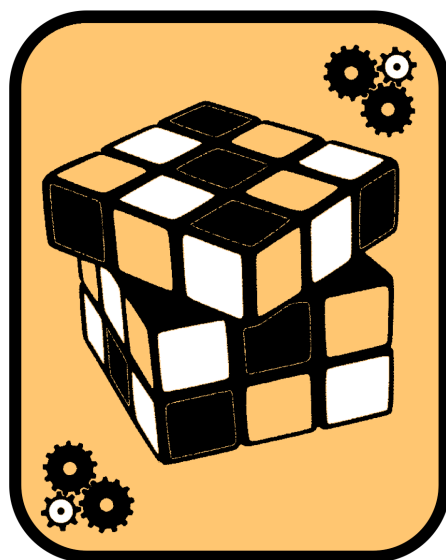
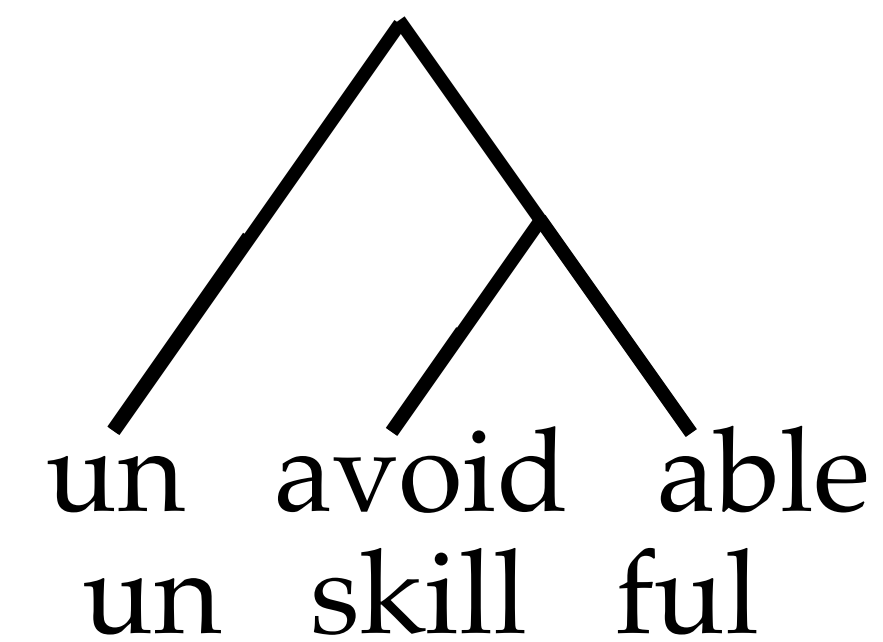
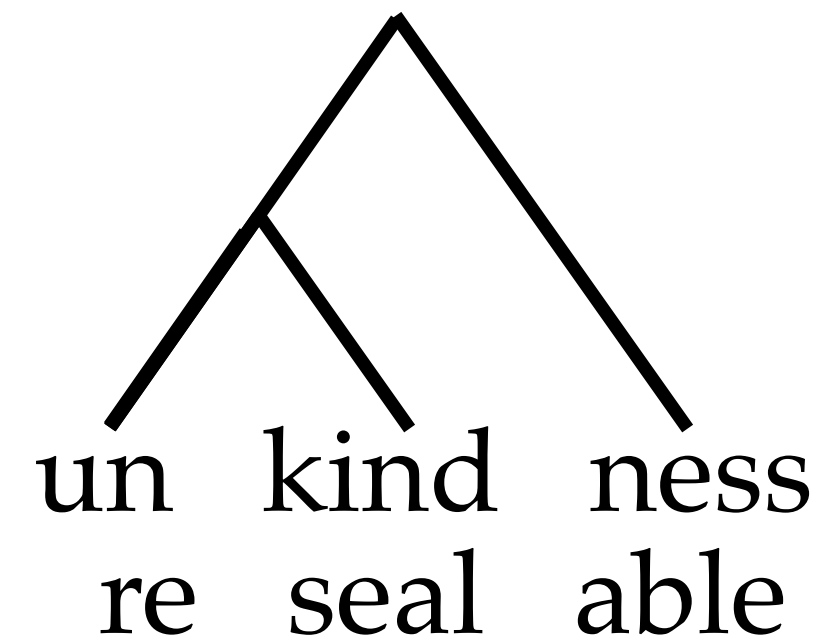
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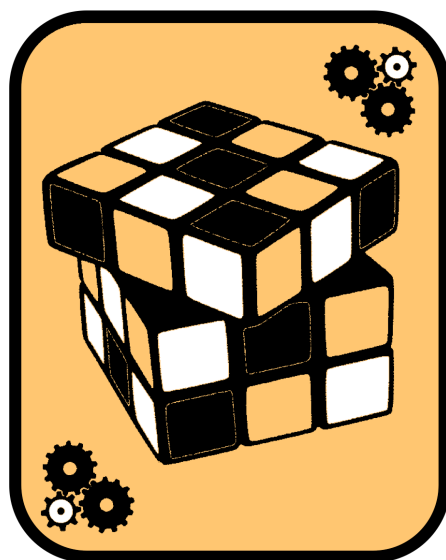
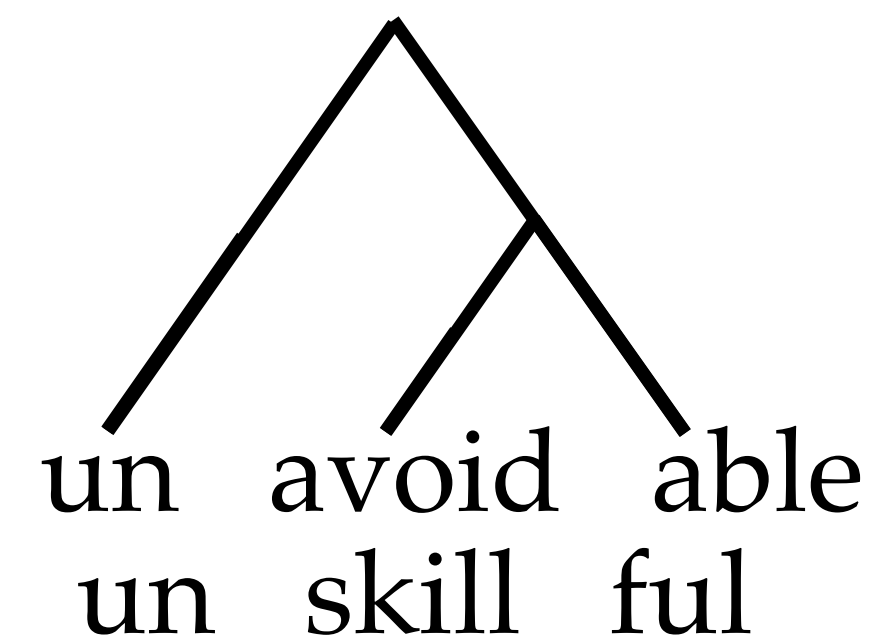
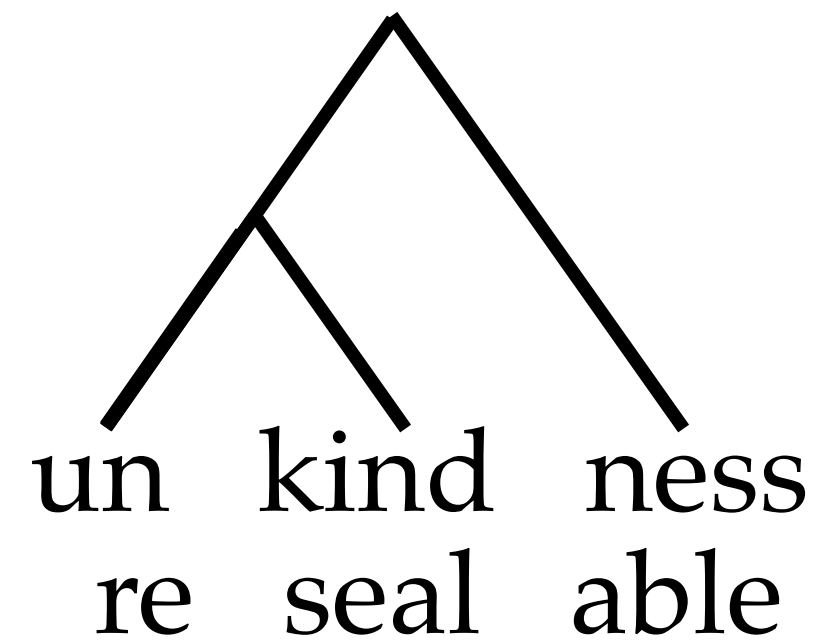
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Hierarchy in Morphology?

- Are multi-morphemic words represented hierarchically in our mental lexicon? **What's the alternative?**

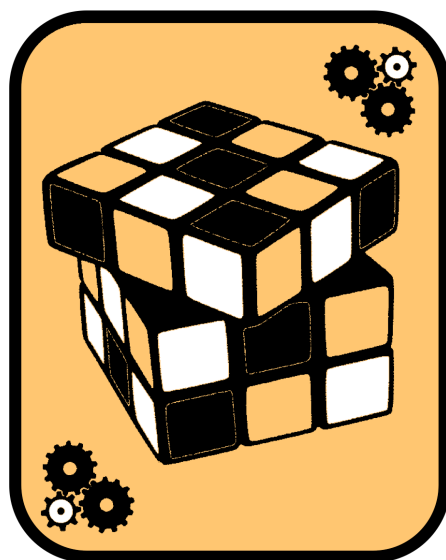


Hierarchy in Morphology?

- Are multi-morphemic words represented hierarchically in our mental lexicon? **What's the alternative?**

un kind ness
re seal able

un avoid able
un skill ful



Lexical Decision Task

❖ CAT

Lexical Decision Task

❖ SAUCER

Lexical Decision Task

❖ XFDUFIWE

Lexical Decision Task

❖PIG

Lexical Decision Task

❖ INPARKMENT

Lexical Decision Task

❖ CONFLAY

Lexical Decision Task

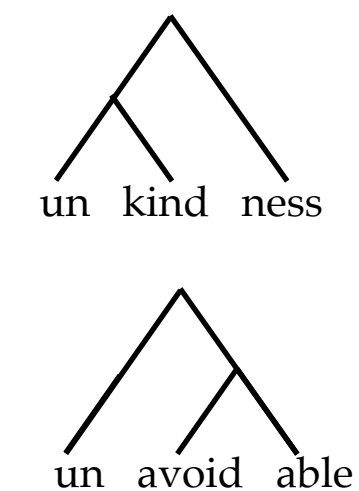
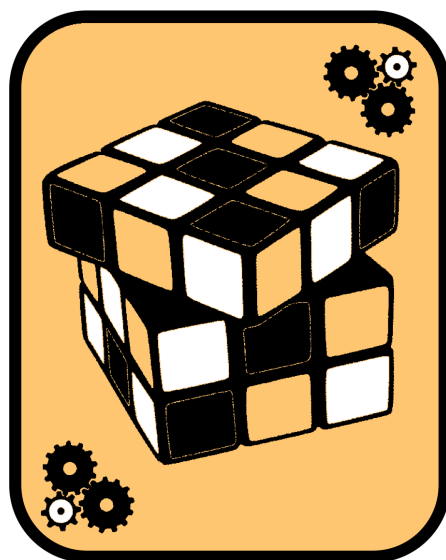
❖STOOP

Lexical Decision Task

❖ DOG

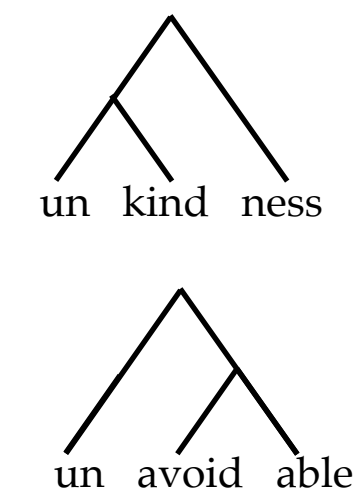
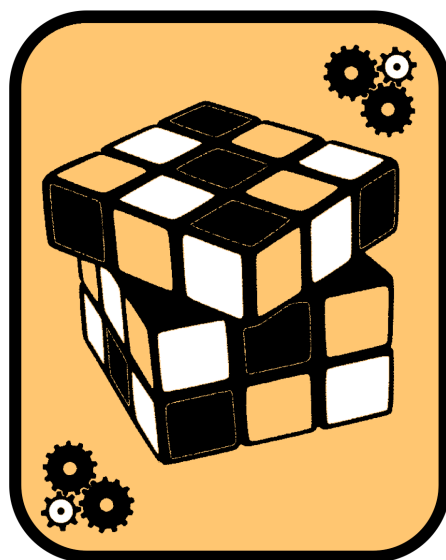
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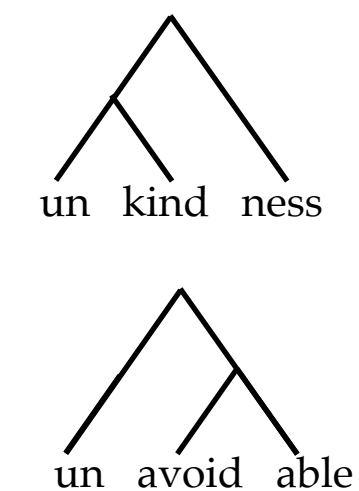
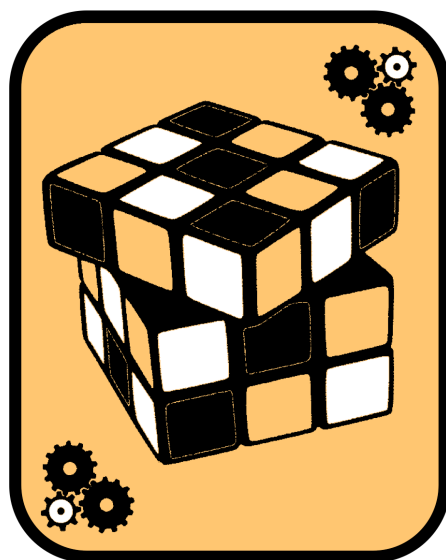
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(listen)

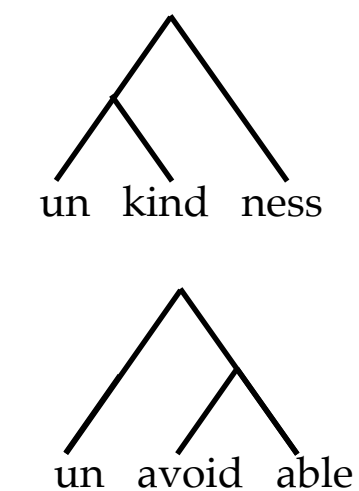
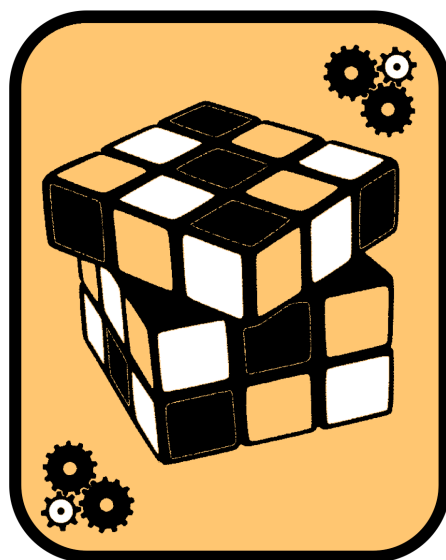


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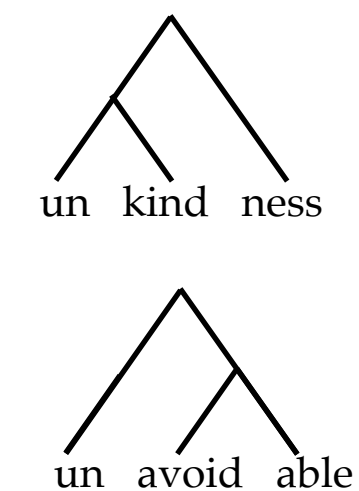
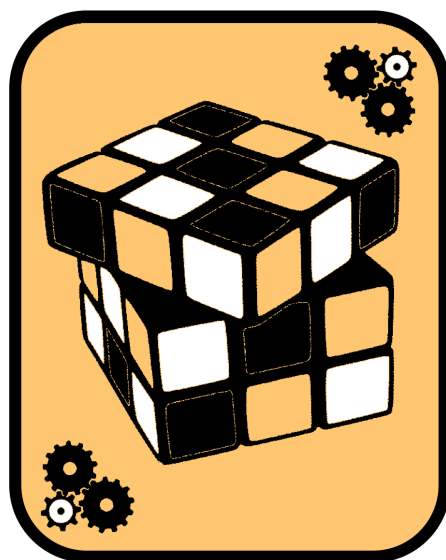


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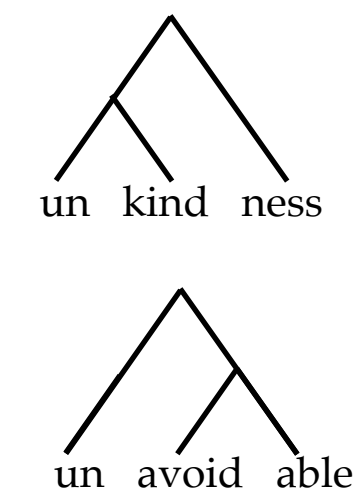
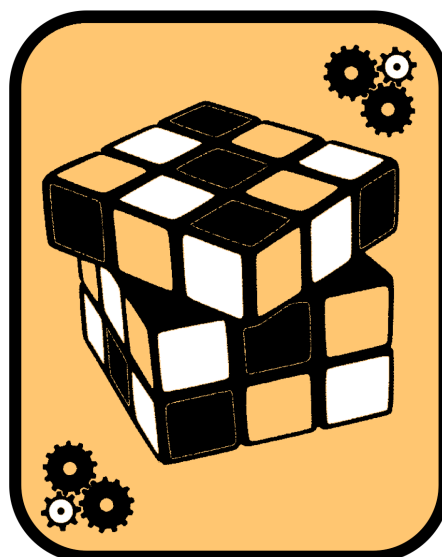
Prime
(listen)

Target
(read)

UNKIND
(~650ms)



UNKINDNESS



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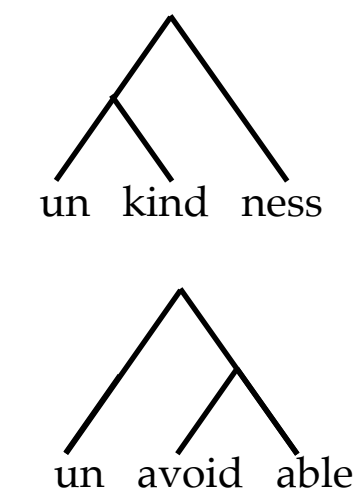
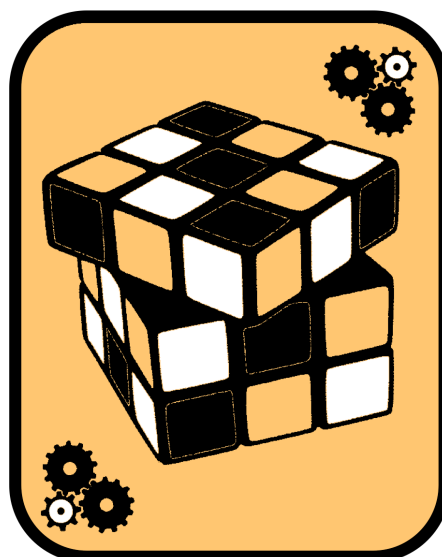
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UNKINDNESS



Real word or not?



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**Lexical
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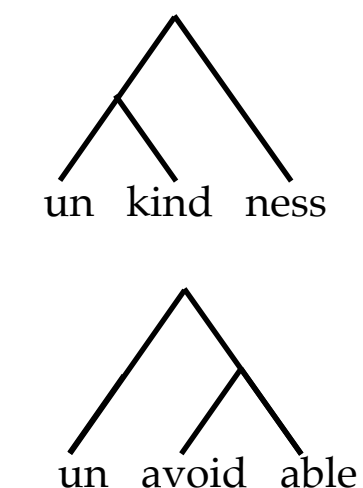
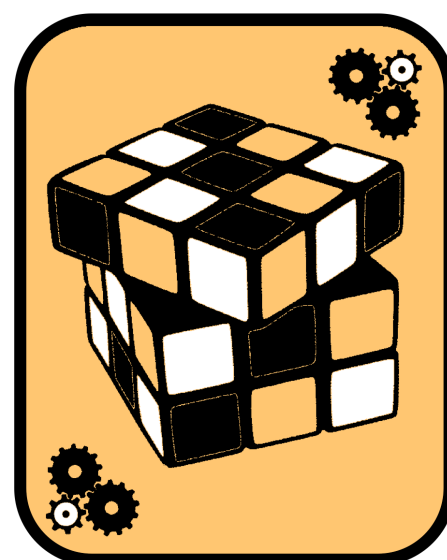
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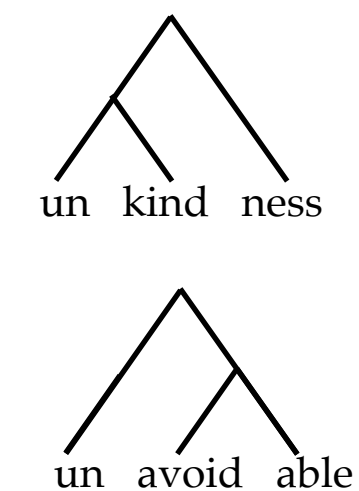
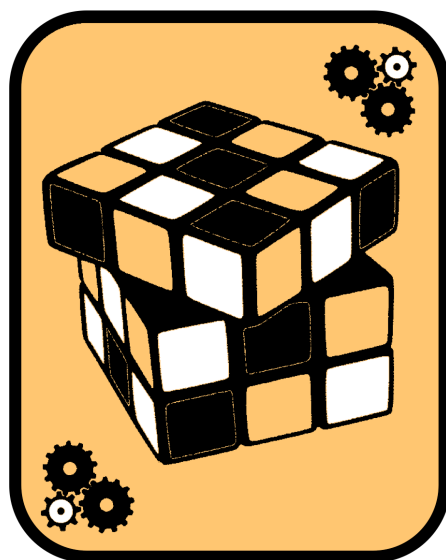


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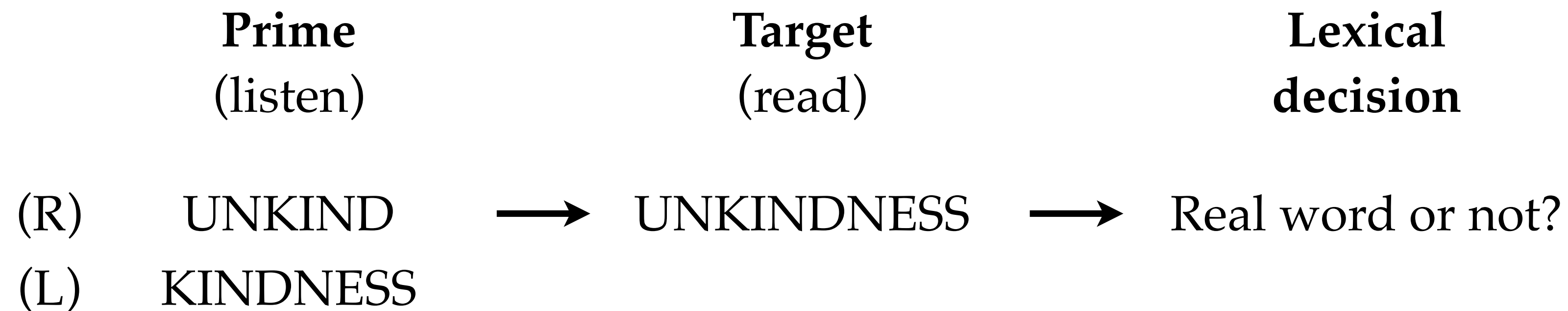


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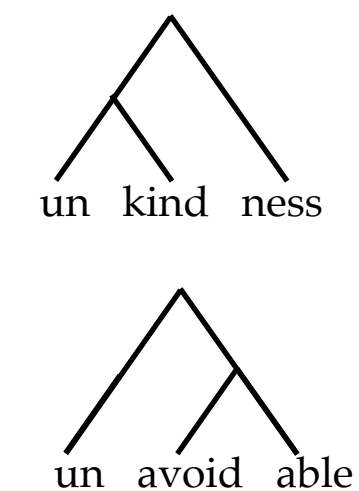
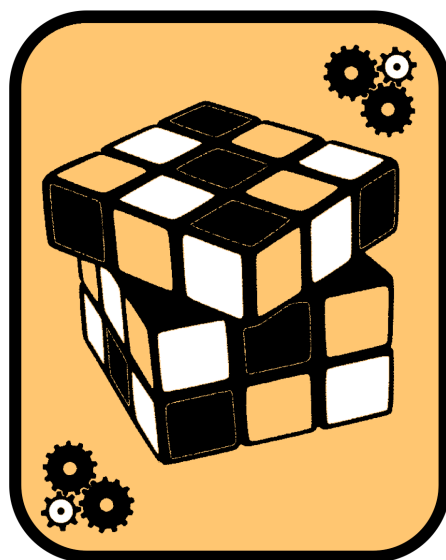


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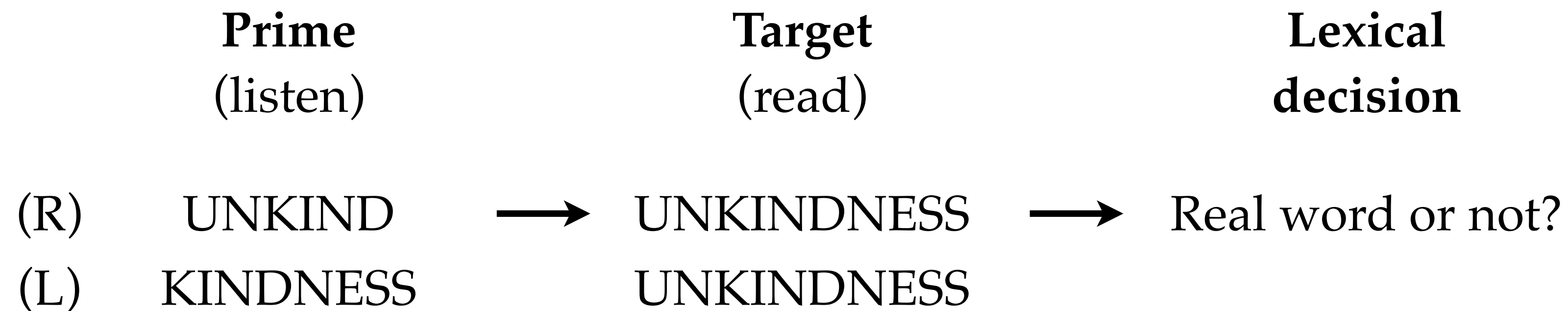


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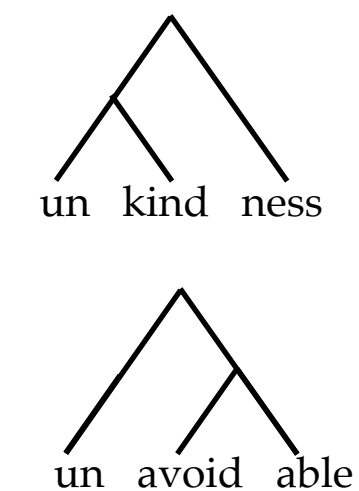
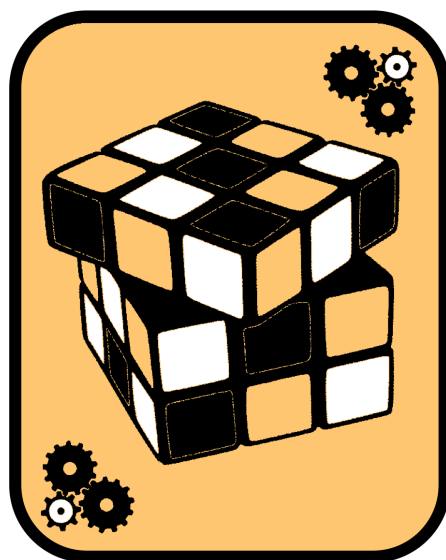


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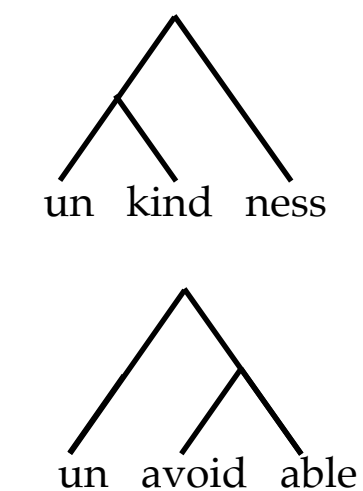
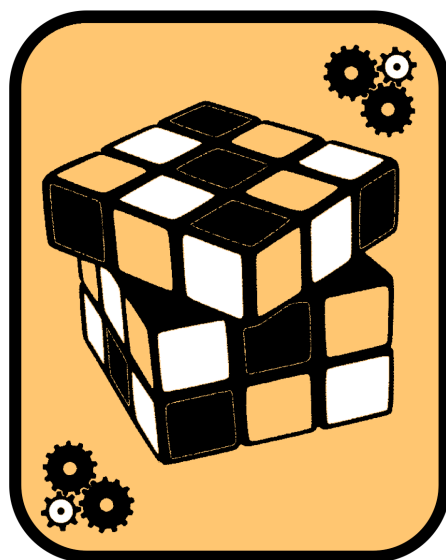
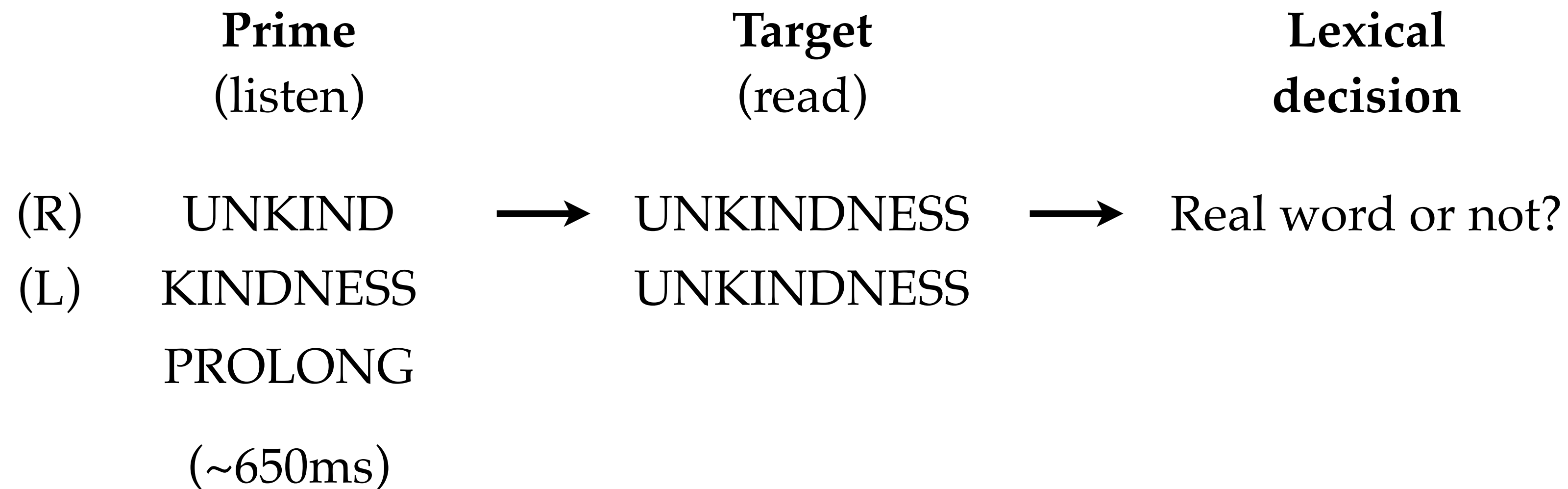


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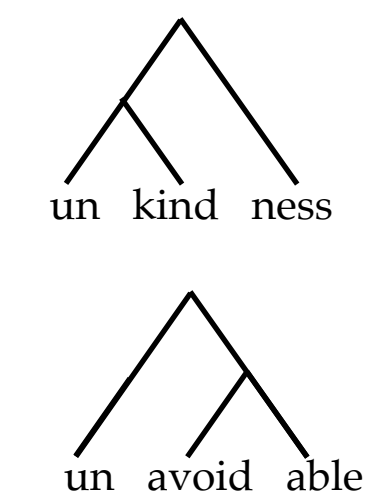
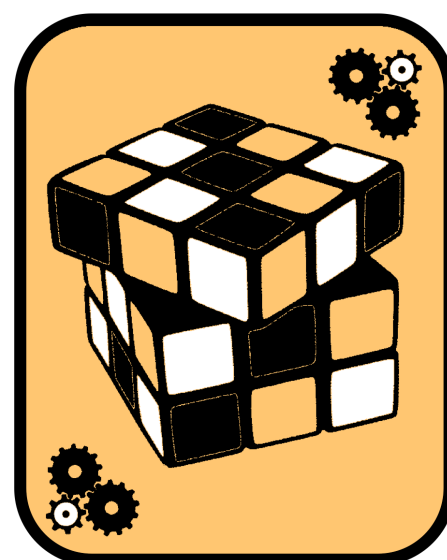
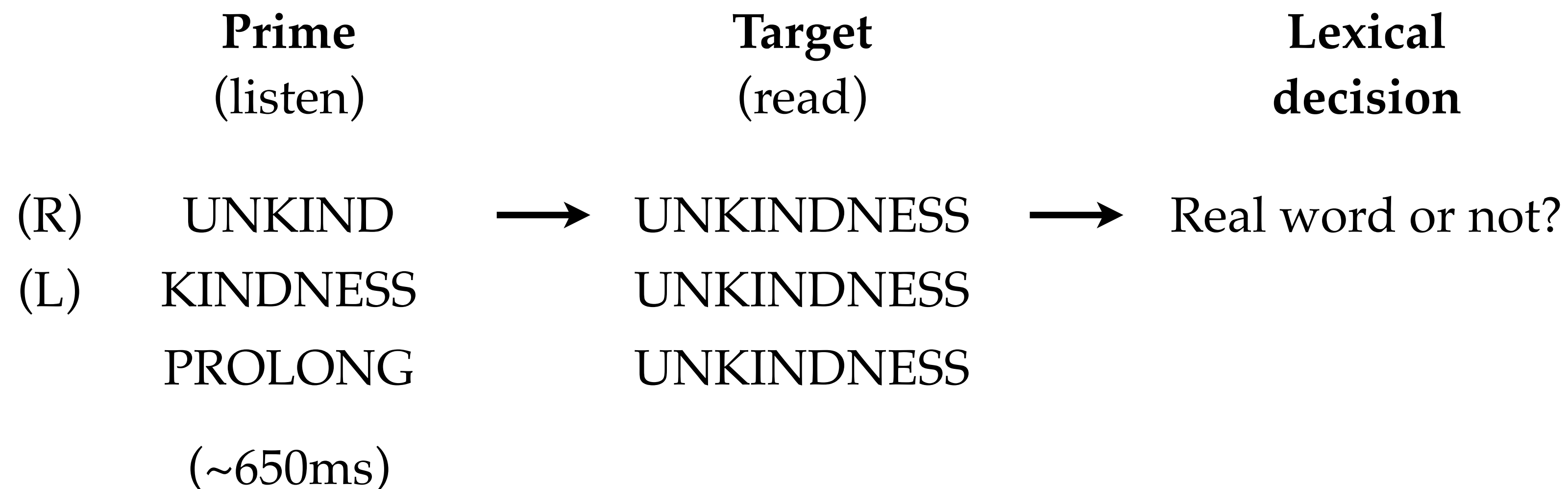
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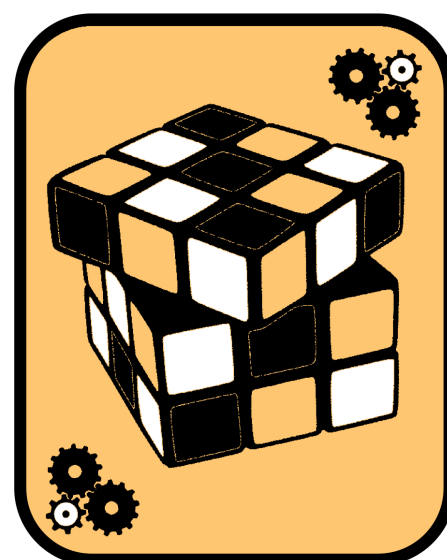
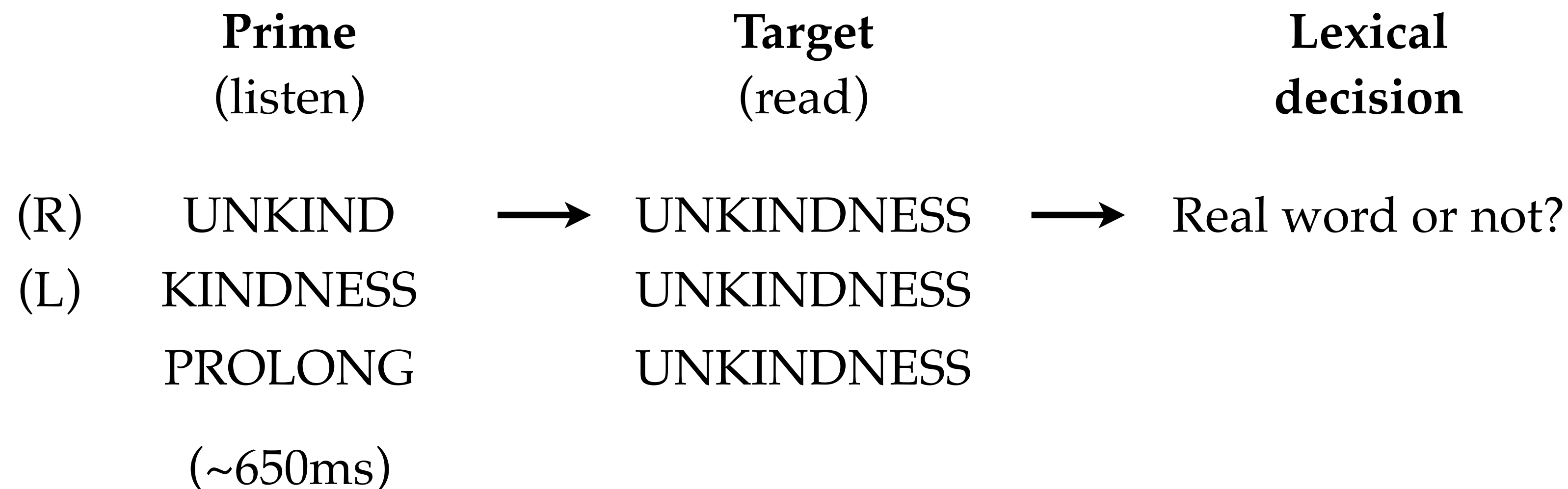
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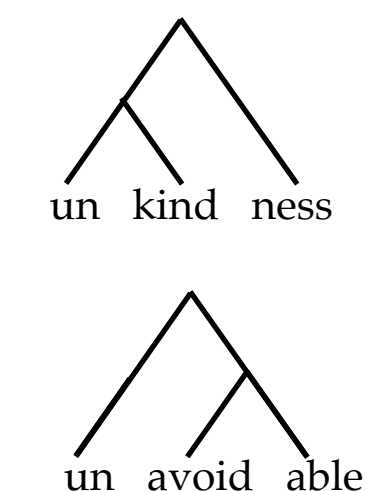


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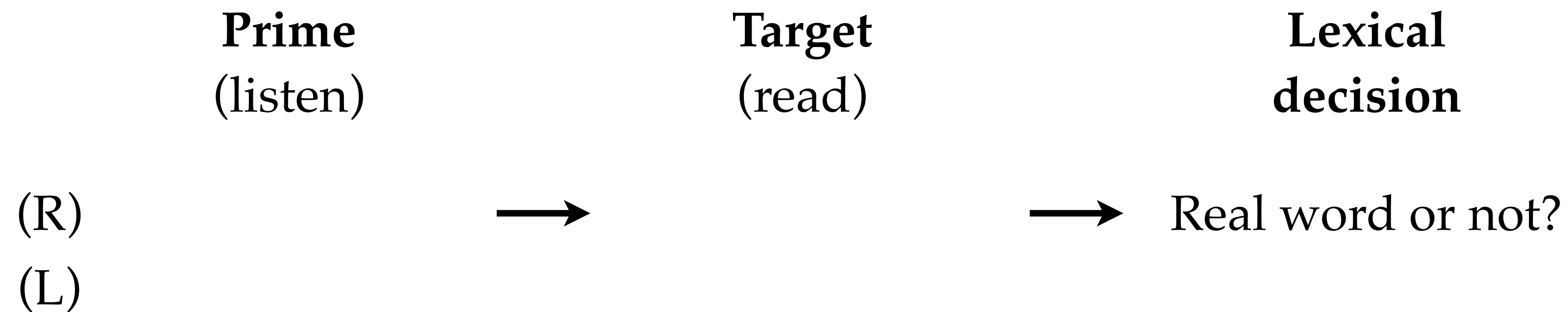


What is the prediction?

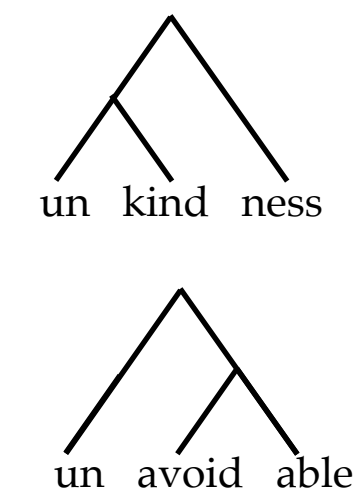
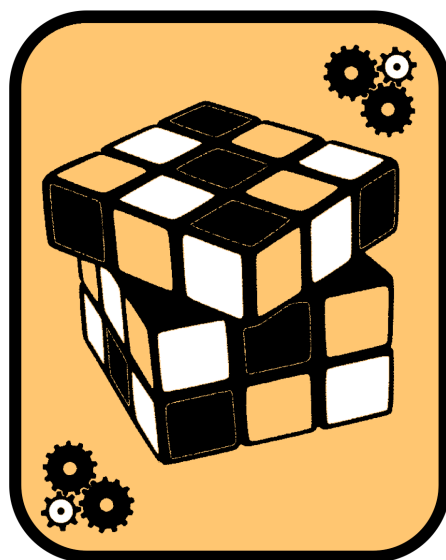


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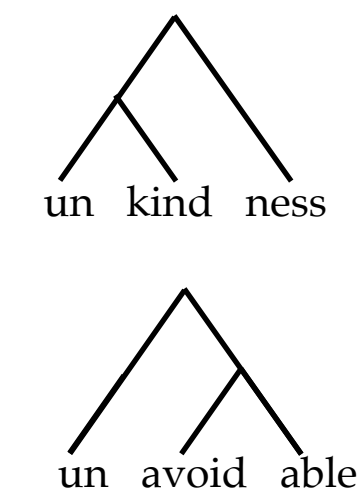
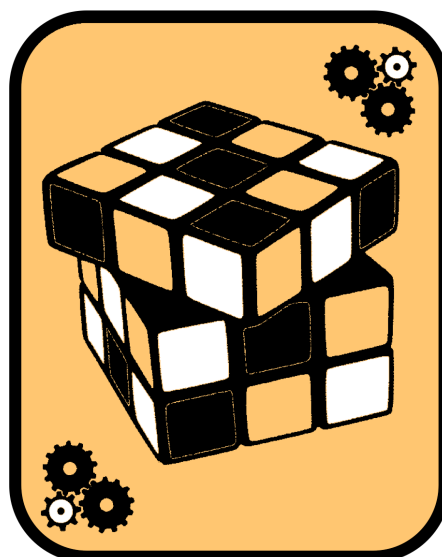
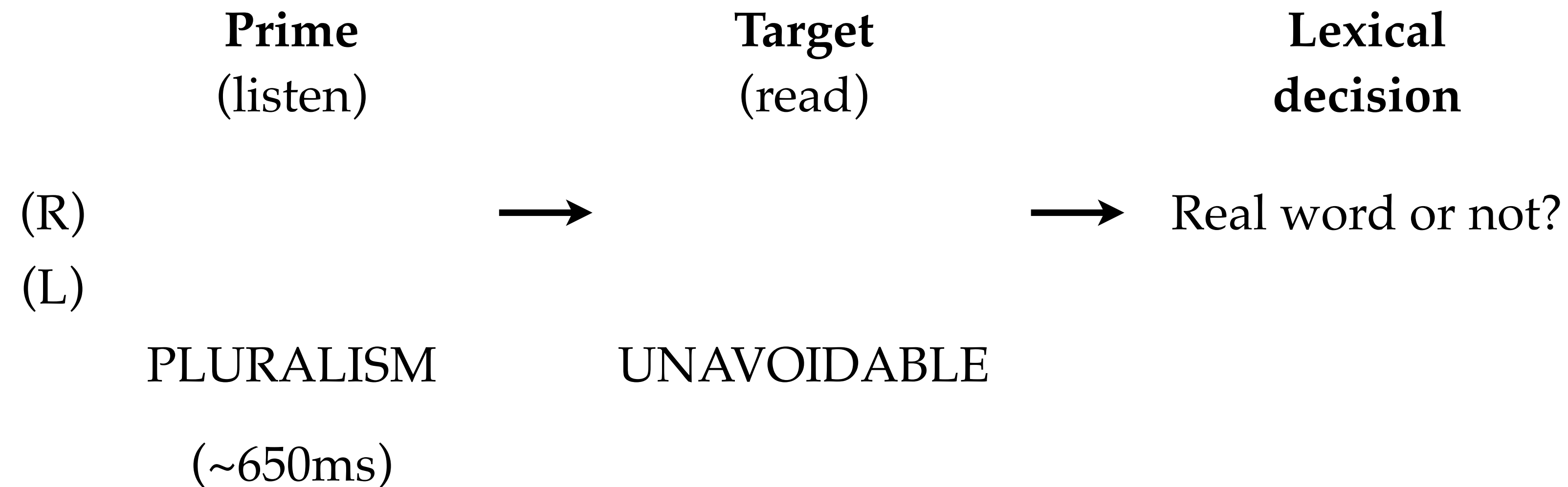


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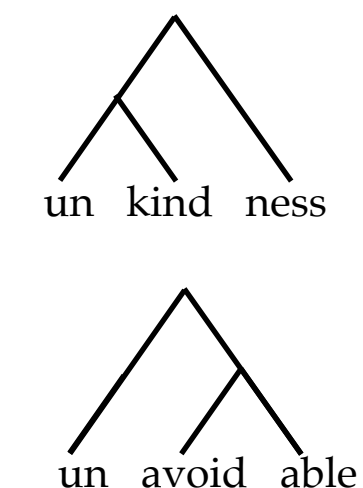
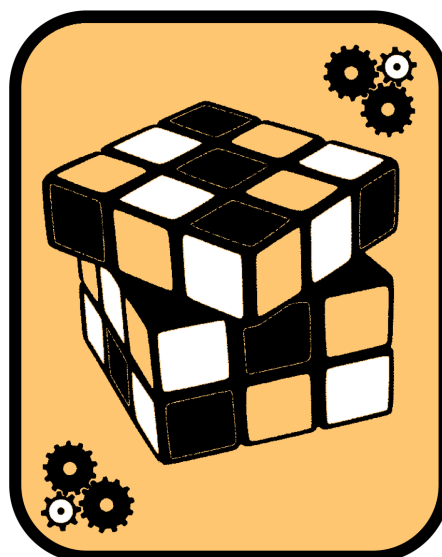
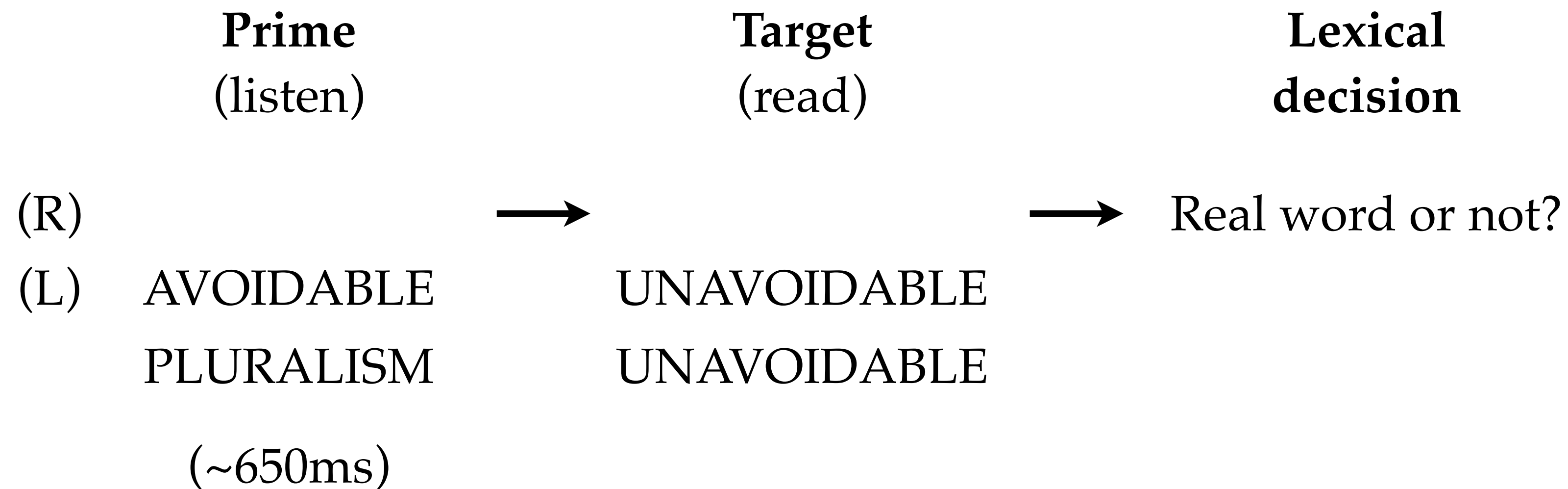
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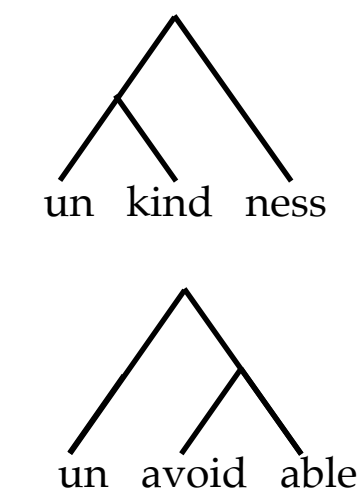
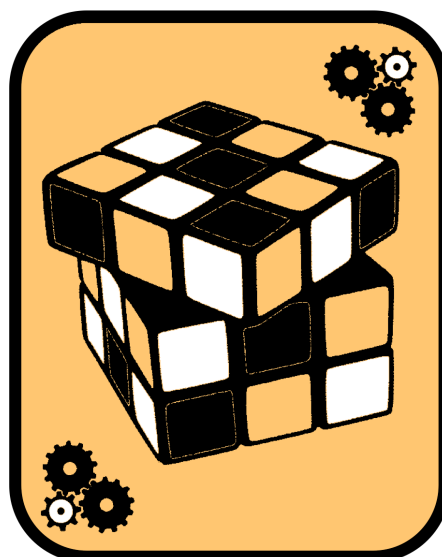
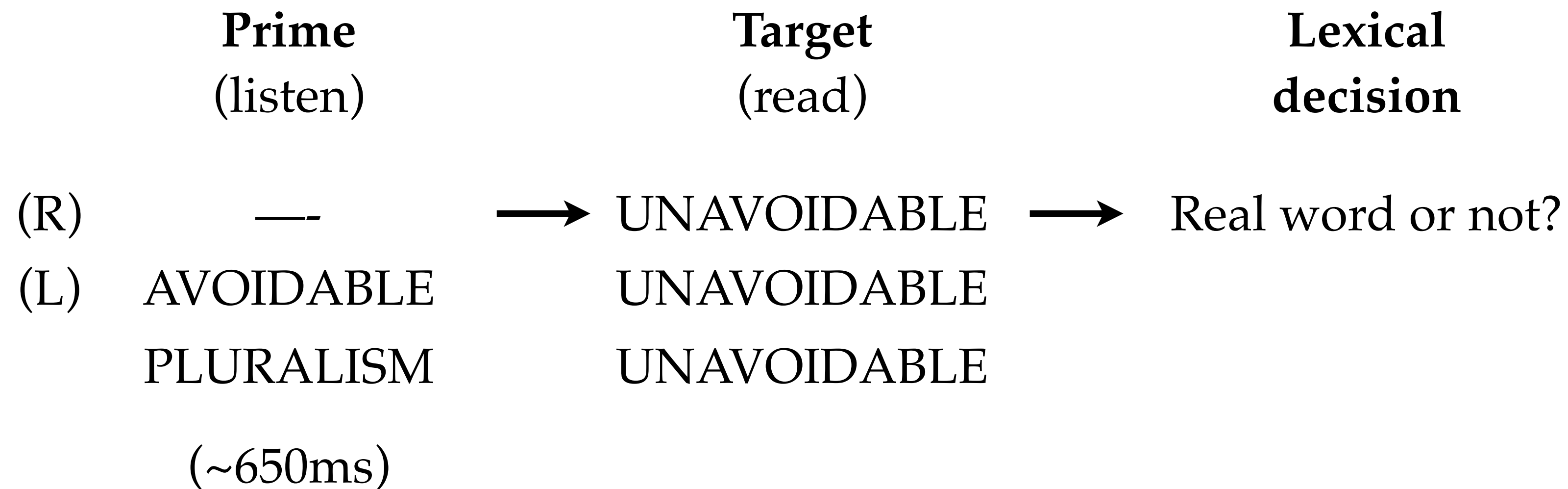
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(listen)

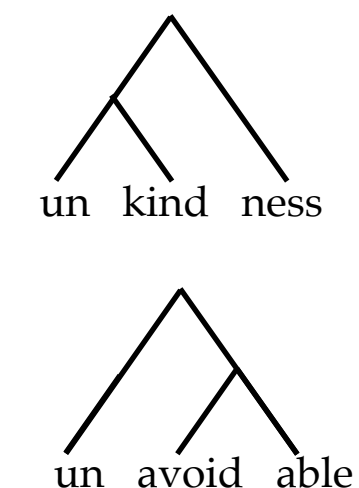
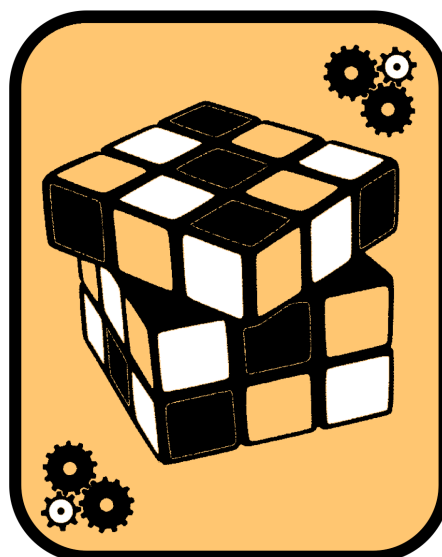


Target
(read)



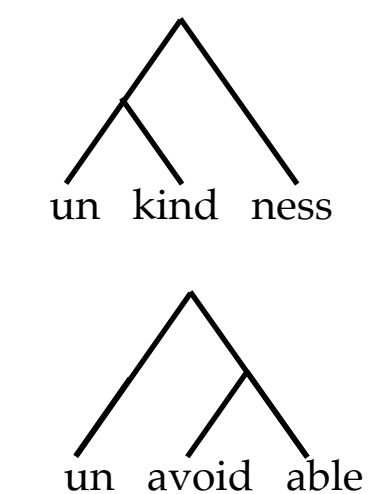
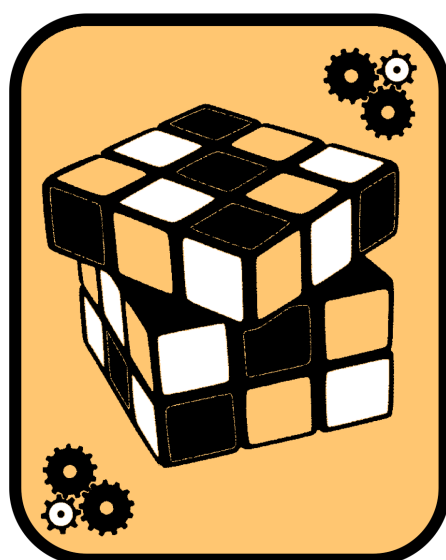
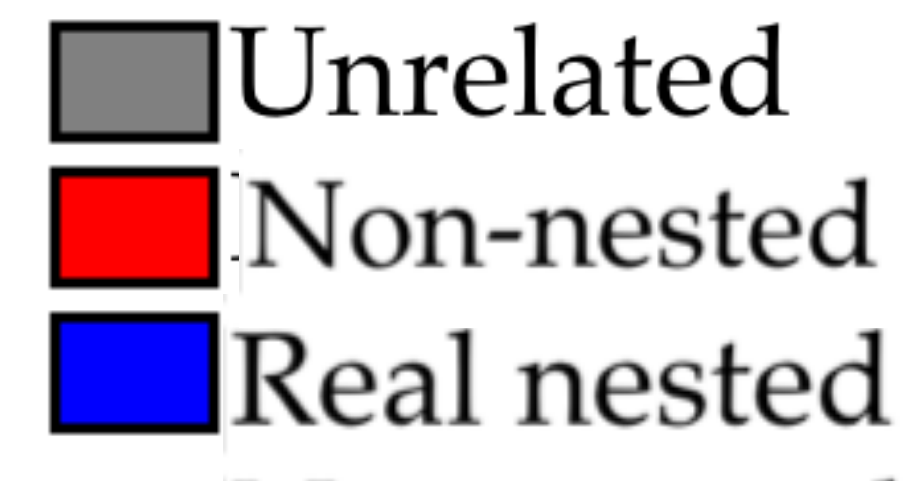
**Lexical
decision**

- Prediction: if hierarchical structure is represented, then priming with real nested parts should lead to better task performance



Hierarchy in Morphology: Results

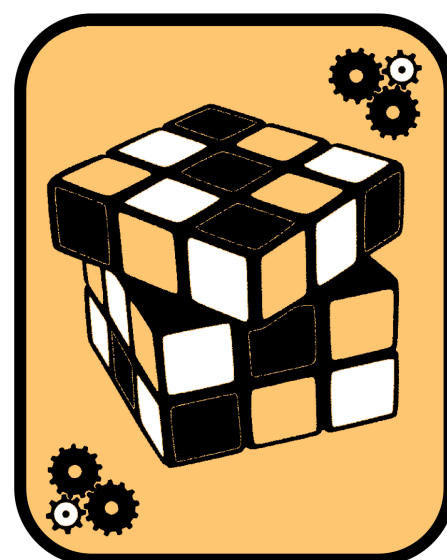
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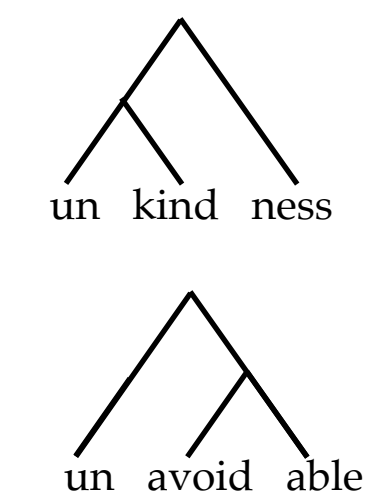
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■ Unrelated
■ Non-nested
■ Real nested



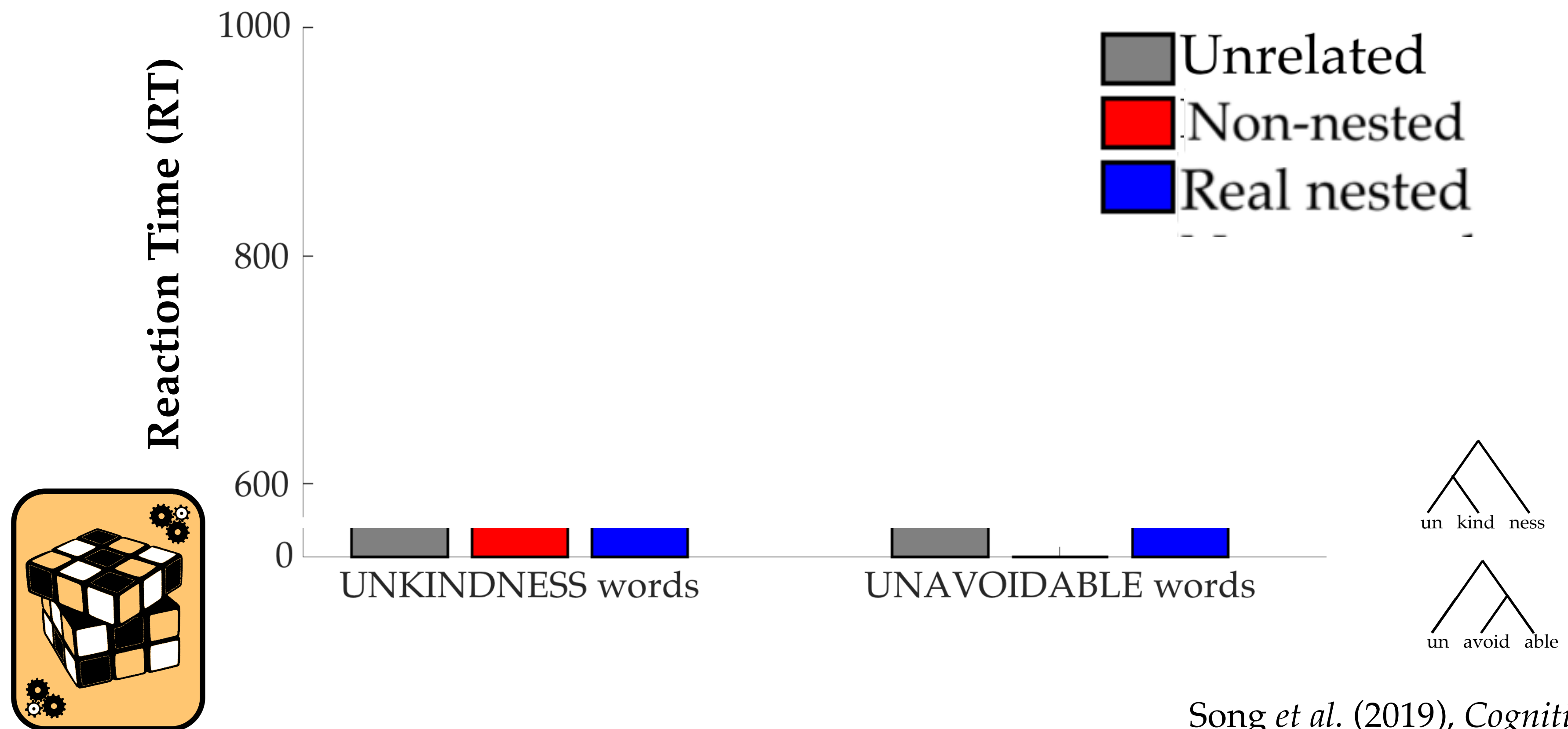
■ ■ ■
UNKINDNESS words

■ ■ ■
UNAVOIDABLE words



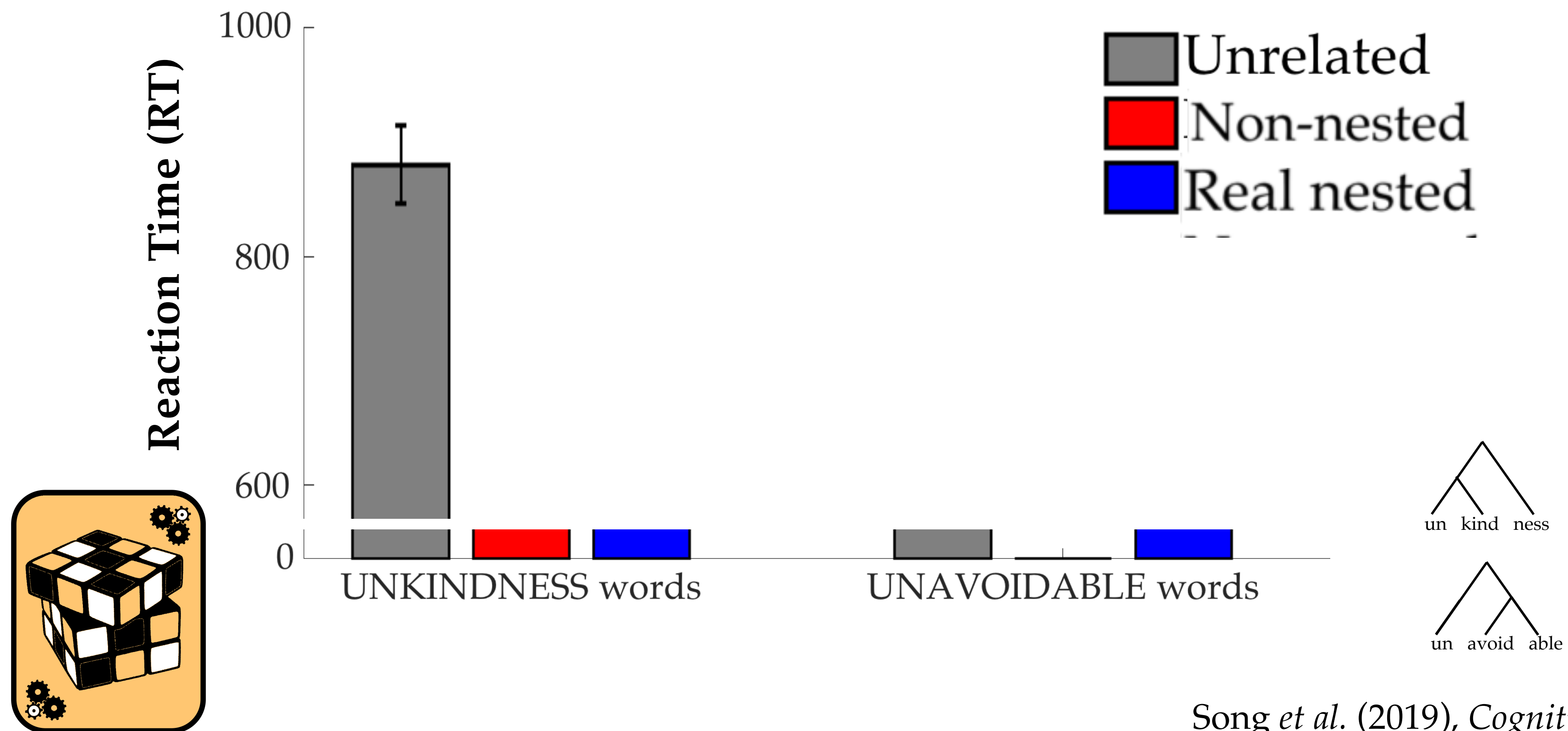
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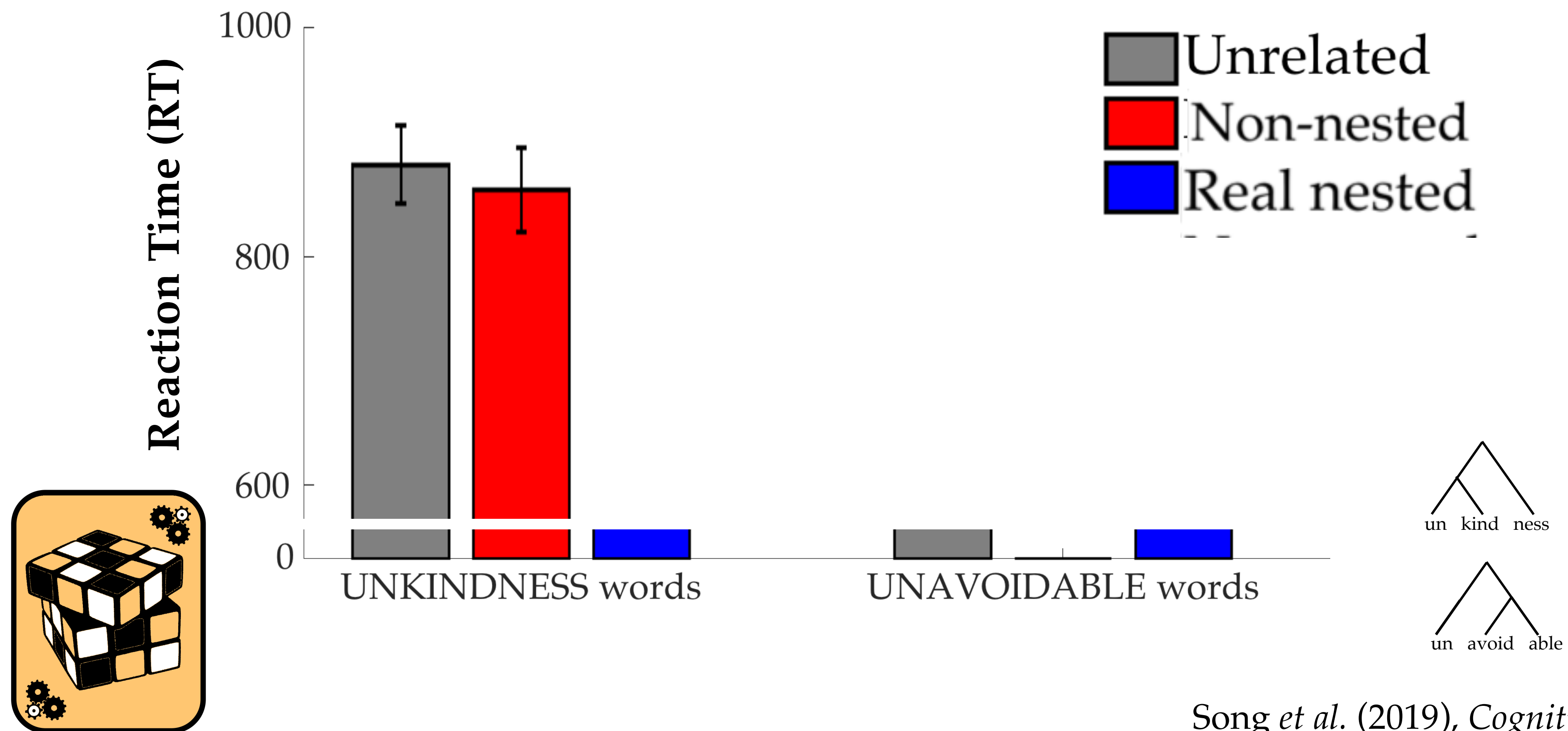
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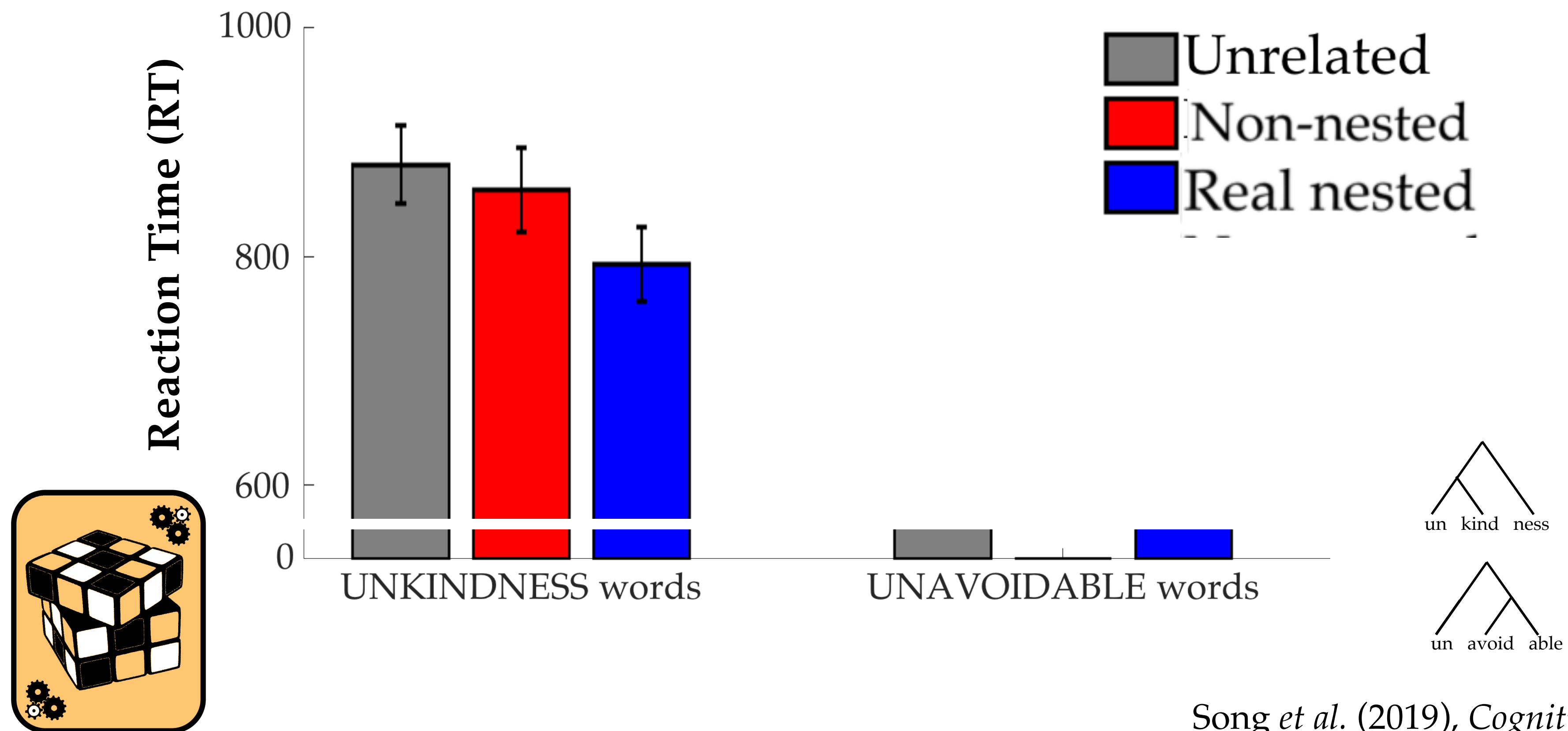
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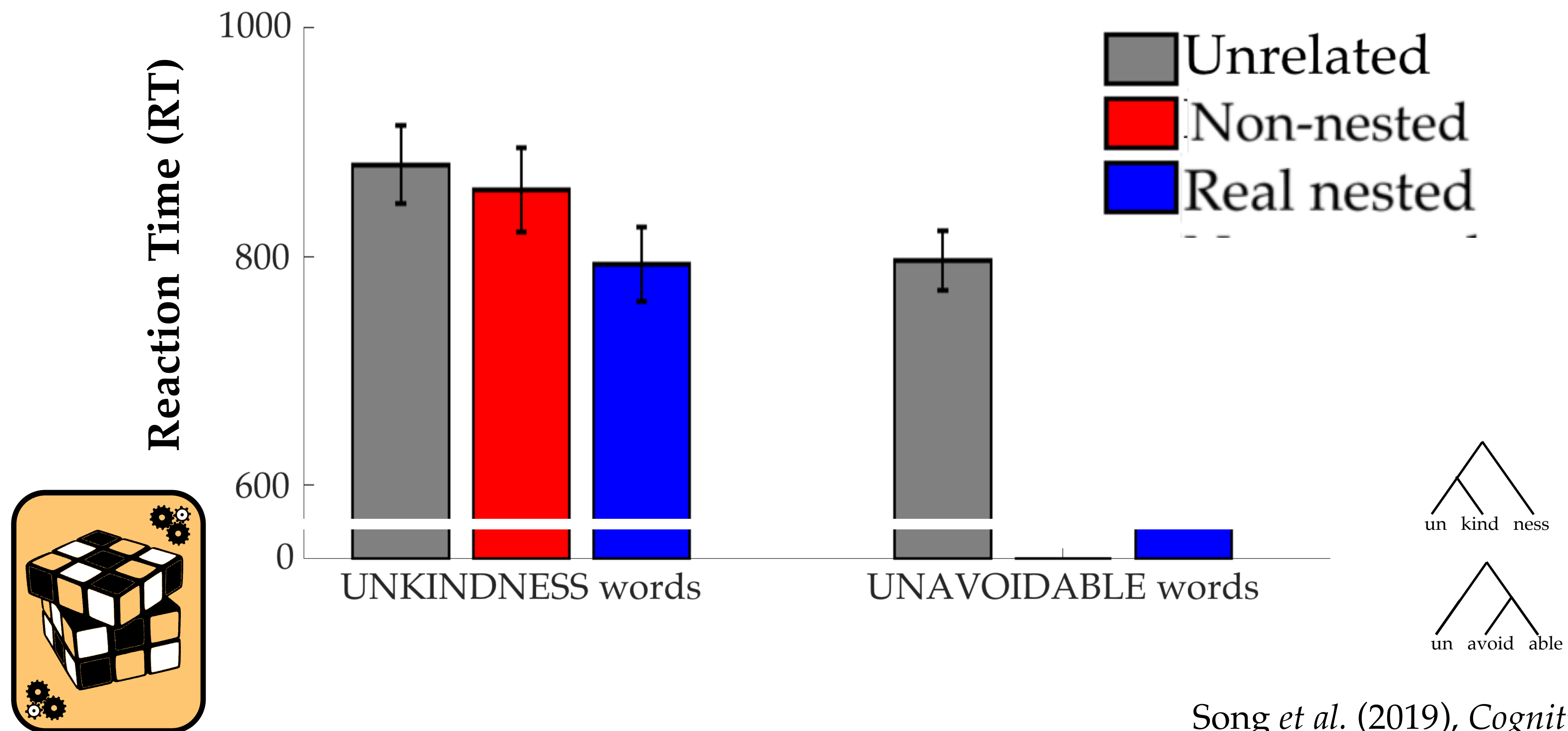
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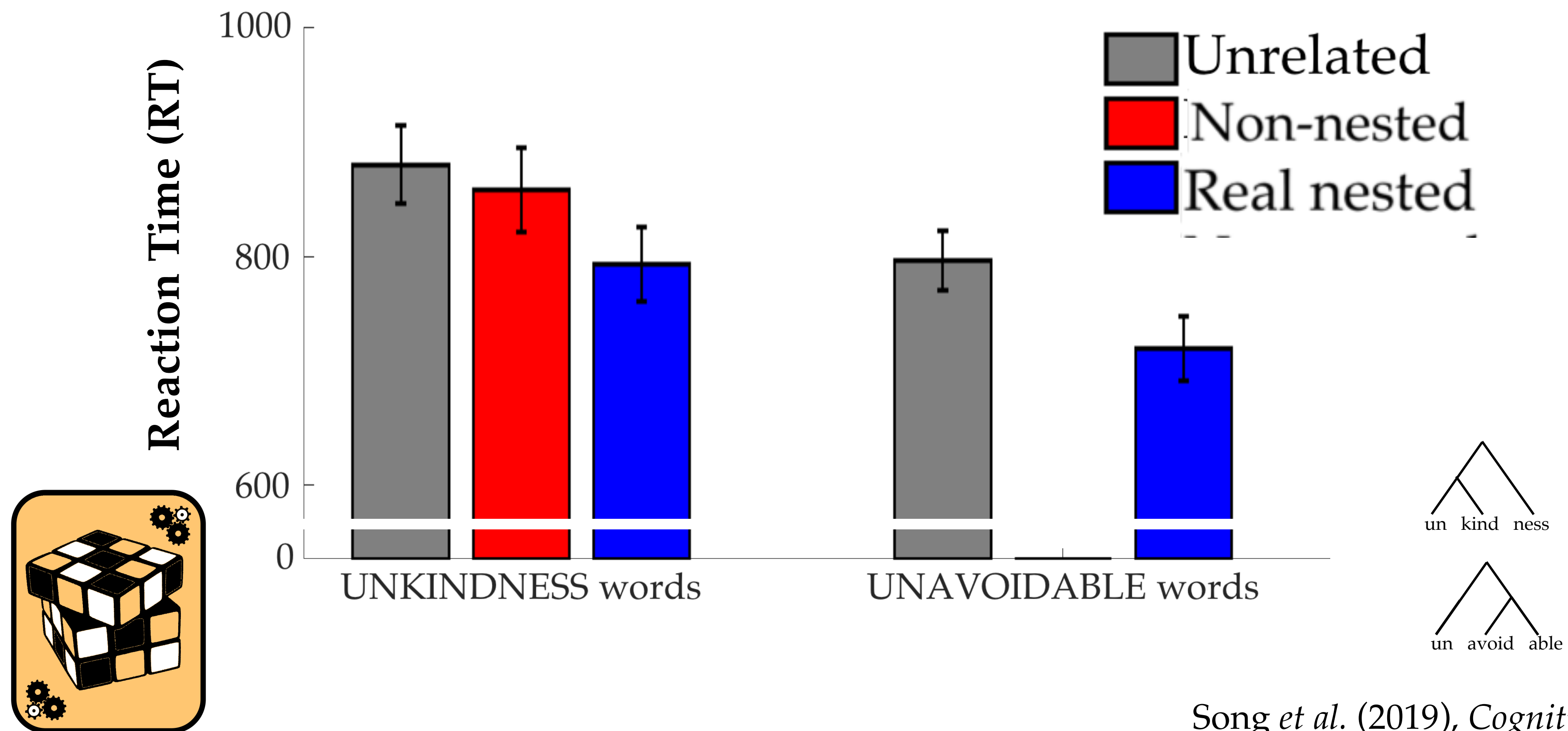
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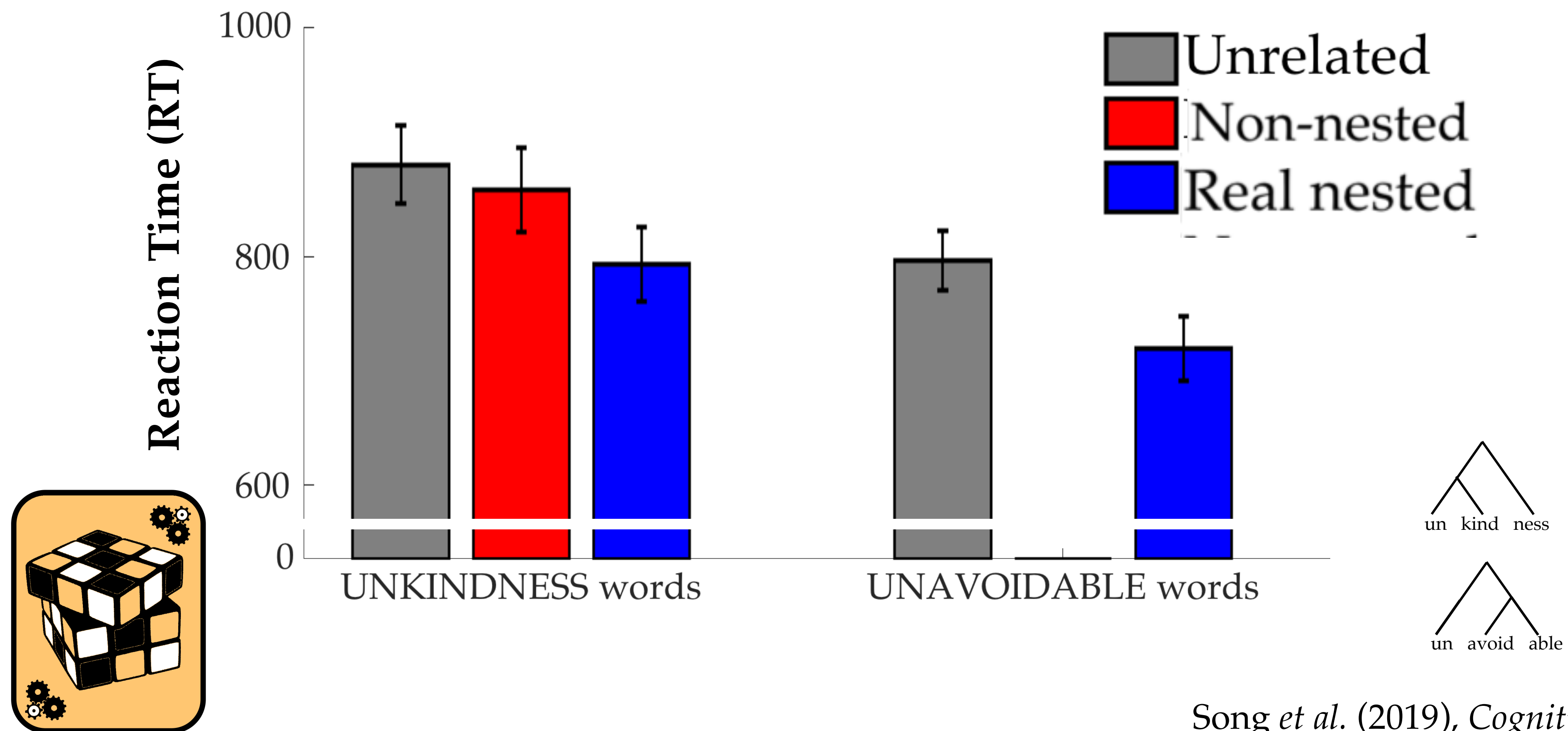
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Hierarchy in Morphology: Results

- Are multi-morphemic words represented hierarchically in our mental lexicon? YES!



-
-
- Phonology: sound patterns
 - Morphology: making words
 - **Syntax: putting words together**
 - Semantics: literal meaning
 - Pragmatics: non-literal meaning

Syntax!

'Twas brillig, and the slithy toves
Did gyre and gimble in the wabe
All mimsy were the borogoves
And the mome raths outgrabe

Syntax!

brillig the Twas slithy and toves
gyre in and gimble the Did wabe
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Syntax!

All languages require that speakers follow syntactic rules when combining words into sentences.

We were ~able to make judgments between the original jabberwocky sentence vs. the gibberish one because we have abstract knowledge of English **syntax**: its word order, structure, and grammatical relations.

Syntax!

But word order is not always fixed — e.g., Turkish and Russian have free-er word order compared to English

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Человек

Man (biter)

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Человек

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собаку

Man (biter)

bites

dog (bitten)

Собаку

кусаем

человек

Dog (bitten)

bites

man (biter)

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Adverbs (ADV): quickly, often, ...

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closed-class words

Parts of Speech in One Corpus

Tag	Description	Example	Tag	Description	Example
CC	Coordin. Conjunction	<i>and, but, or</i>	SYM	Symbol	<i>+, %, &</i>
CD	Cardinal number	<i>one, two, three</i>	TO	“to”	<i>to</i>
DT	Determiner	<i>a, the</i>	UH	Interjection	<i>ah, oops</i>
EX	Existential ‘there’	<i>there</i>	VB	Verb, base form	<i>eat</i>
FW	Foreign word	<i>mea culpa</i>	VBD	Verb, past tense	<i>ate</i>
IN	Preposition/sub-conj	<i>of, in, by</i>	VBG	Verb, gerund	<i>eating</i>
JJ	Adjective	<i>yellow</i>	VBN	Verb, past participle	<i>eaten</i>
JJR	Adj., comparative	<i>bigger</i>	VBP	Verb, non-3sg pres	<i>eat</i>
JJS	Adj., superlative	<i>wildest</i>	VBZ	Verb, 3sg pres	<i>eats</i>
LS	List item marker	<i>1, 2, One</i>	WDT	Wh-determiner	<i>which, that</i>
MD	Modal	<i>can, should</i>	WP	Wh-pronoun	<i>what, who</i>
NN	Noun, sing. or mass	<i>llama</i>	WP\$	Possessive wh-	<i>whose</i>
NNS	Noun, plural	<i>llamas</i>	WRB	Wh-adverb	<i>how, where</i>
NNP	Proper noun, singular	<i>IBM</i>	PP\$	Possessive pronoun	<i>your, one’s</i>
NNPS	Proper noun, plural	<i>Carolinas</i>	RB	Adverb	<i>quickly, never</i>
PDT	Predeterminer	<i>all, both</i>	RBR	Adverb, comparative	<i>faster</i>
POS	Possessive ending	<i>’s</i>	RBS	Adverb, superlative	<i>fastest</i>
PP	Personal pronoun	<i>I, you, he</i>	RP	Particle	<i>up, off</i>

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 - Named by semantic head: a NP has N at its core and *behaves like one*

Some English Phrase Structures

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Disclaimer: we don't know the complete rules of any language

Some English Phrase Structures

$S \rightarrow NP VP$

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Some English Phrase Structures

$S \rightarrow NP VP$ Everybody hurts;

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Some English Phrase Structures

$S \rightarrow NP VP$ Everybody hurts; I love you;

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$S \rightarrow NP VP$

Everybody hurts; I love you; Give me one reason

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$S \rightarrow NP VP$

Everybody hurts; I love you; Give me one reason

$S \rightarrow VP$

Stop!

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Some English Phrase Structures

$S \rightarrow NP VP$ Everybody hurts; I love you; Give me one reason

$S \rightarrow VP$ Stop! Let it go;

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Some English Phrase Structures

$S \rightarrow NP VP$

Everybody hurts; I love you; Give me one reason

$S \rightarrow VP$

Stop! Let it go; Take another little piece of my heart

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Some English Phrase Structures

$S \rightarrow NP VP$	Everybody hurts; I love you; Give me one reason
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$S \rightarrow aux NP VP$	

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$NP \rightarrow N \mid Pronoun$	yesterday she

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$NP \rightarrow N PP$	

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$NP \rightarrow Det (Adj^*) NP$	my big fat Greek wedding
$NP \rightarrow NP S$	the reason voting is important
$NP \rightarrow N PP$	stairway to heaven

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$NP \rightarrow N PP \quad PP \rightarrow Prep NP$	stairway to heaven

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$NP \rightarrow N \mid Pronoun$	yesterday she
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$VP \rightarrow V NP$	(I) see a little silhouetto of a man; (It's) raining men
$VP \rightarrow V PP$	waving through a window; dancing with myself
$VP \rightarrow V that S$	(I) believe that god lives on a planet called Kolob (recursion)
$NP \rightarrow N \mid Pronoun$	yesterday she
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Phrase-Structure Rules

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- Serial application of rules results in a **derivation** of a sentence from the grammar.

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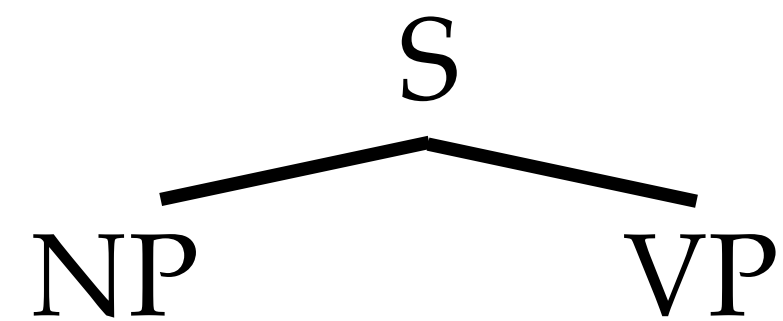
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We parse sentences

Phrase-Structure Rules

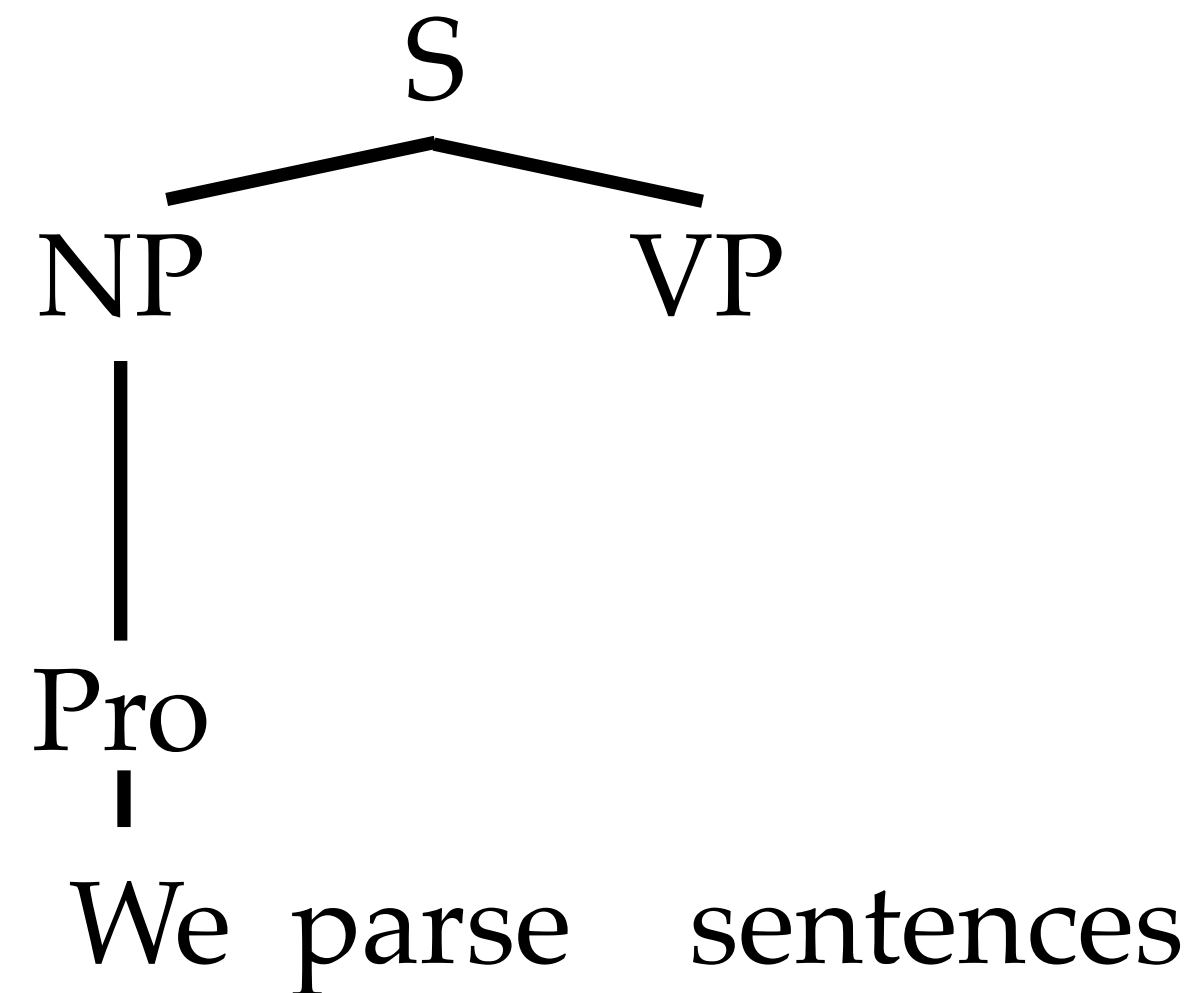
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We parse sentences

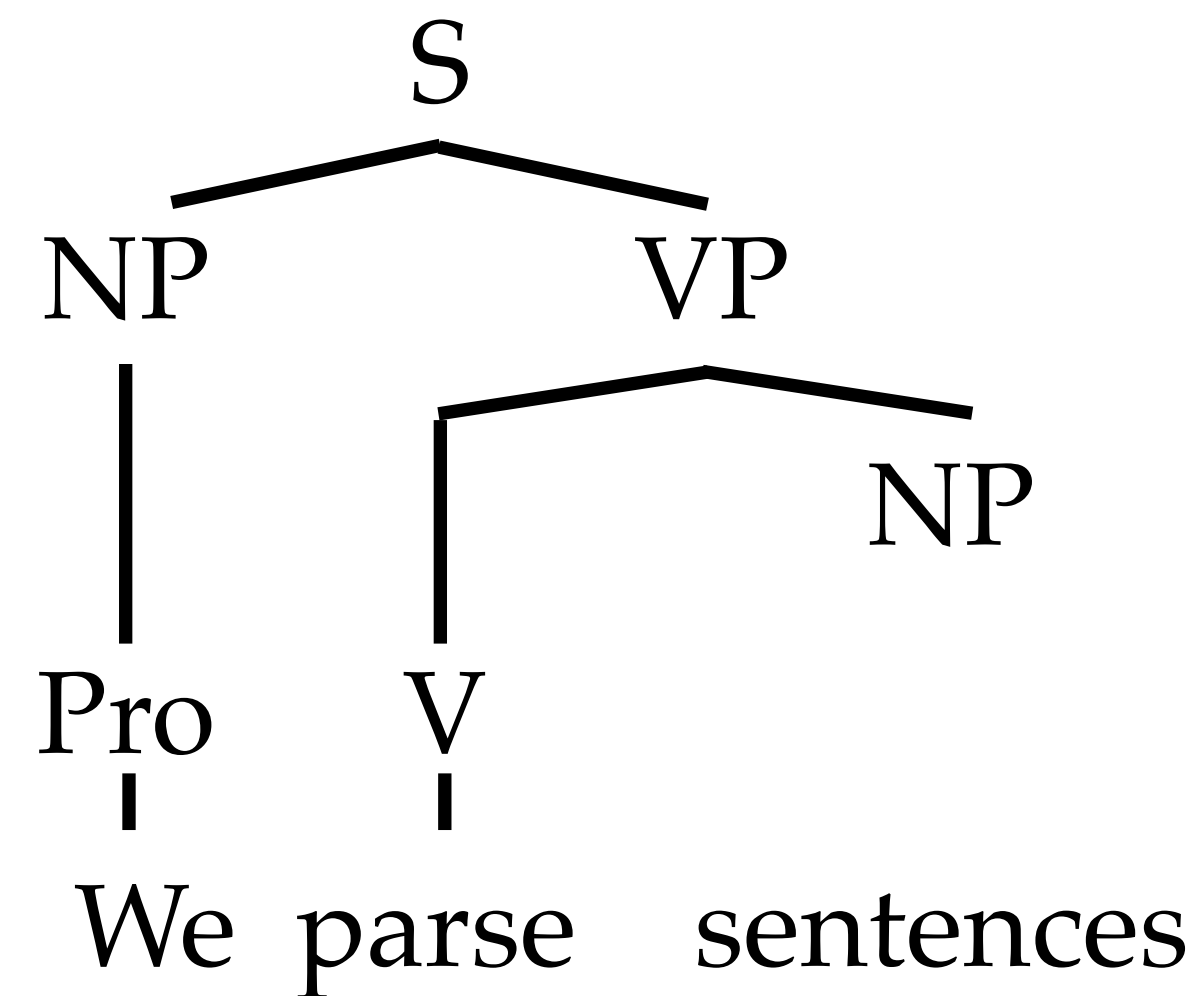
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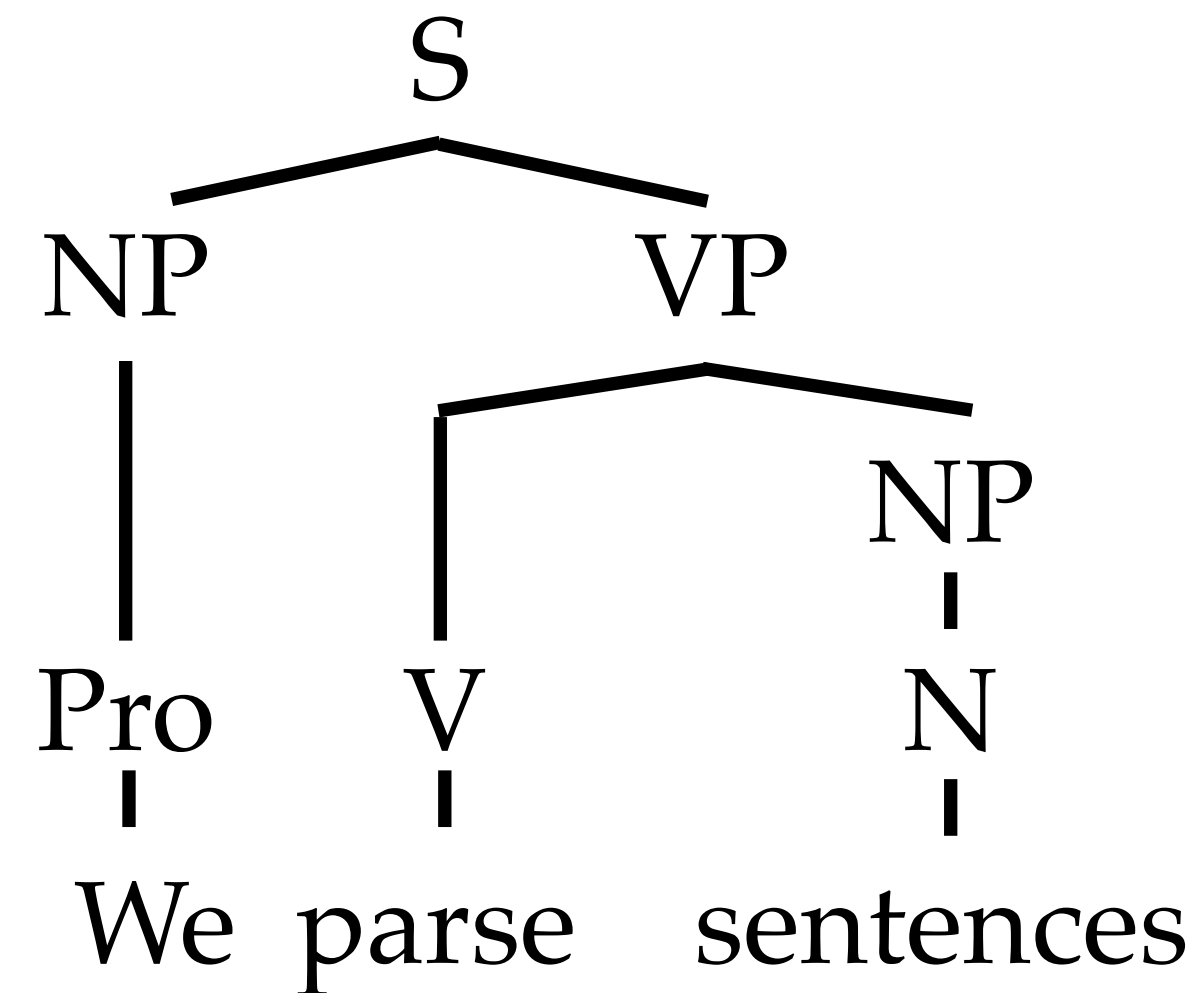
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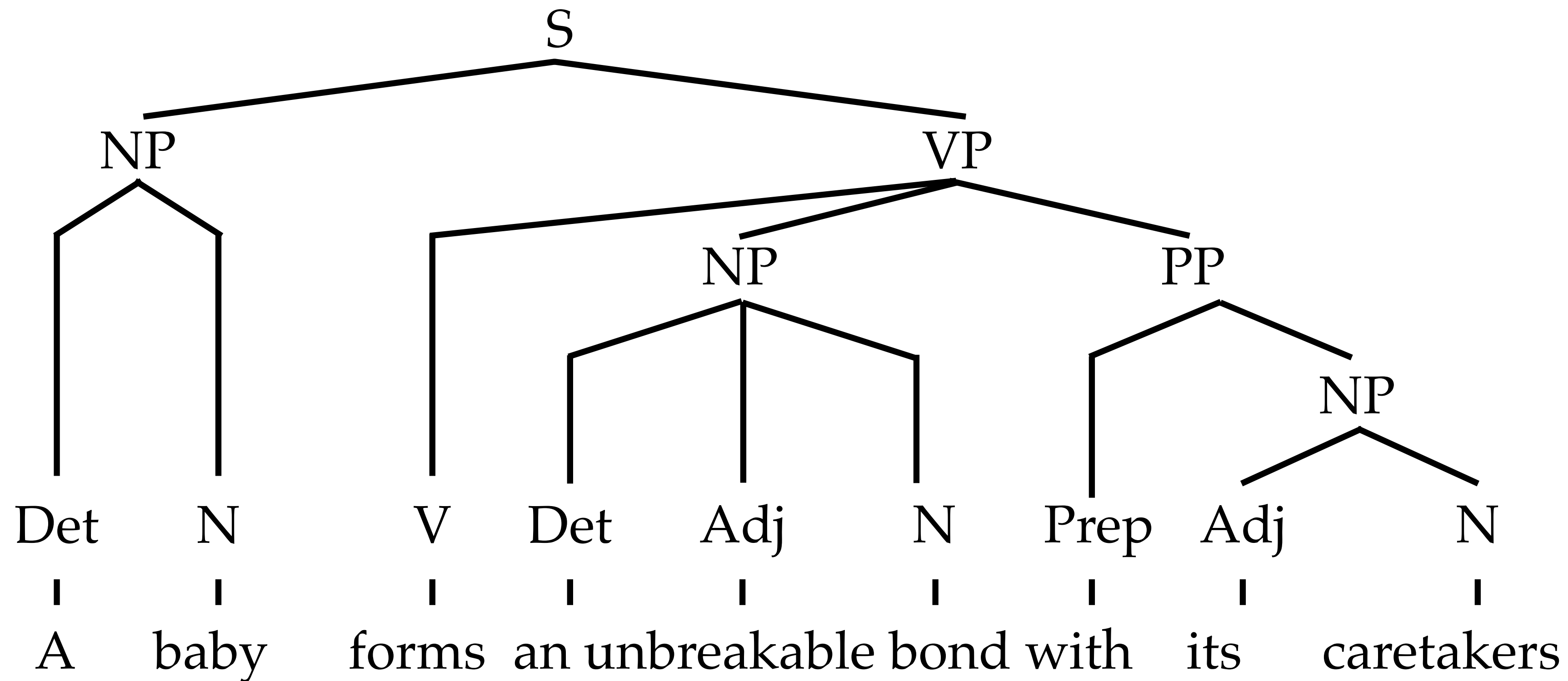
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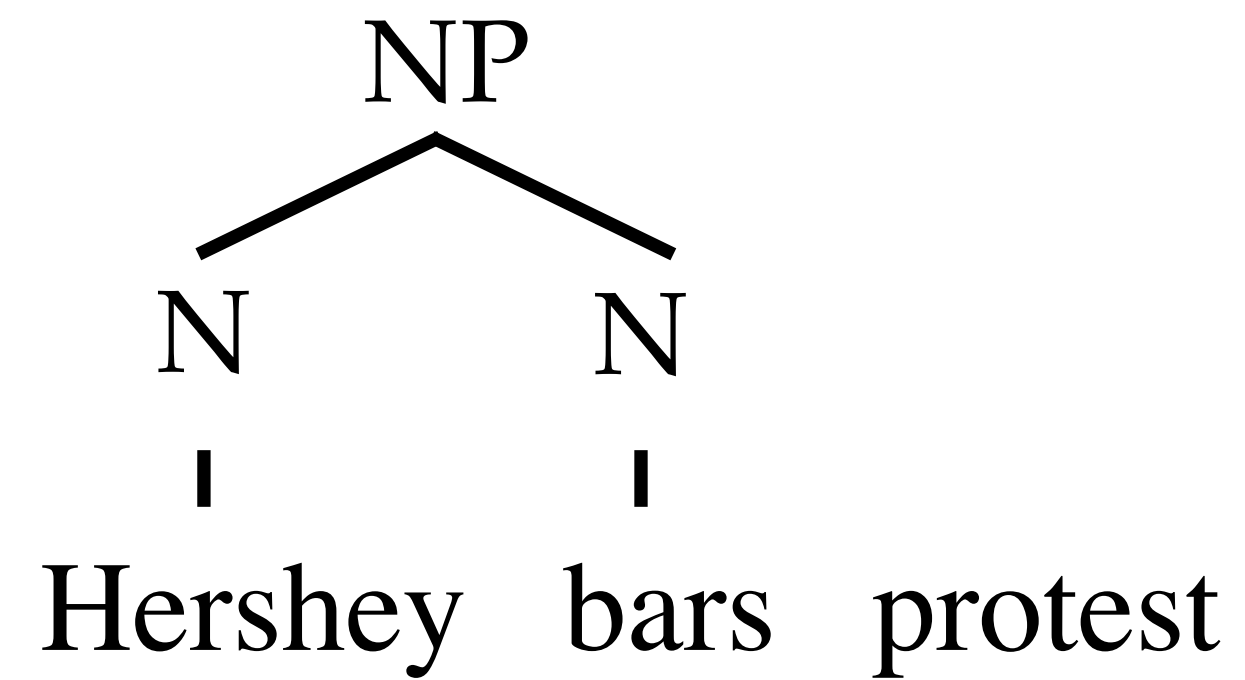
Structural Ambiguity

Hershey bars protest

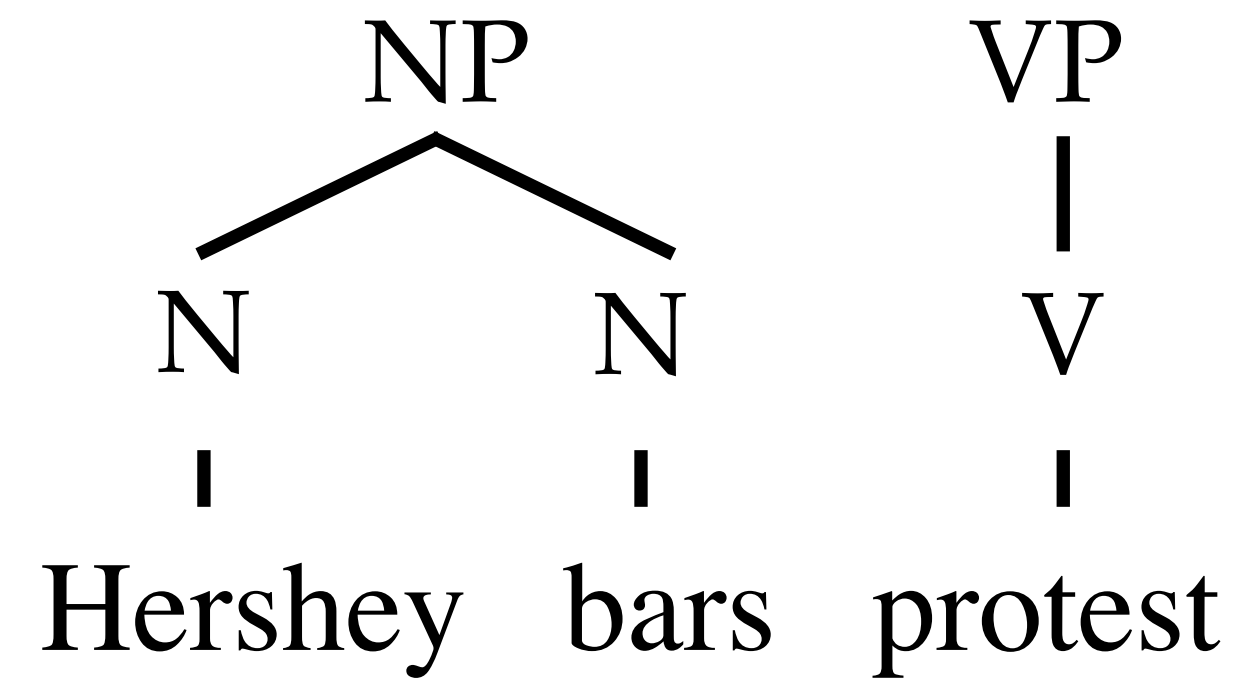
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N N
| |
Hershey bars protest

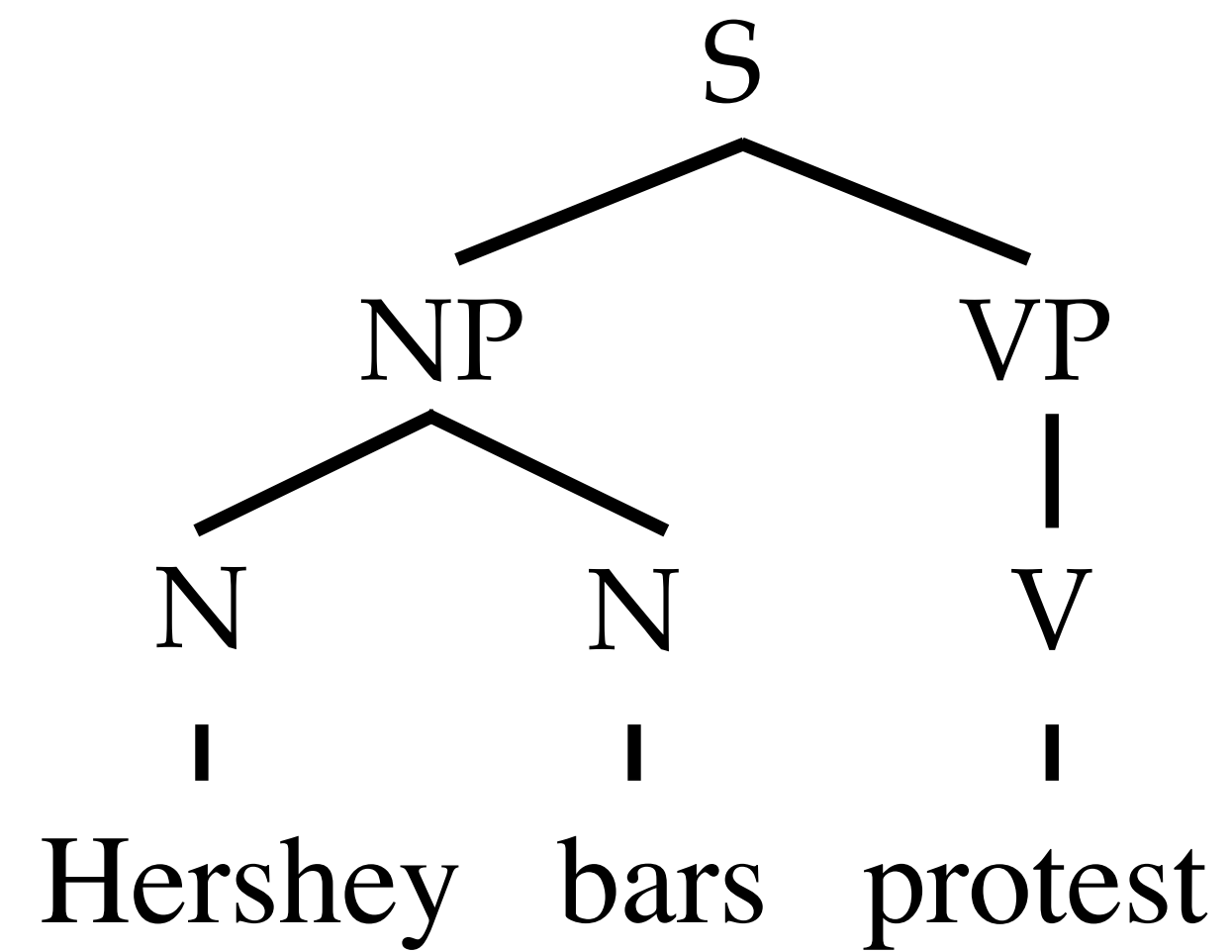
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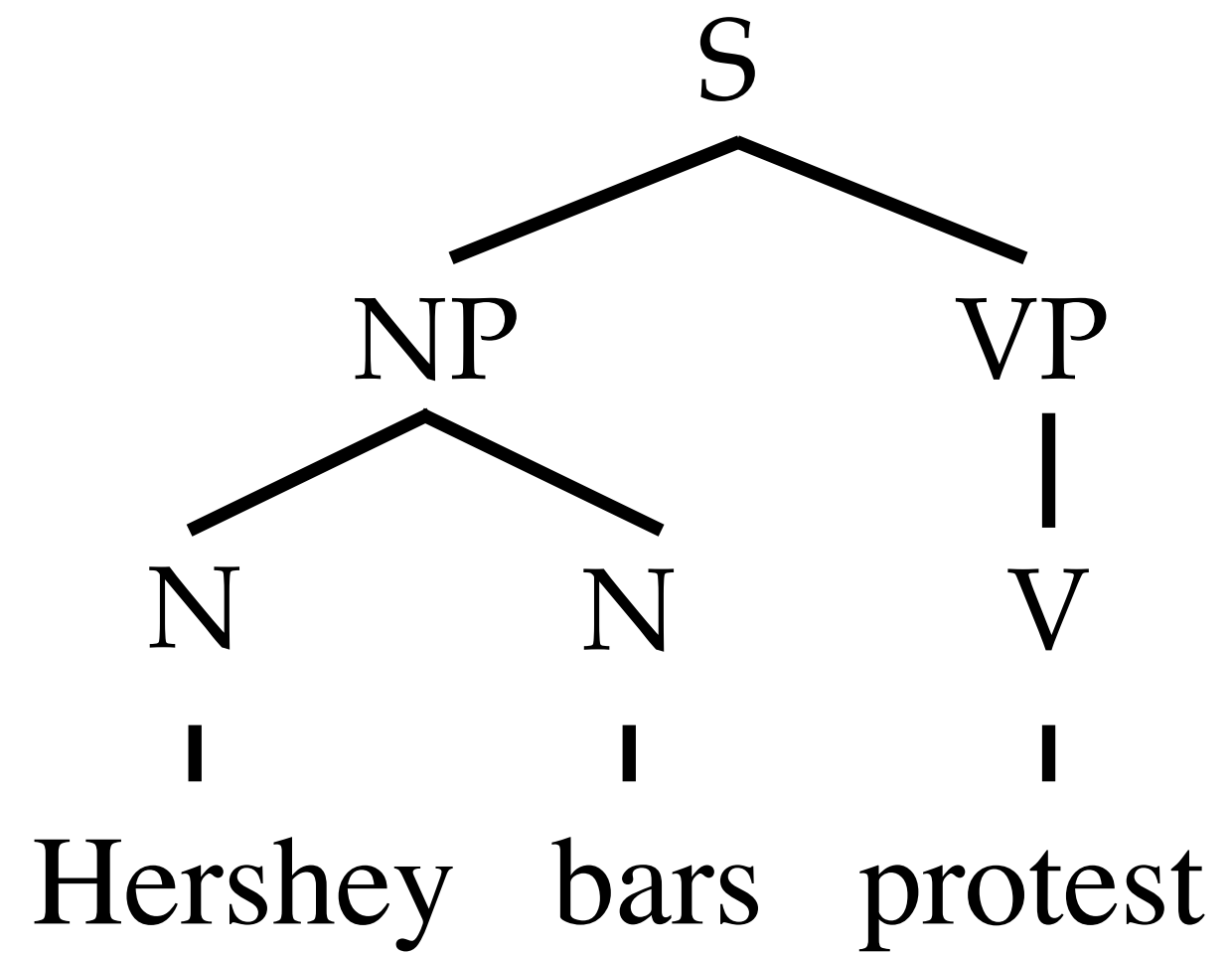
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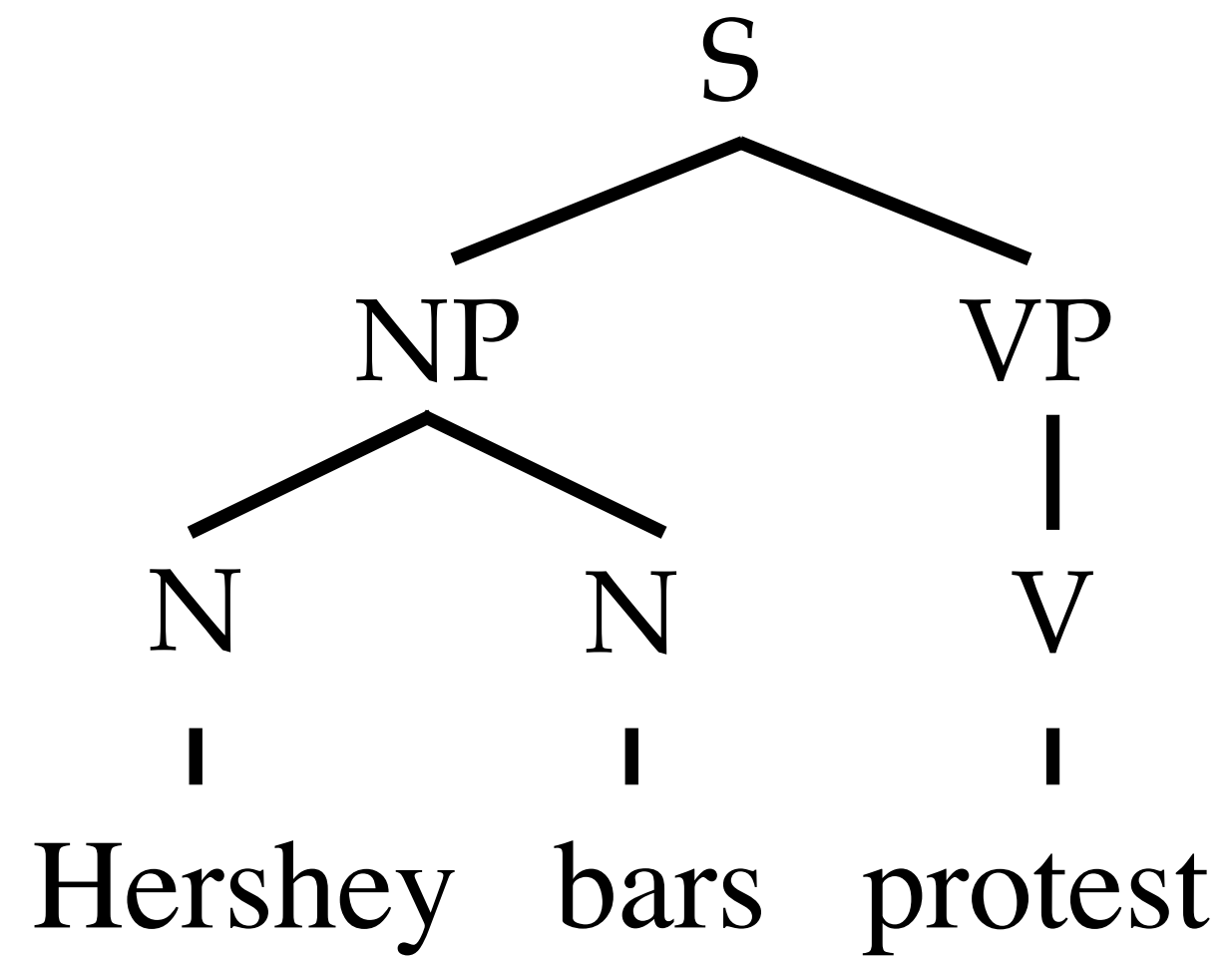
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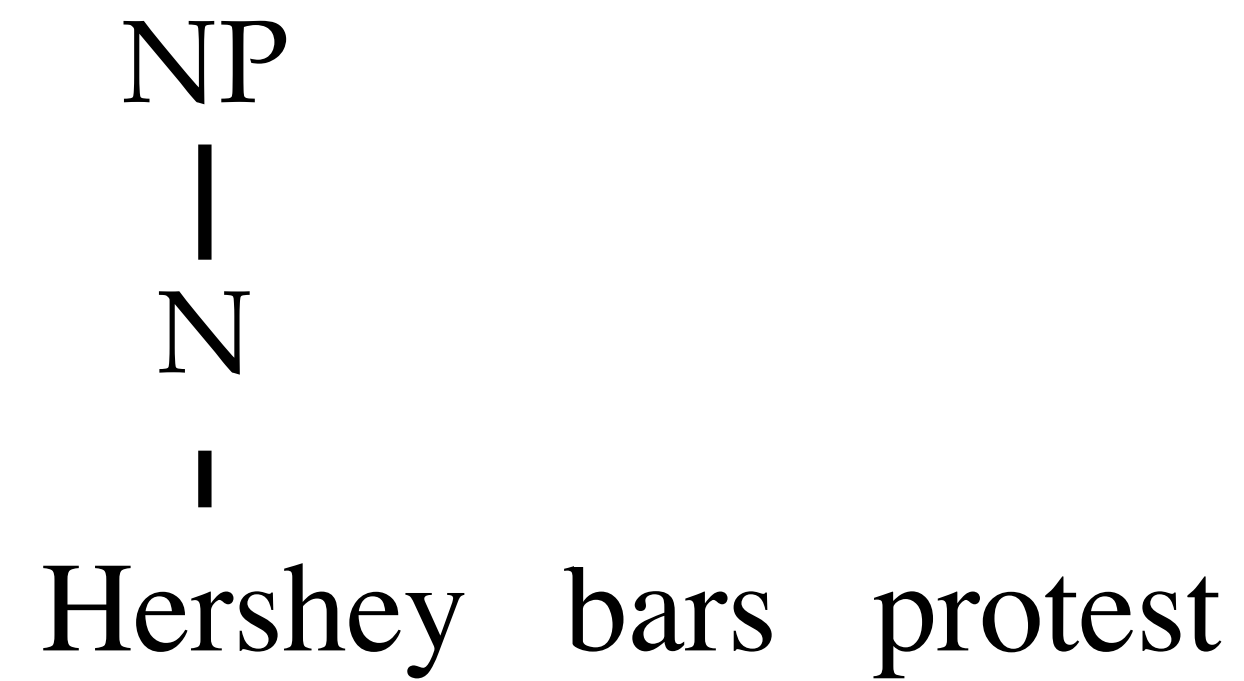
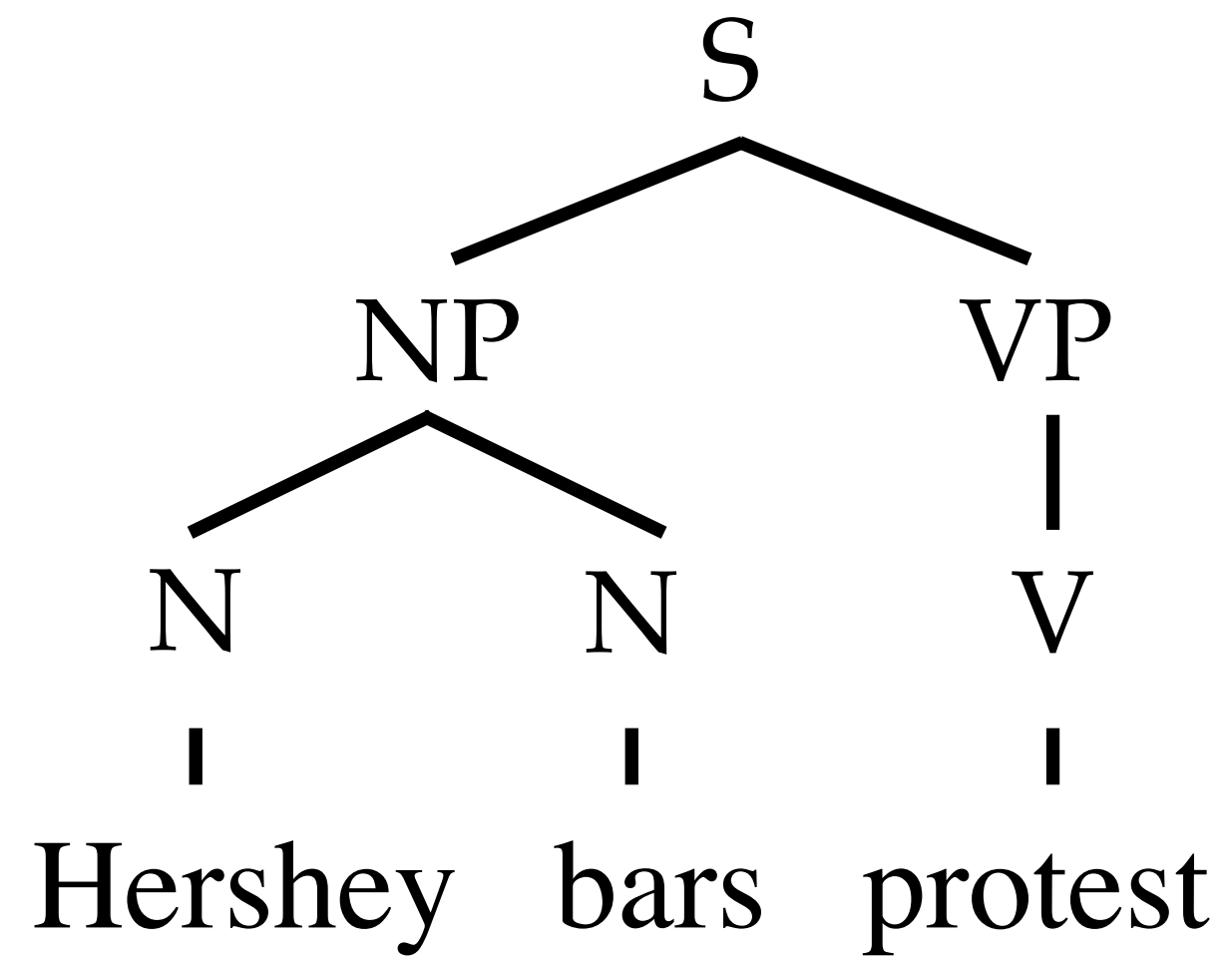


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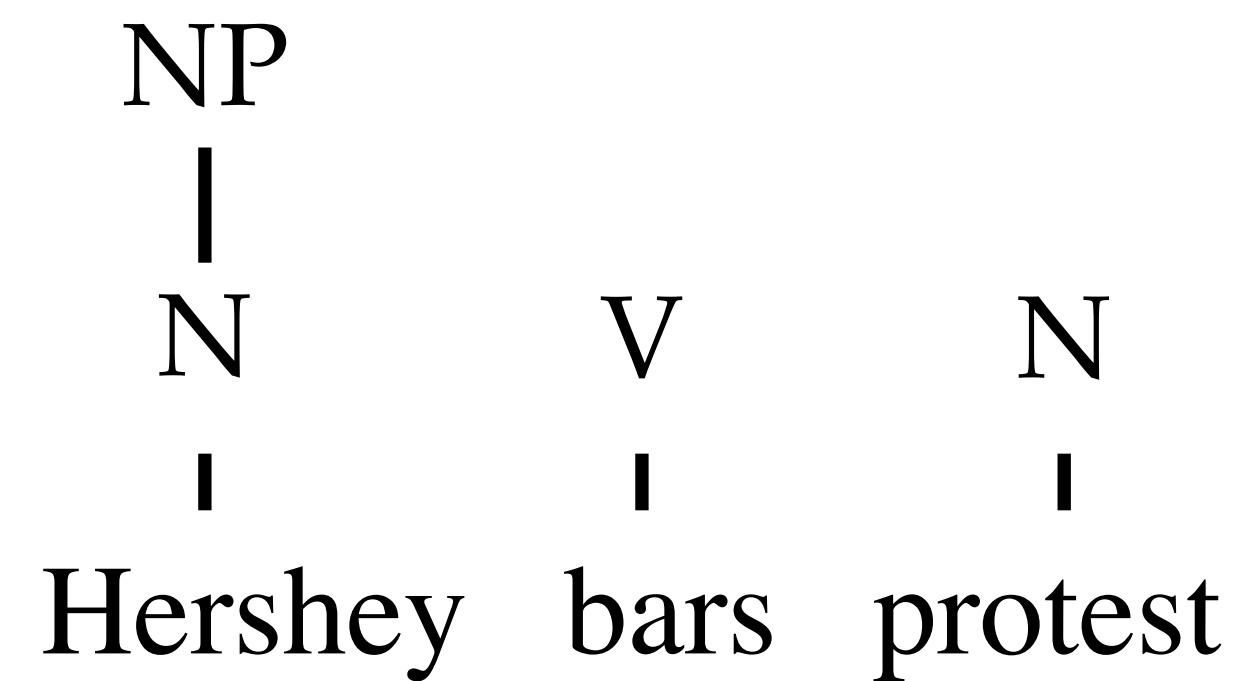
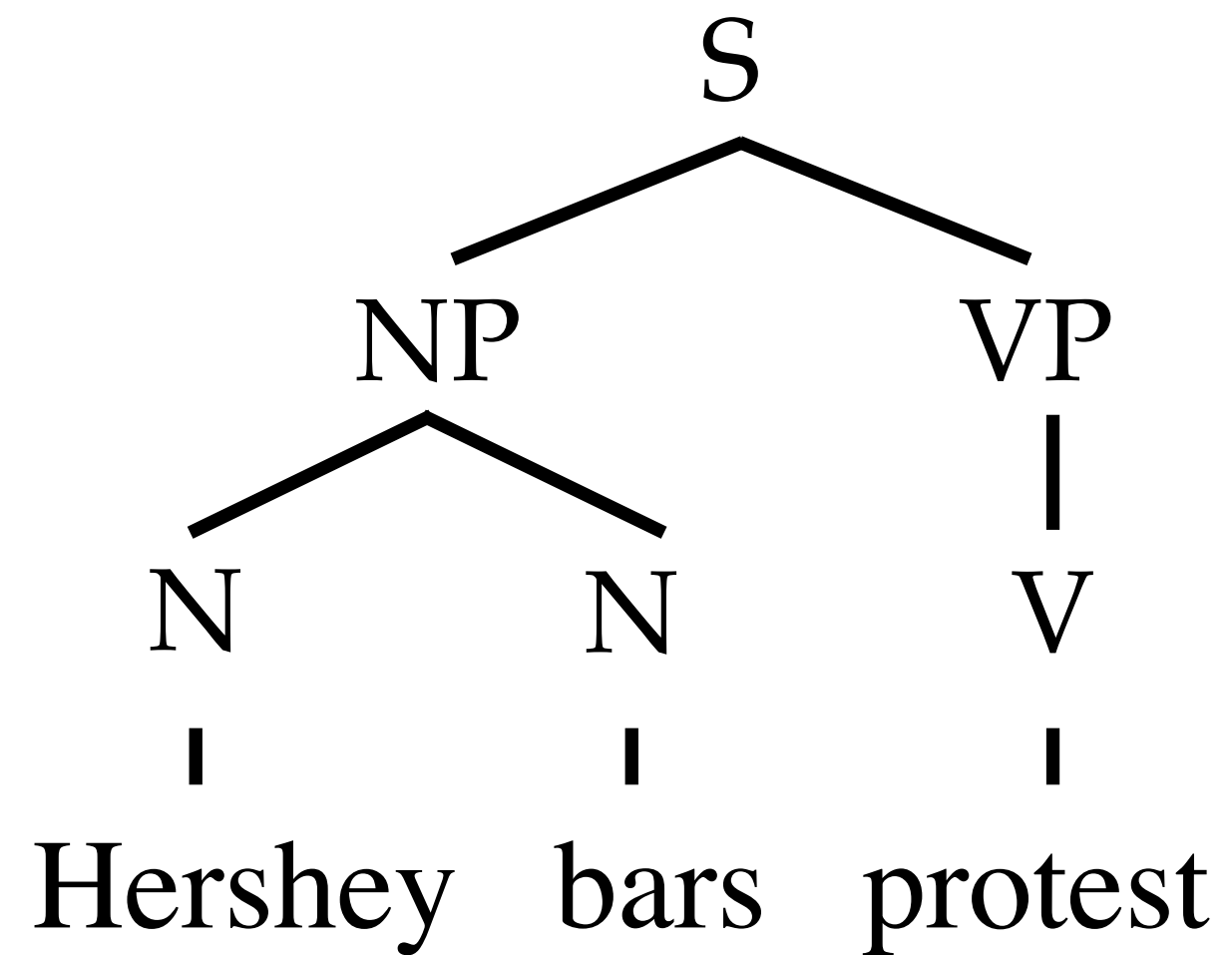


Hershey bars protest

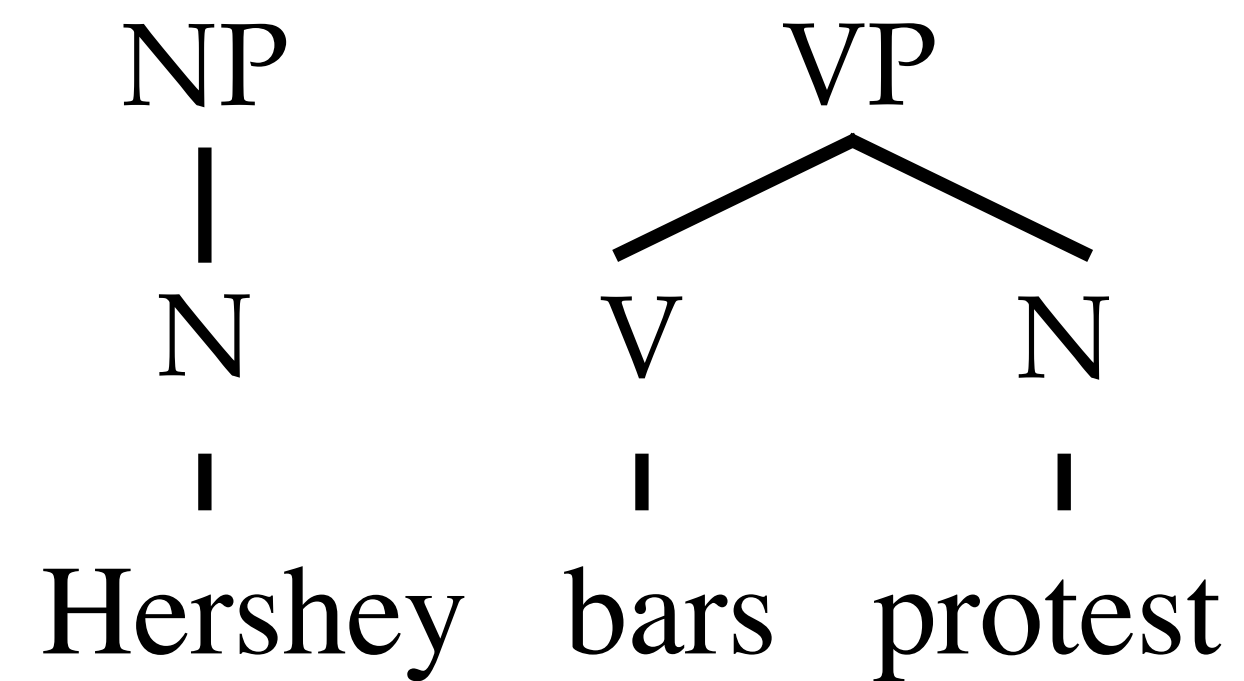
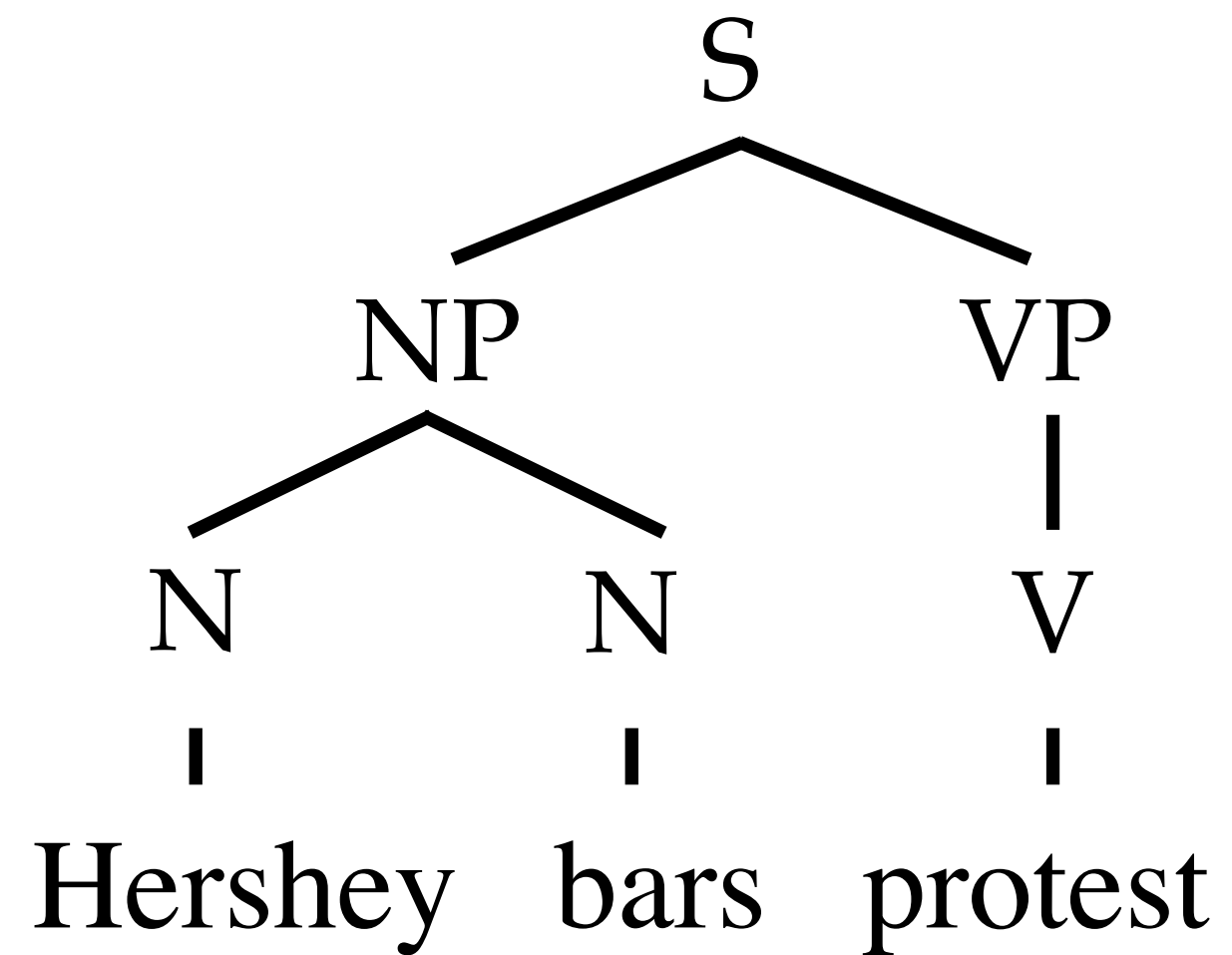
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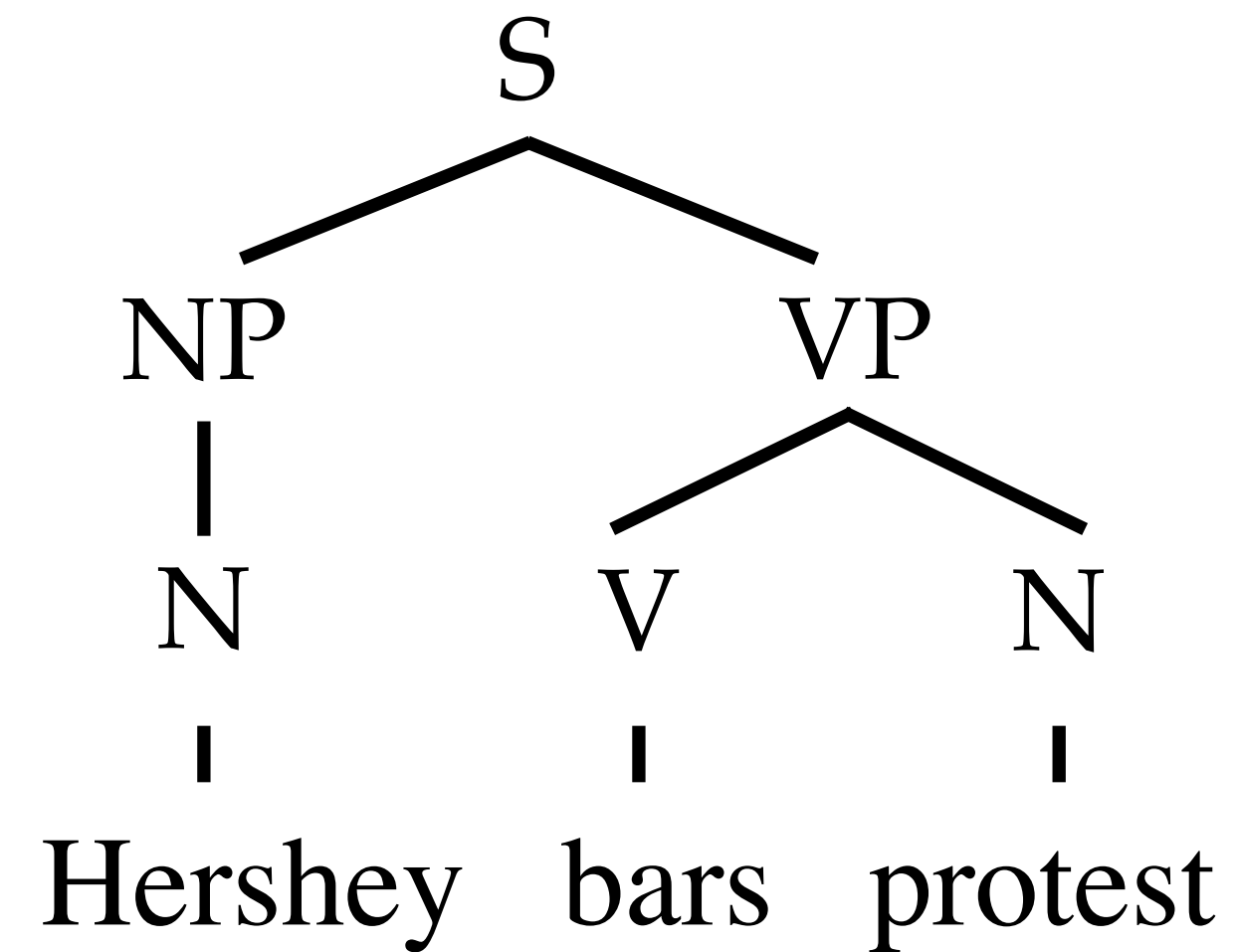
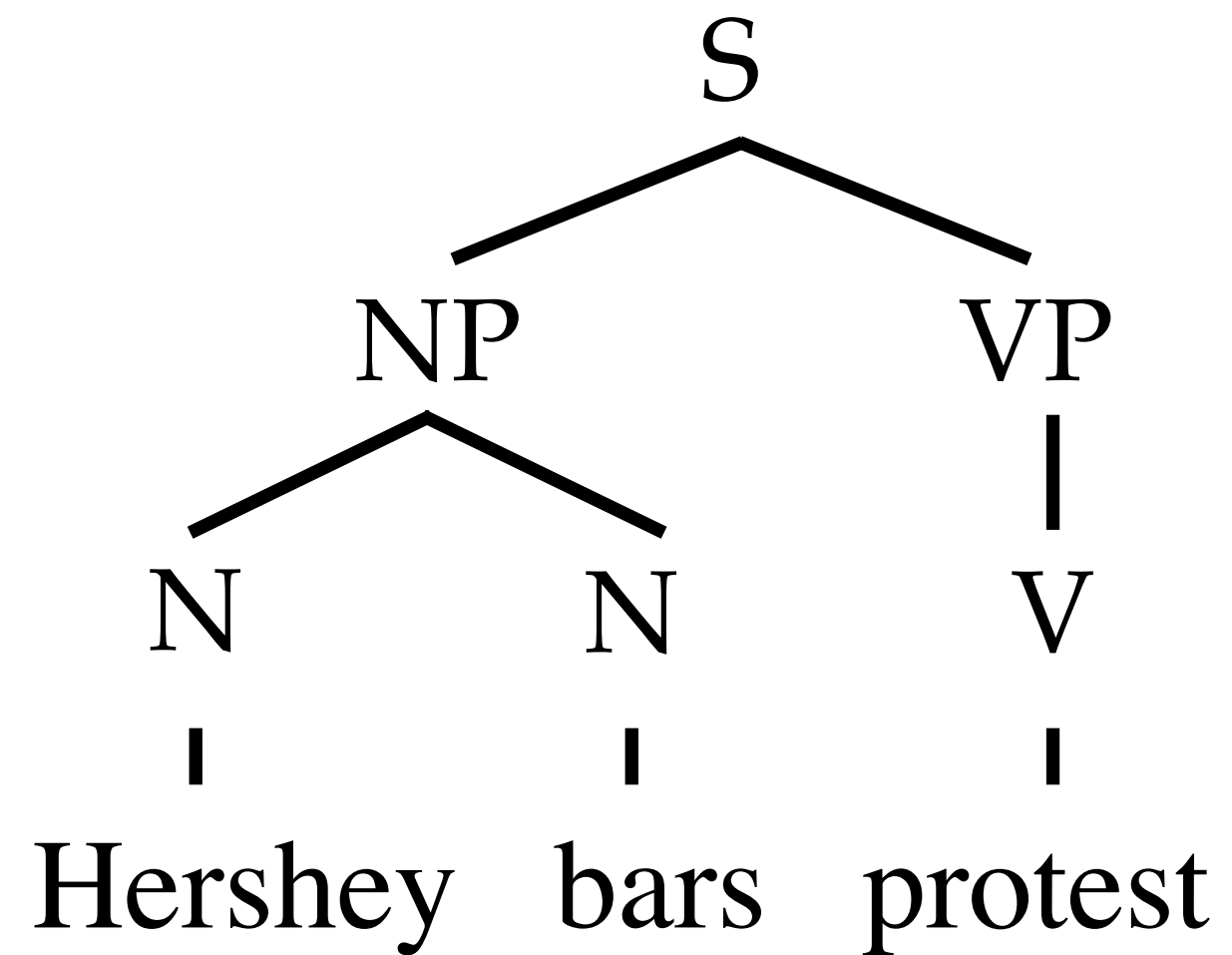
Structural Ambiguity



Structural Ambiguity



Structural Ambiguity



Structural Ambiguity

I saw the man with the telescope

Structural Ambiguity

I saw the man with the telescope

$S \rightarrow NP VP$

$S \rightarrow VP$

$S \rightarrow aux NP VP$

$NP \rightarrow N \mid Pronoun$

$NP \rightarrow Det (Adj^*) NP$

$NP \rightarrow N PP$

$VP \rightarrow V NP$

$VP \rightarrow V PP$

$VP \rightarrow V that S$

$VP \rightarrow V NP PP$

$PP \rightarrow Prep NP$

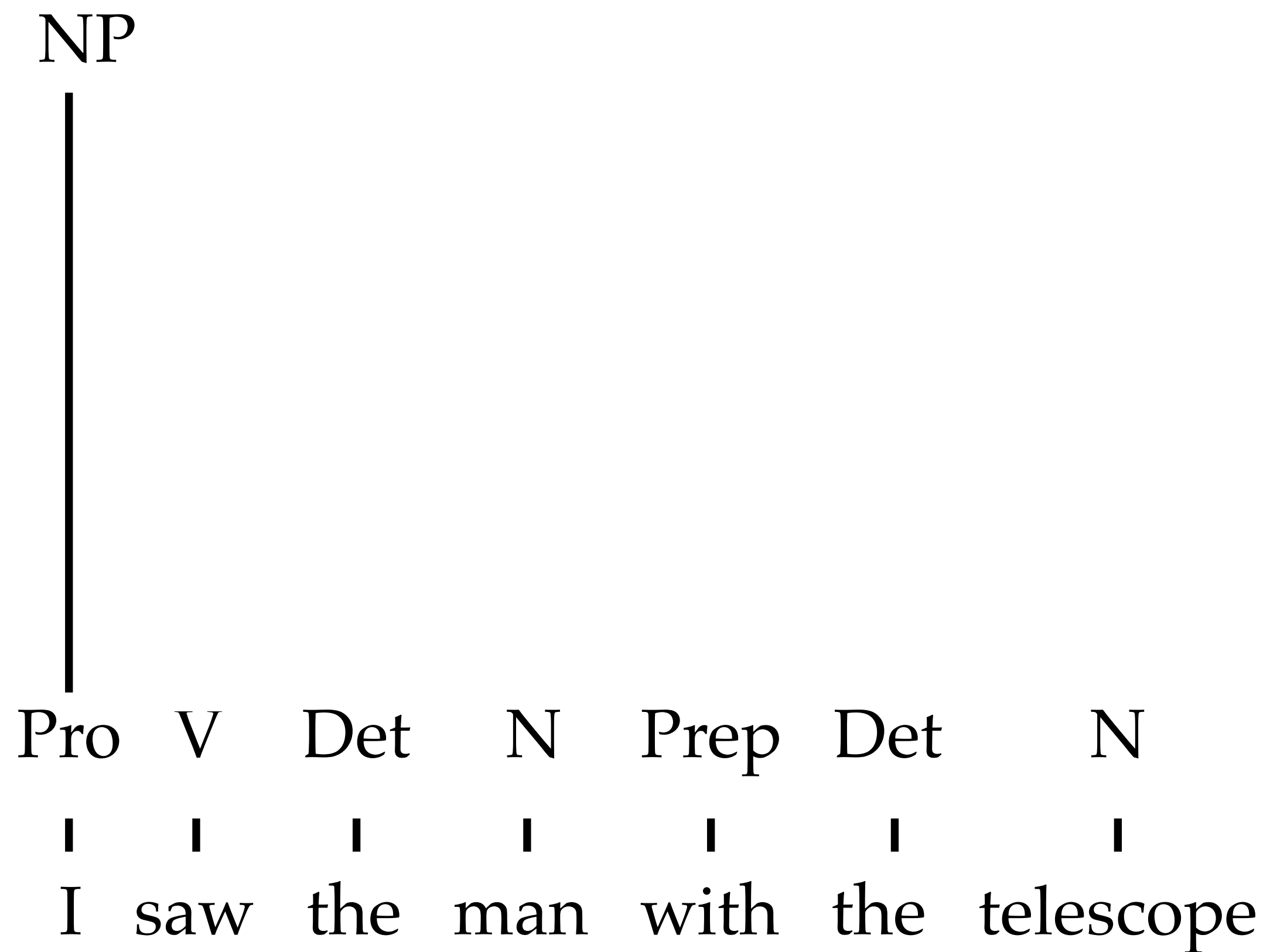
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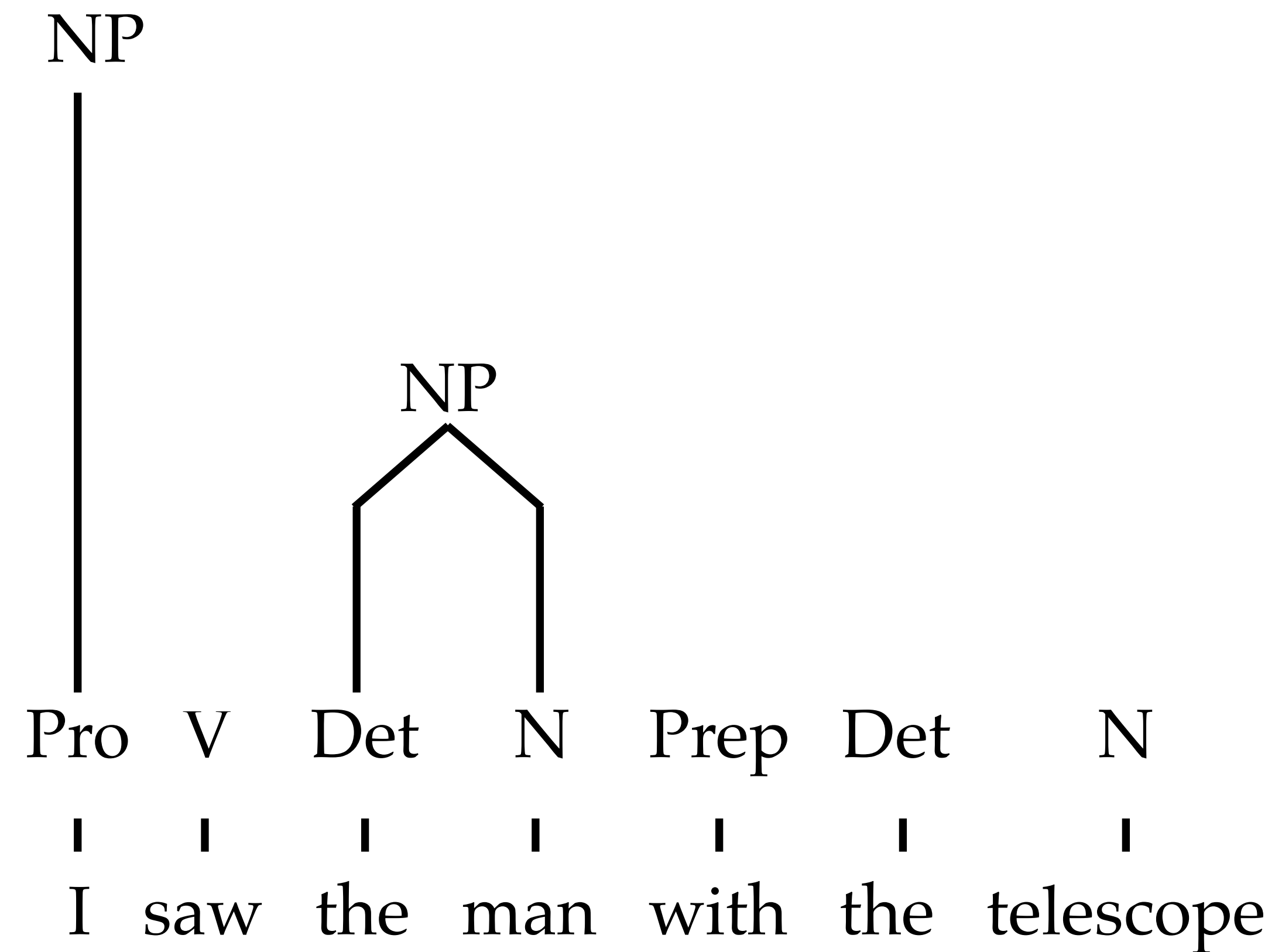
Structural Ambiguity

Pro	V	Det	N	Prep	Det	N
I	saw	the	man	with	the	telescope

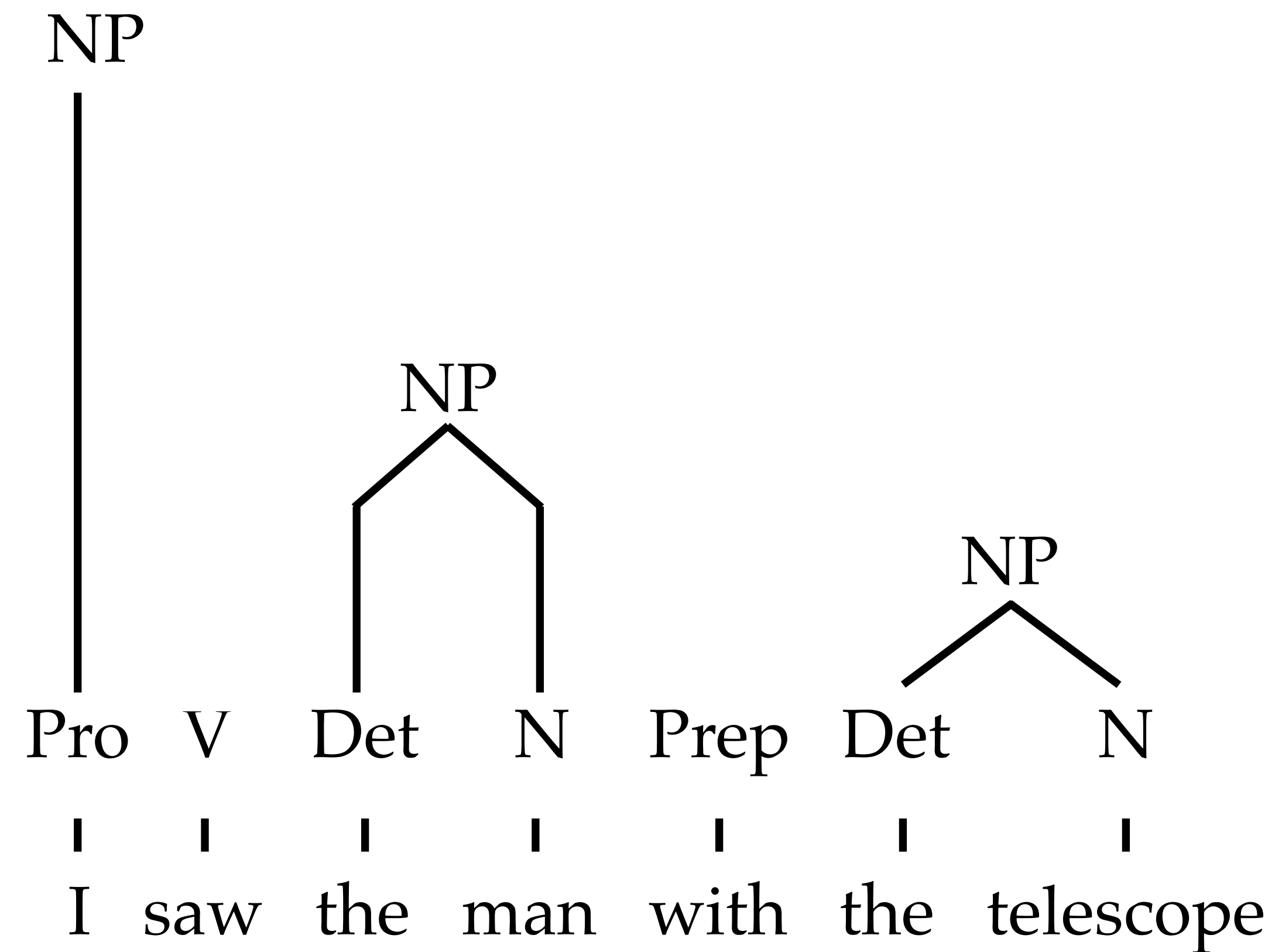
Structural Ambiguity



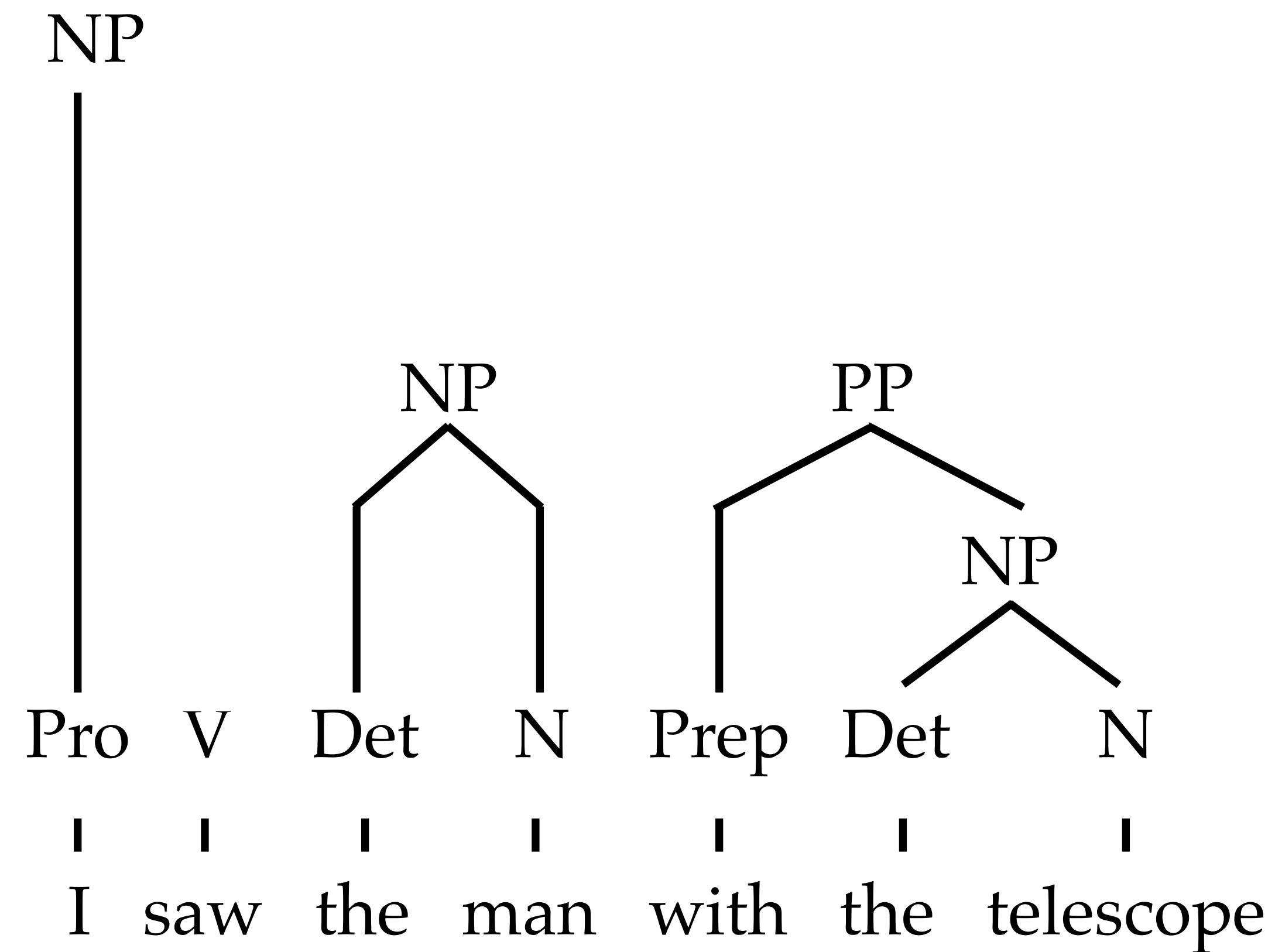
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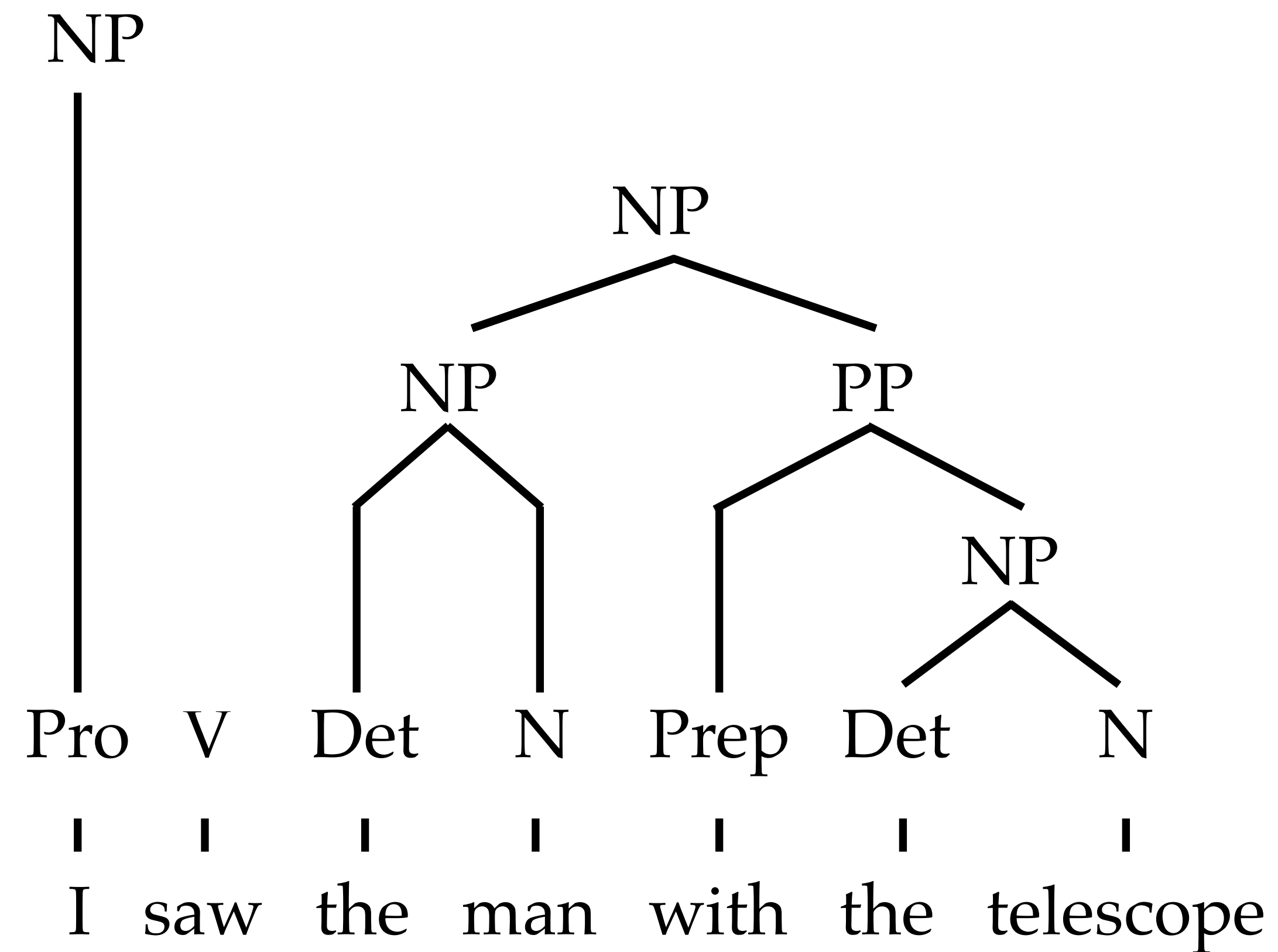
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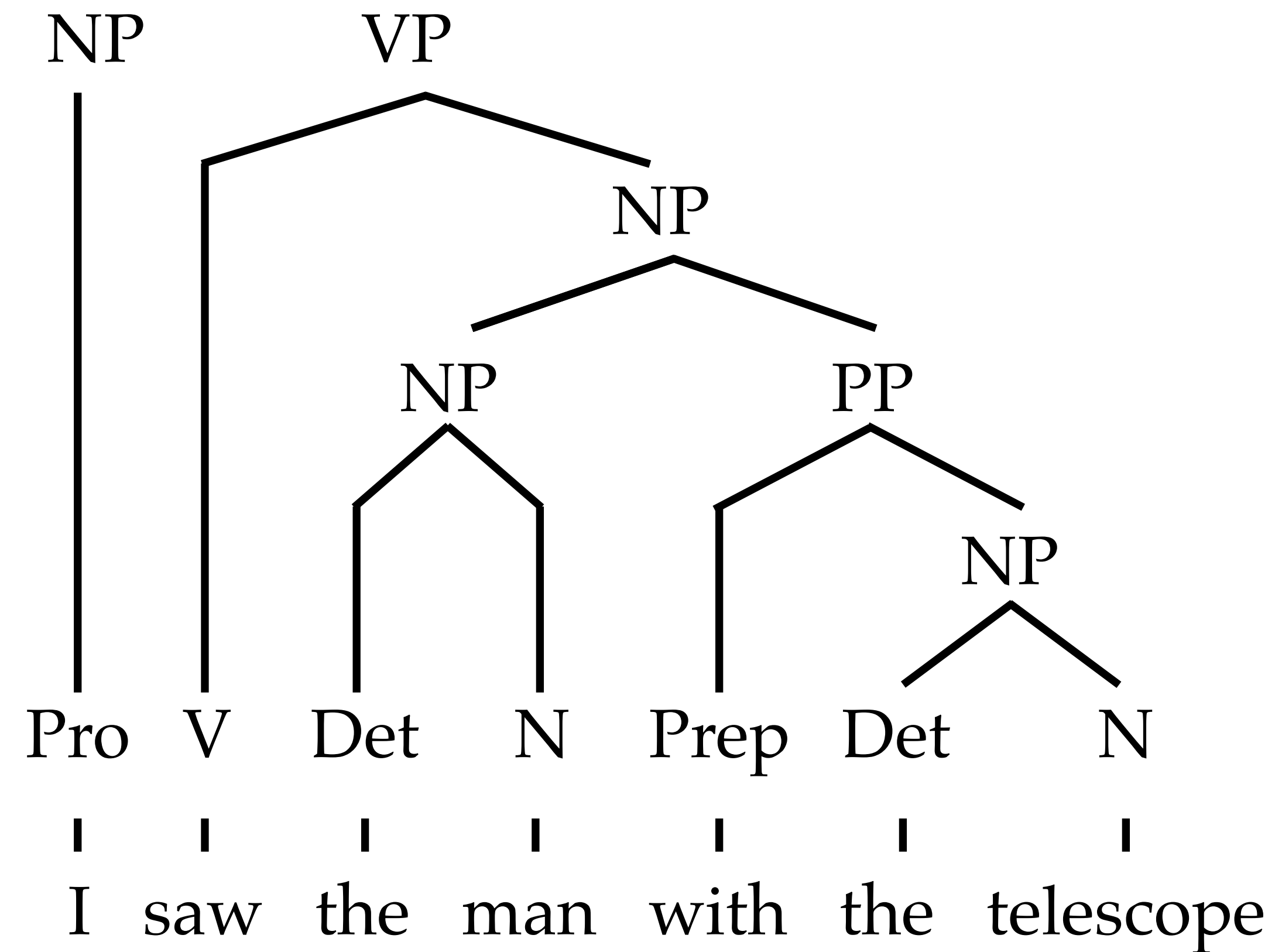
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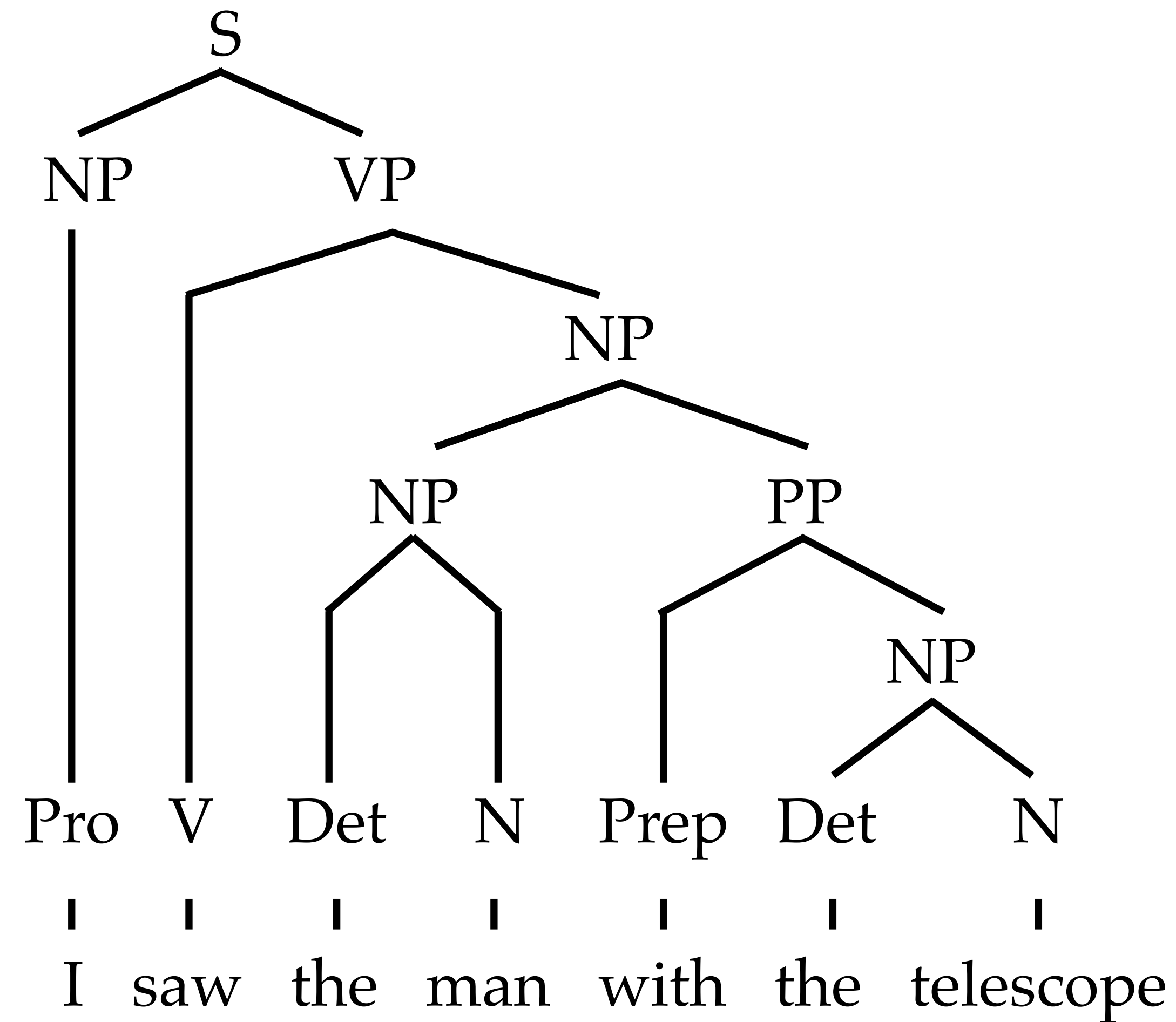
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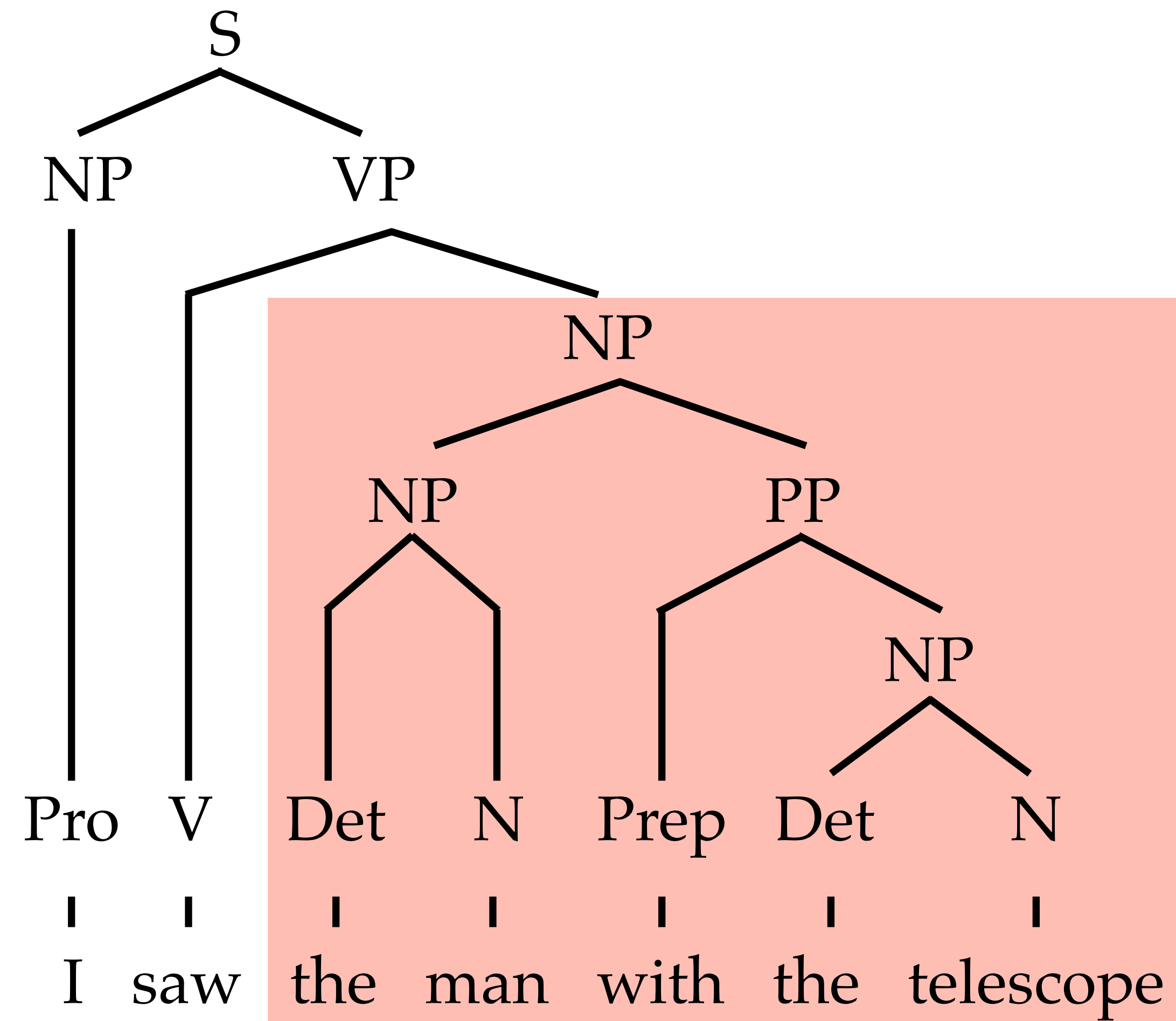
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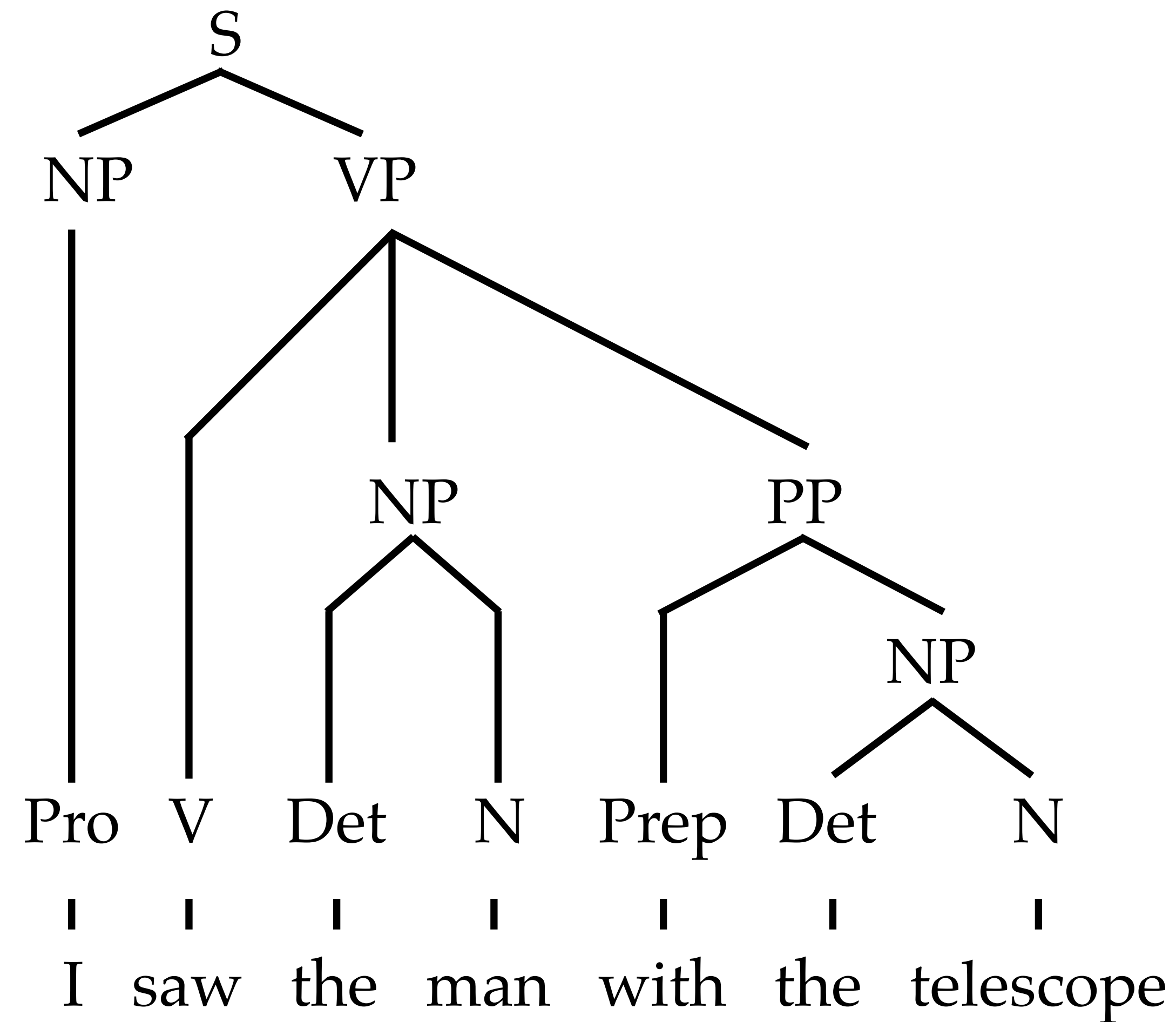
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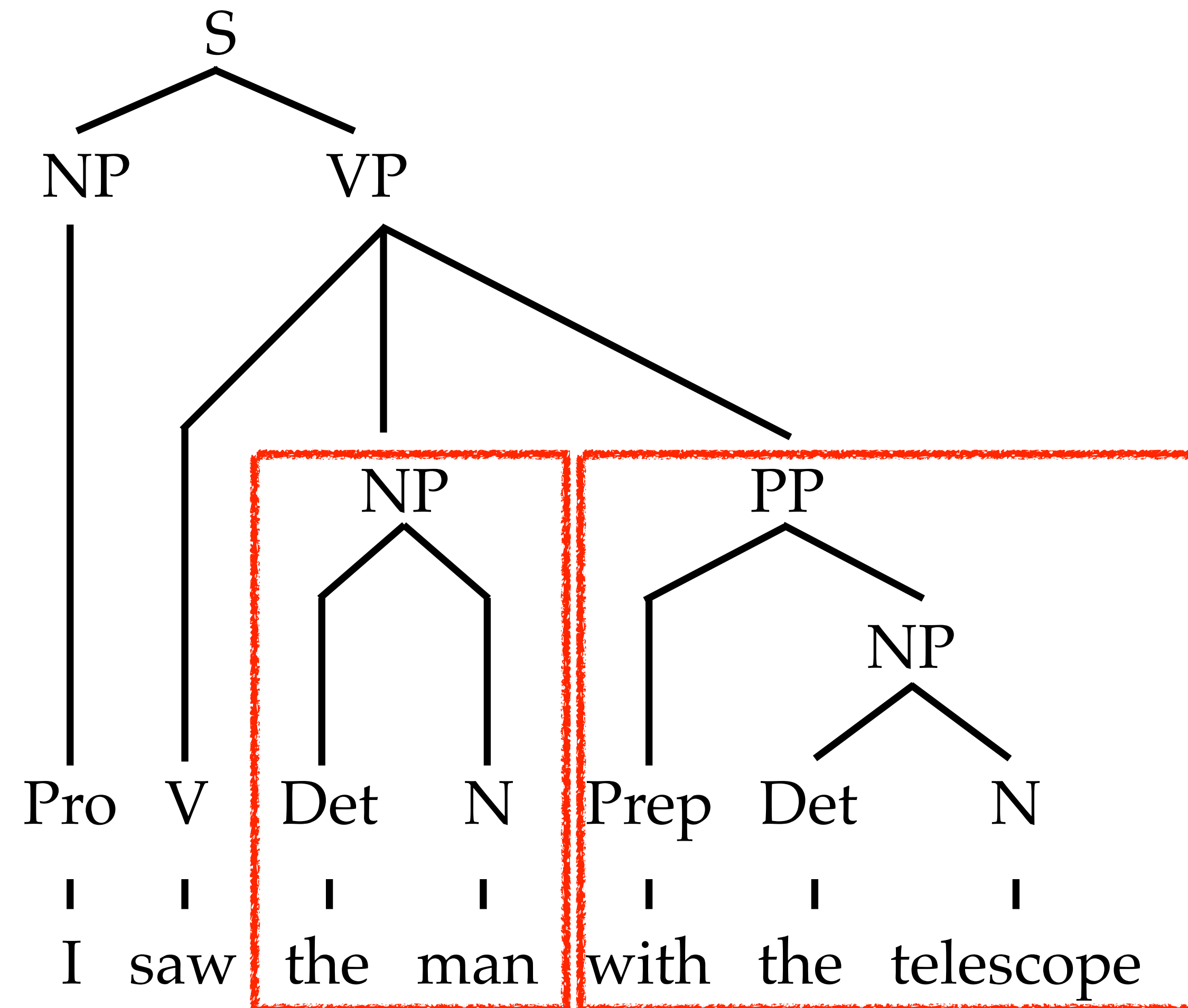
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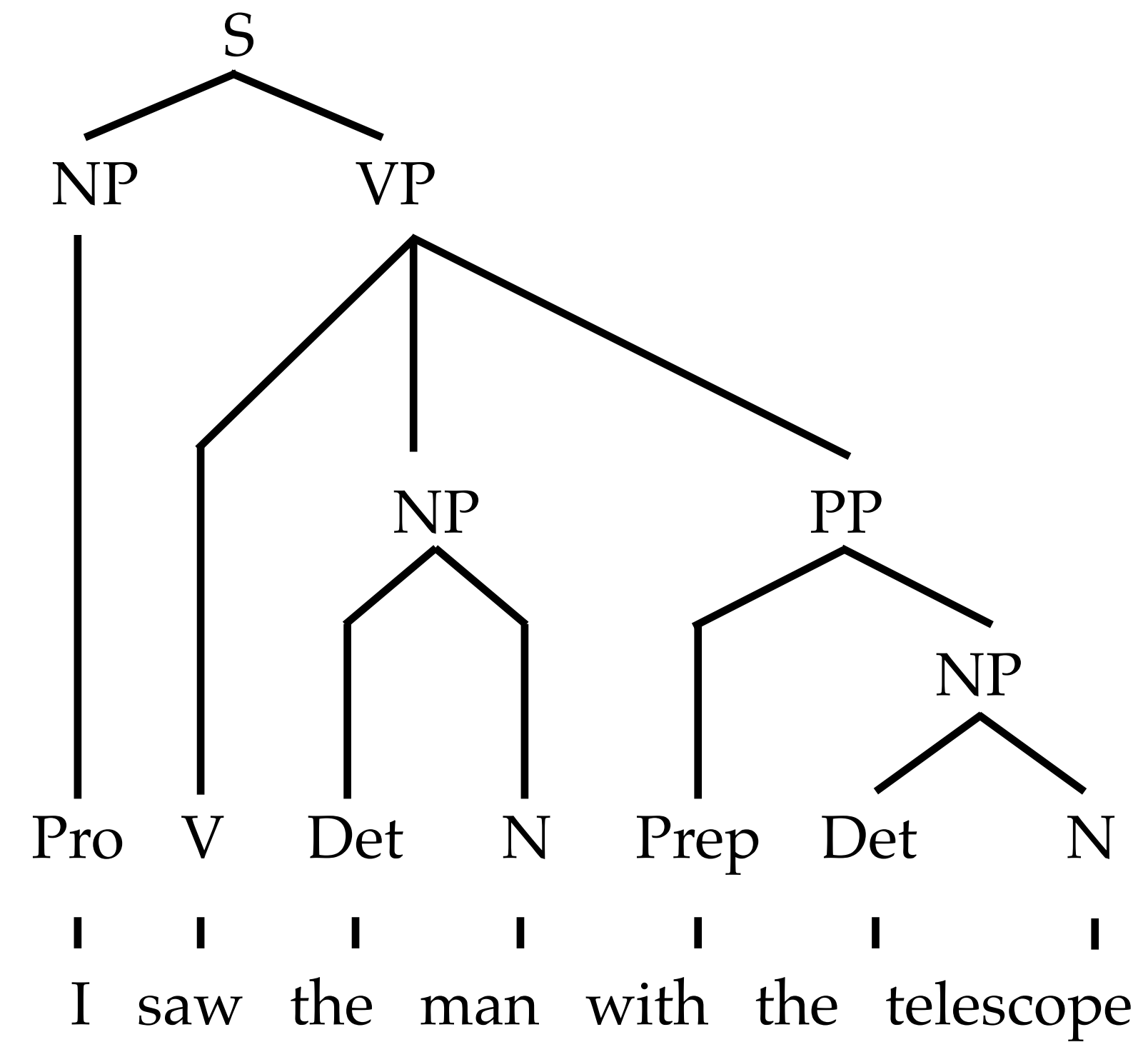
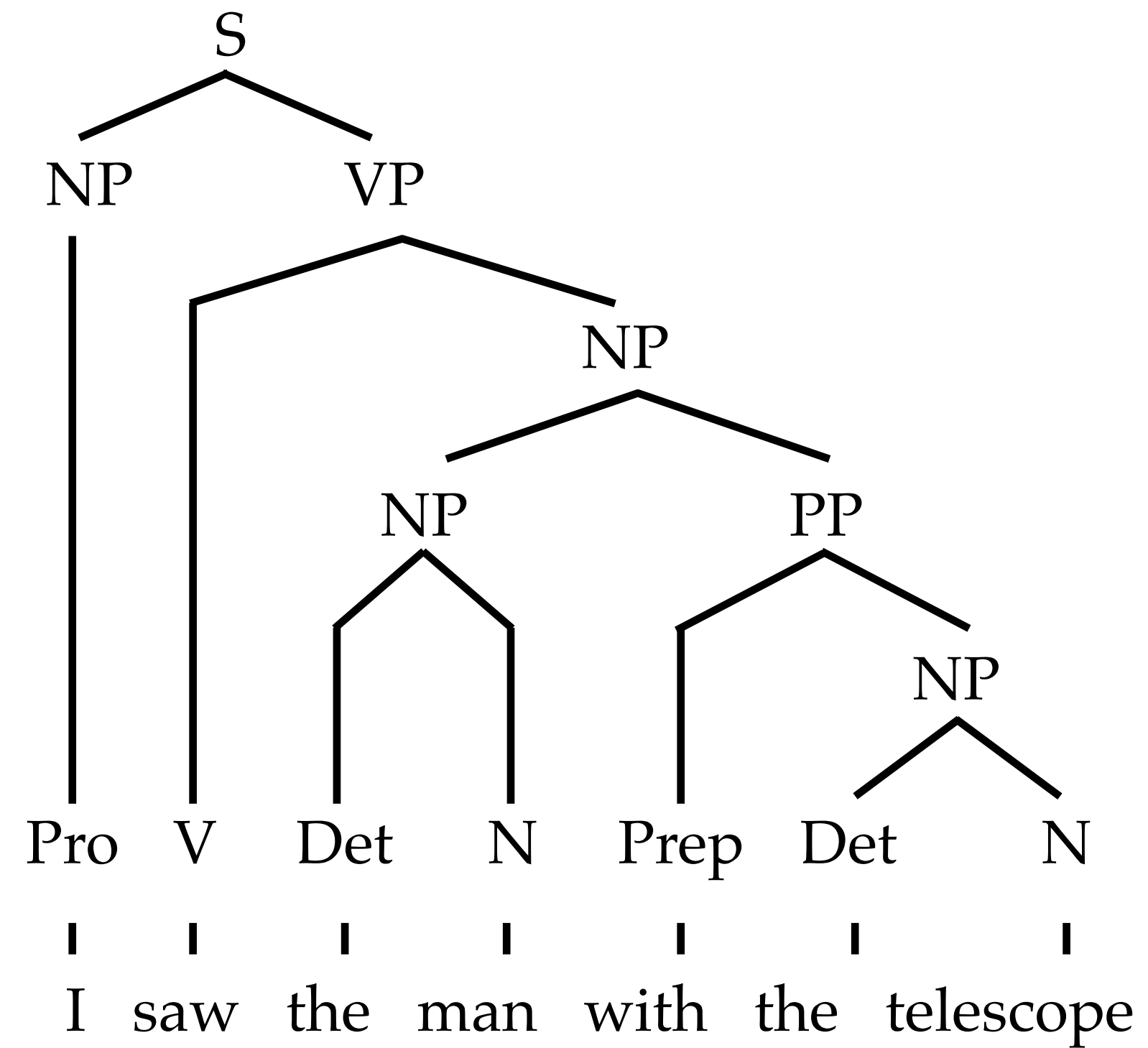
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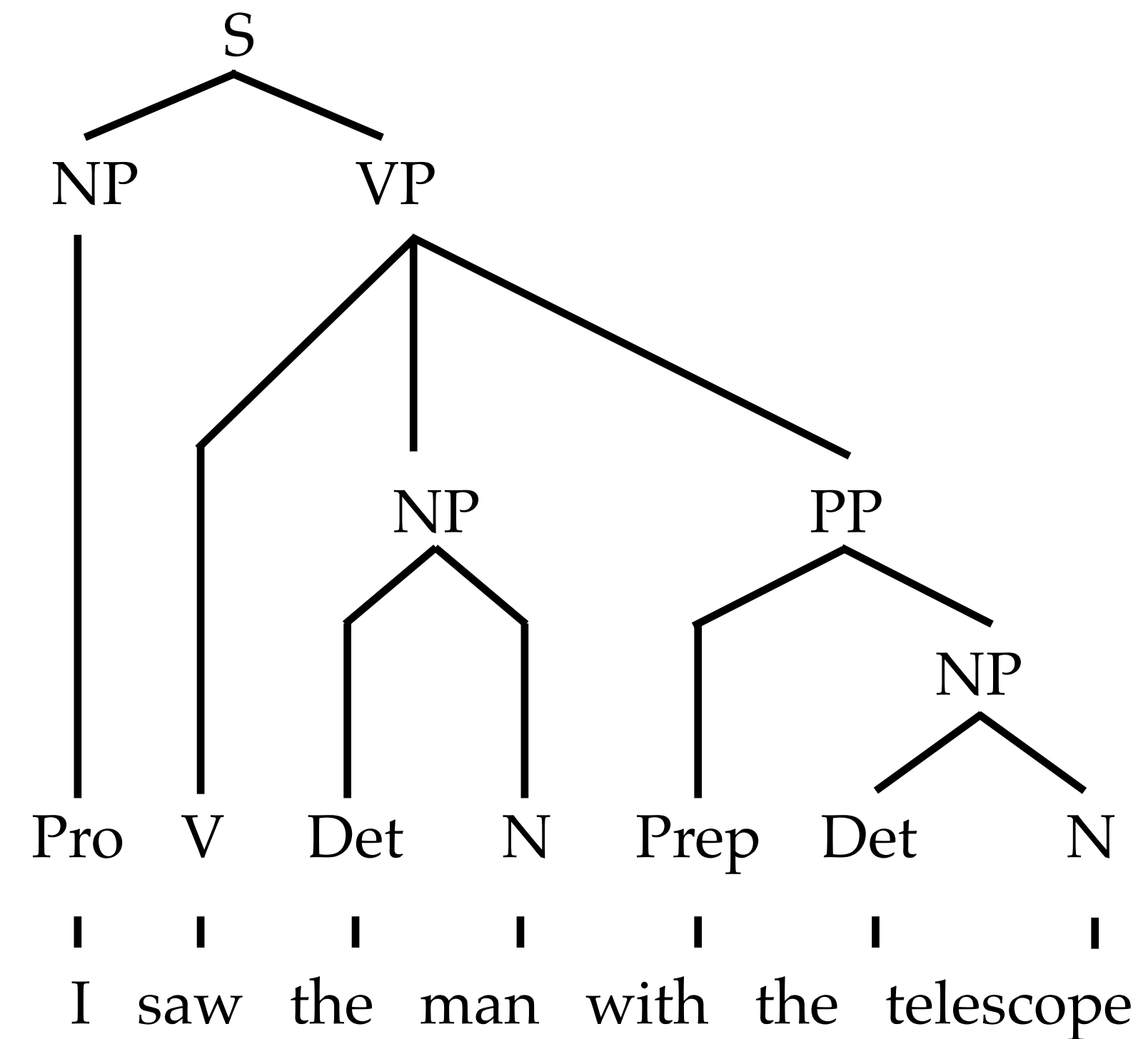
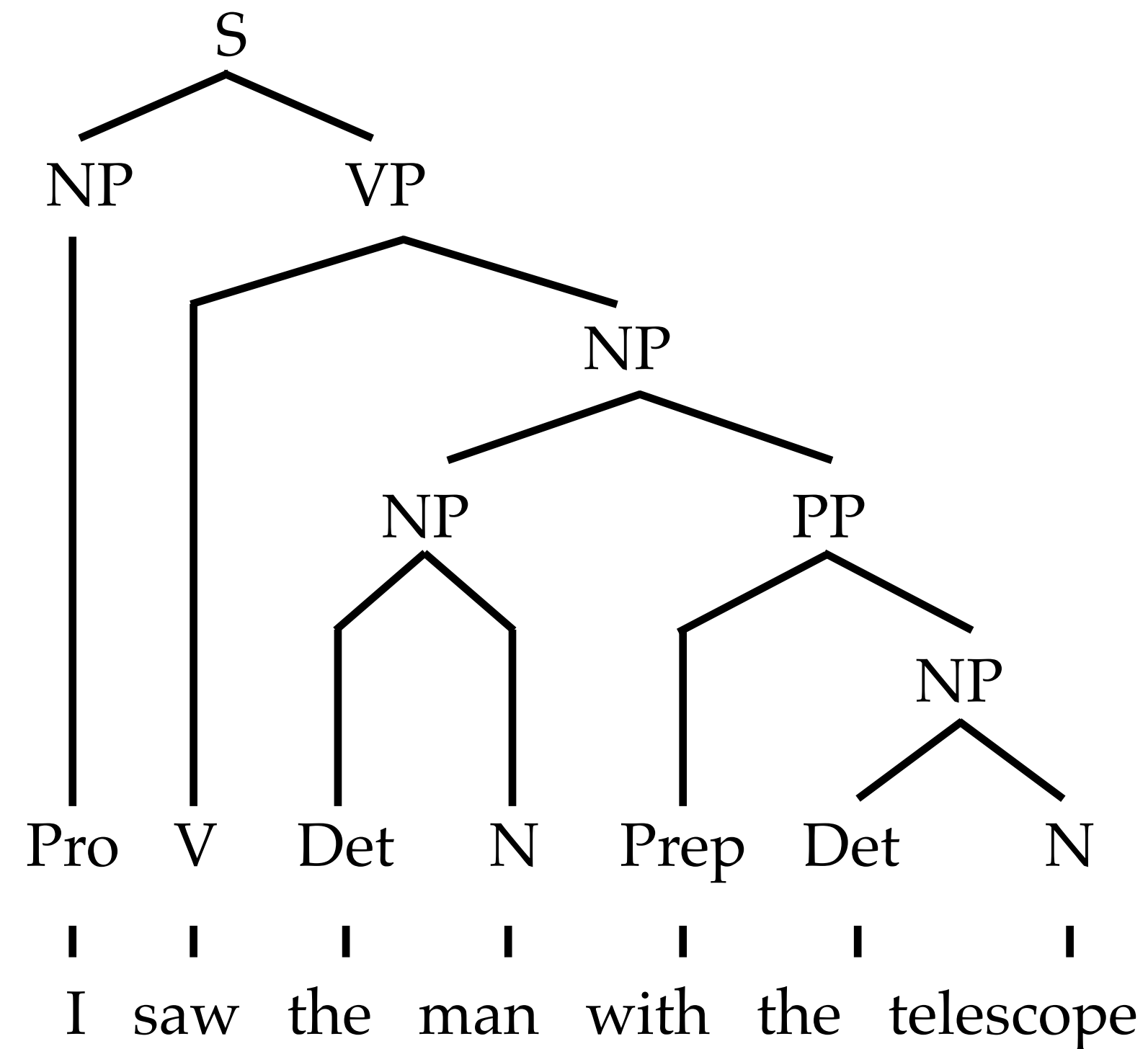


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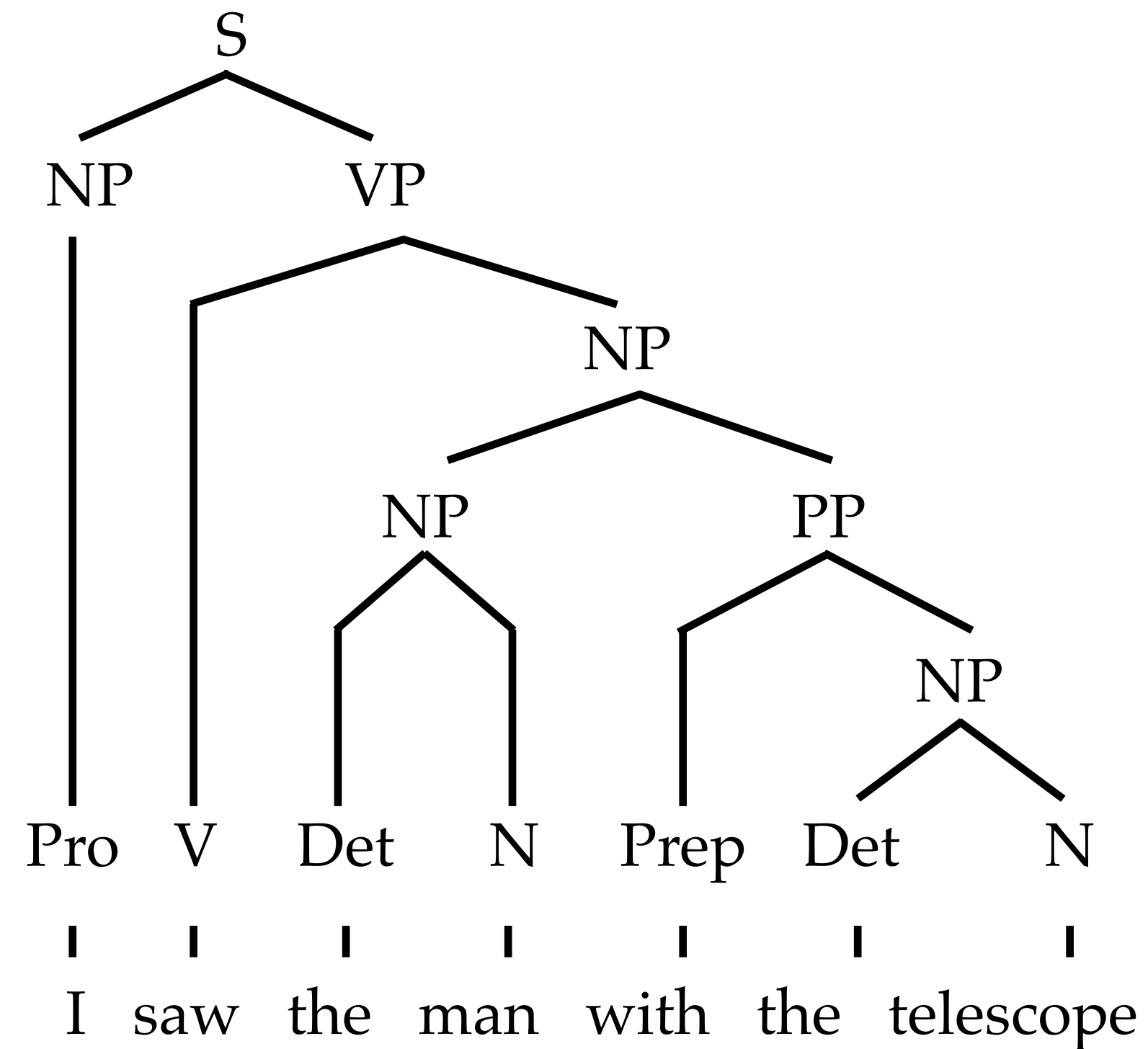
Structural Ambiguity

Lower attachment:
Modifier interpretation
(modifies “the man”)

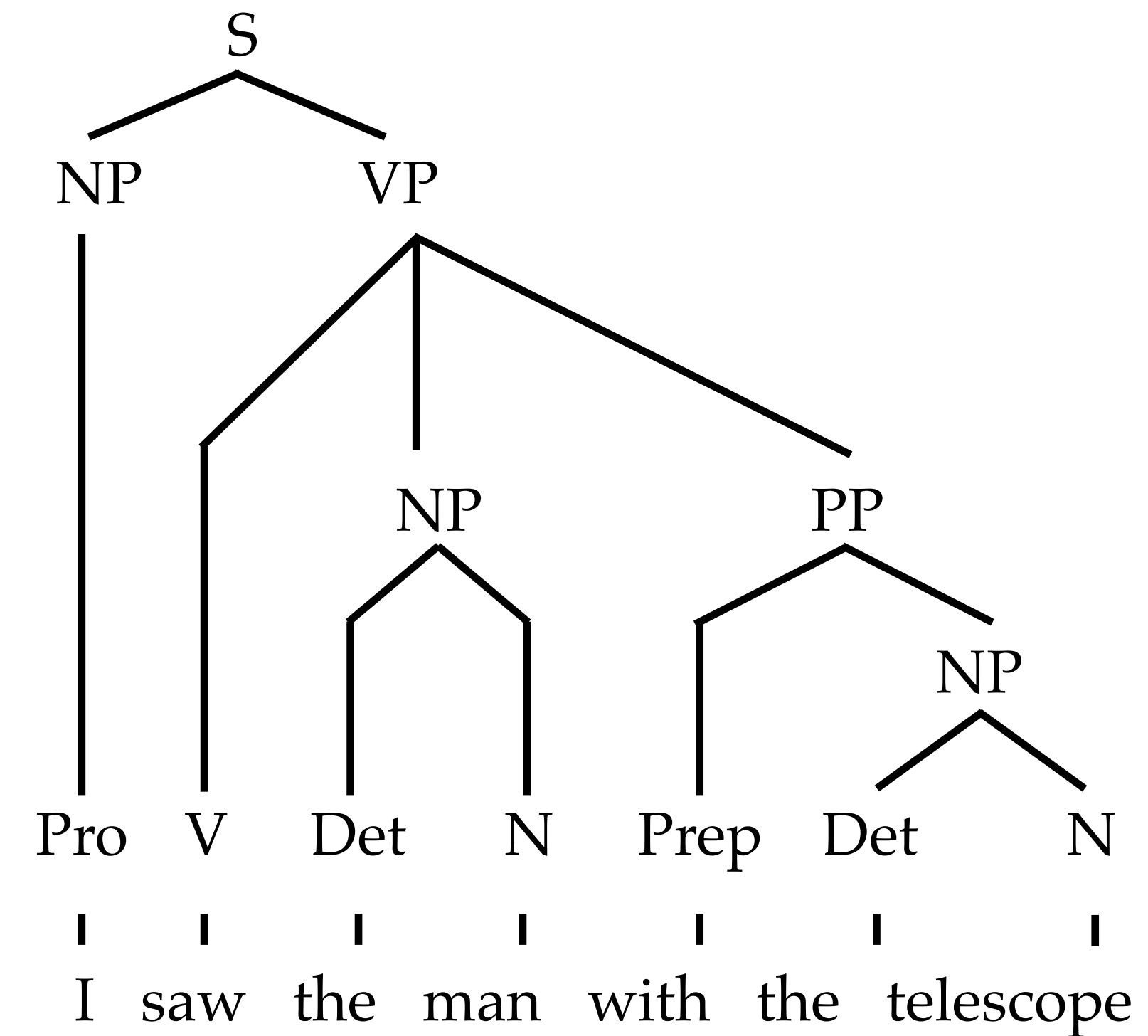


Structural Ambiguity

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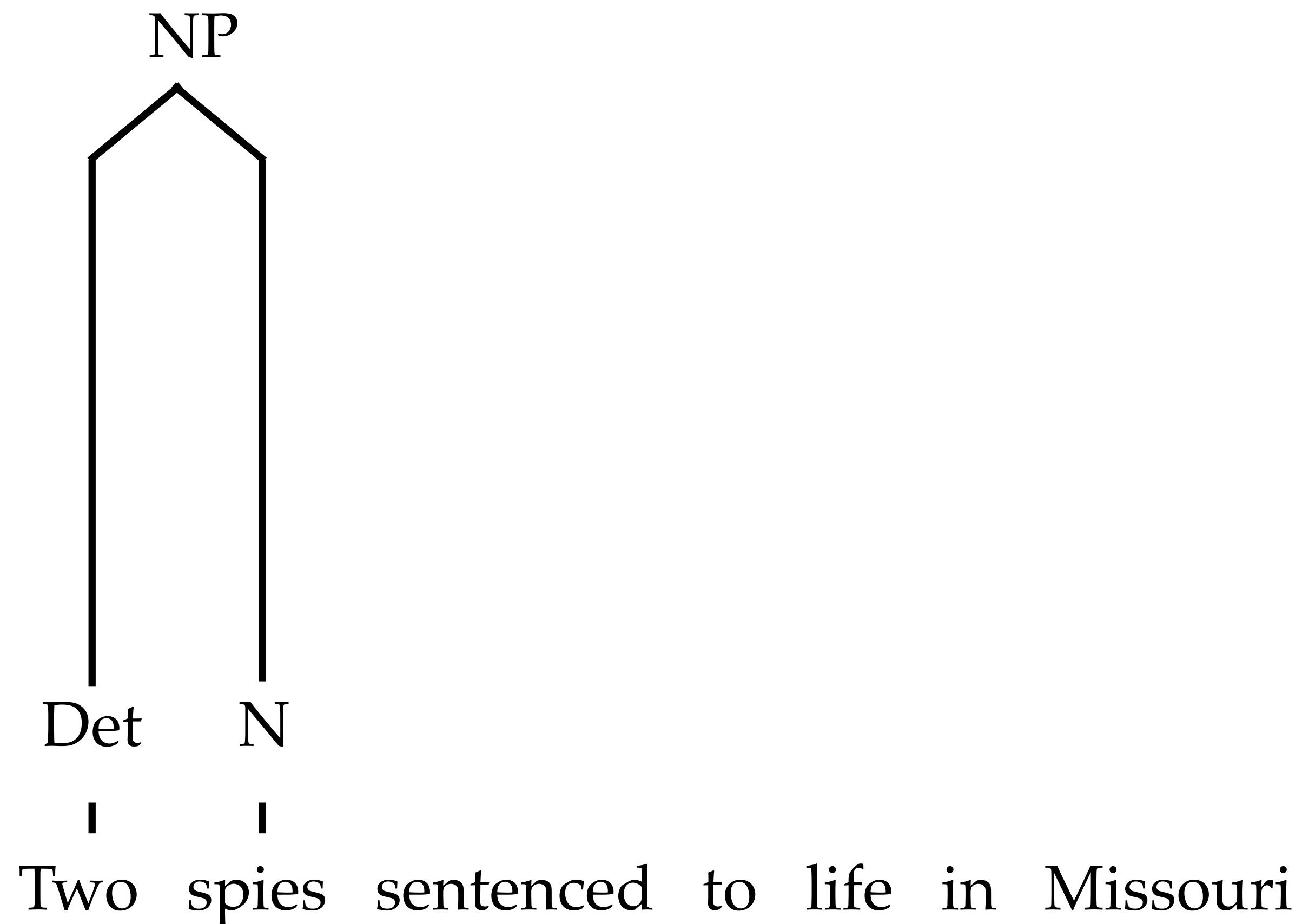
Higher attachment:
Instrument interpretation
(instrument used for seeing)



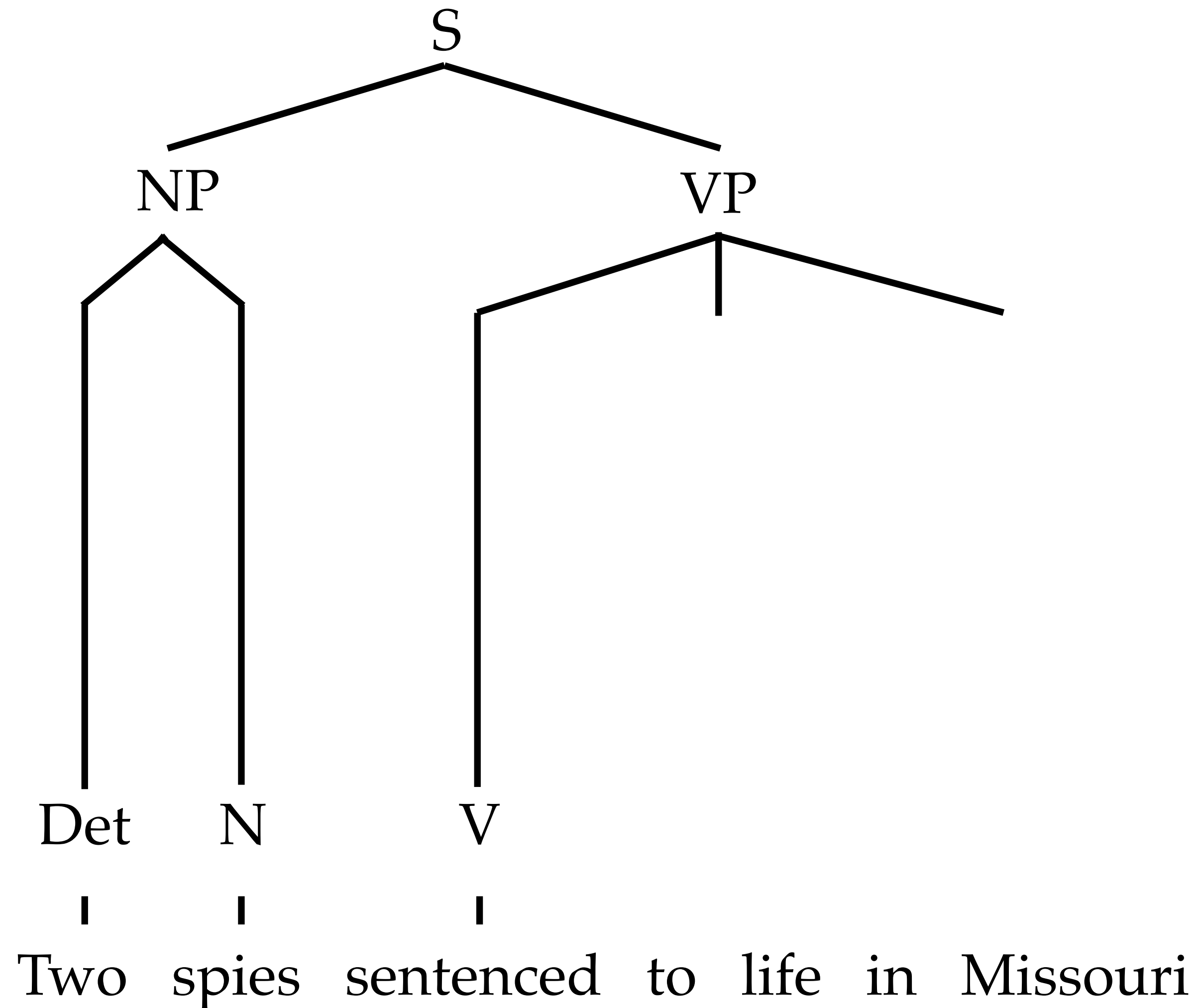
Structural Ambiguity

Two spies sentenced to life in Missouri

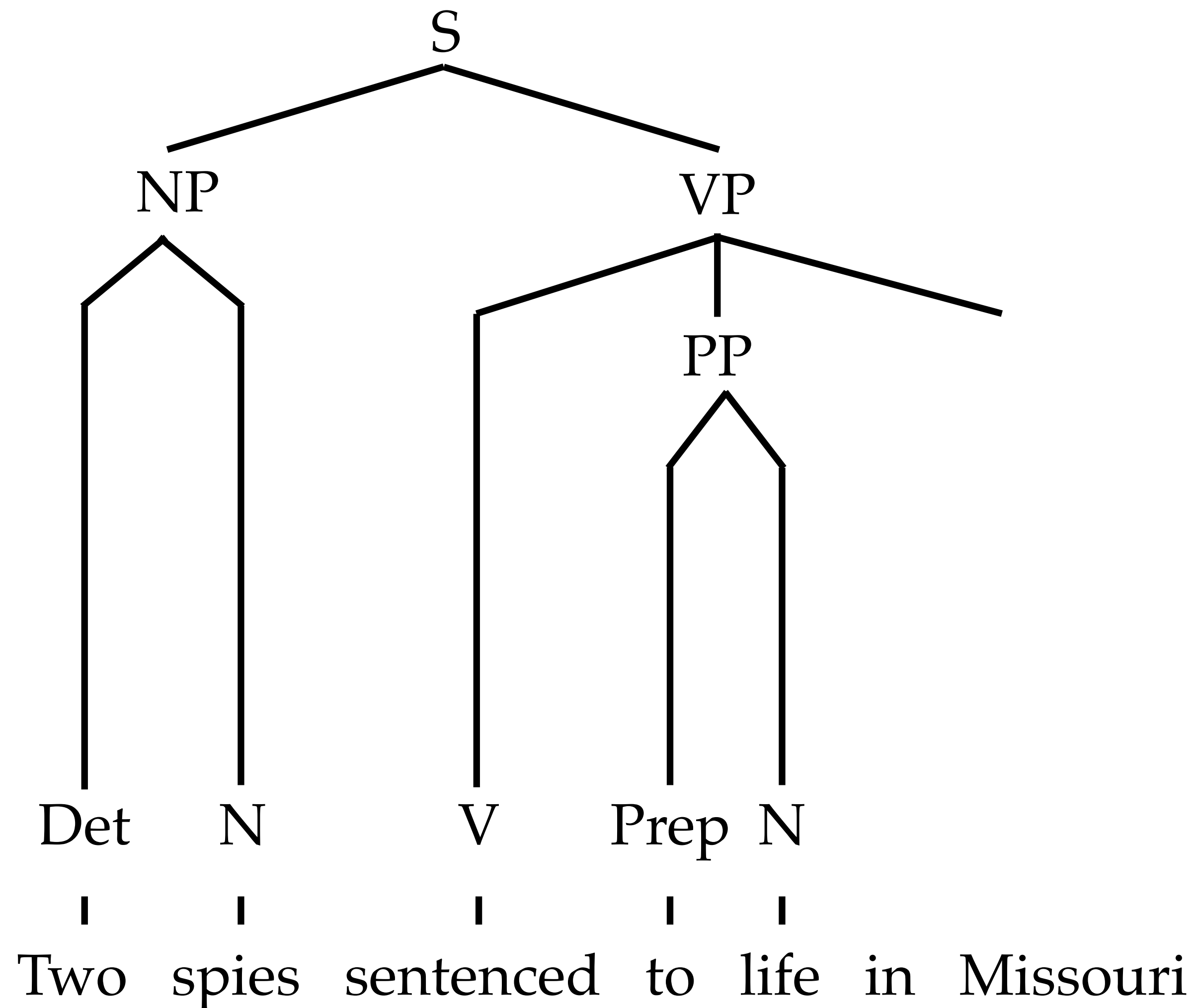
Structural Ambiguity



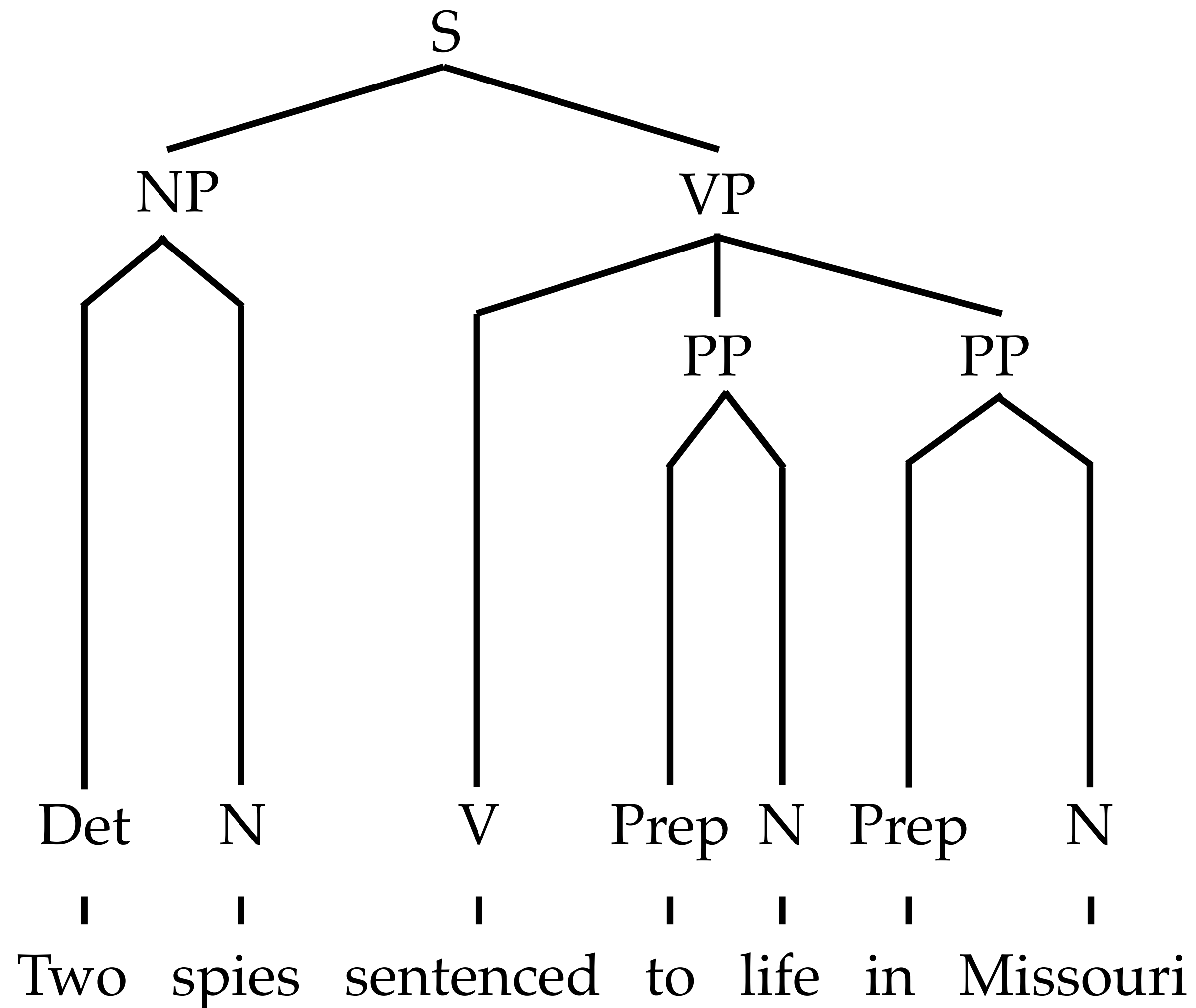
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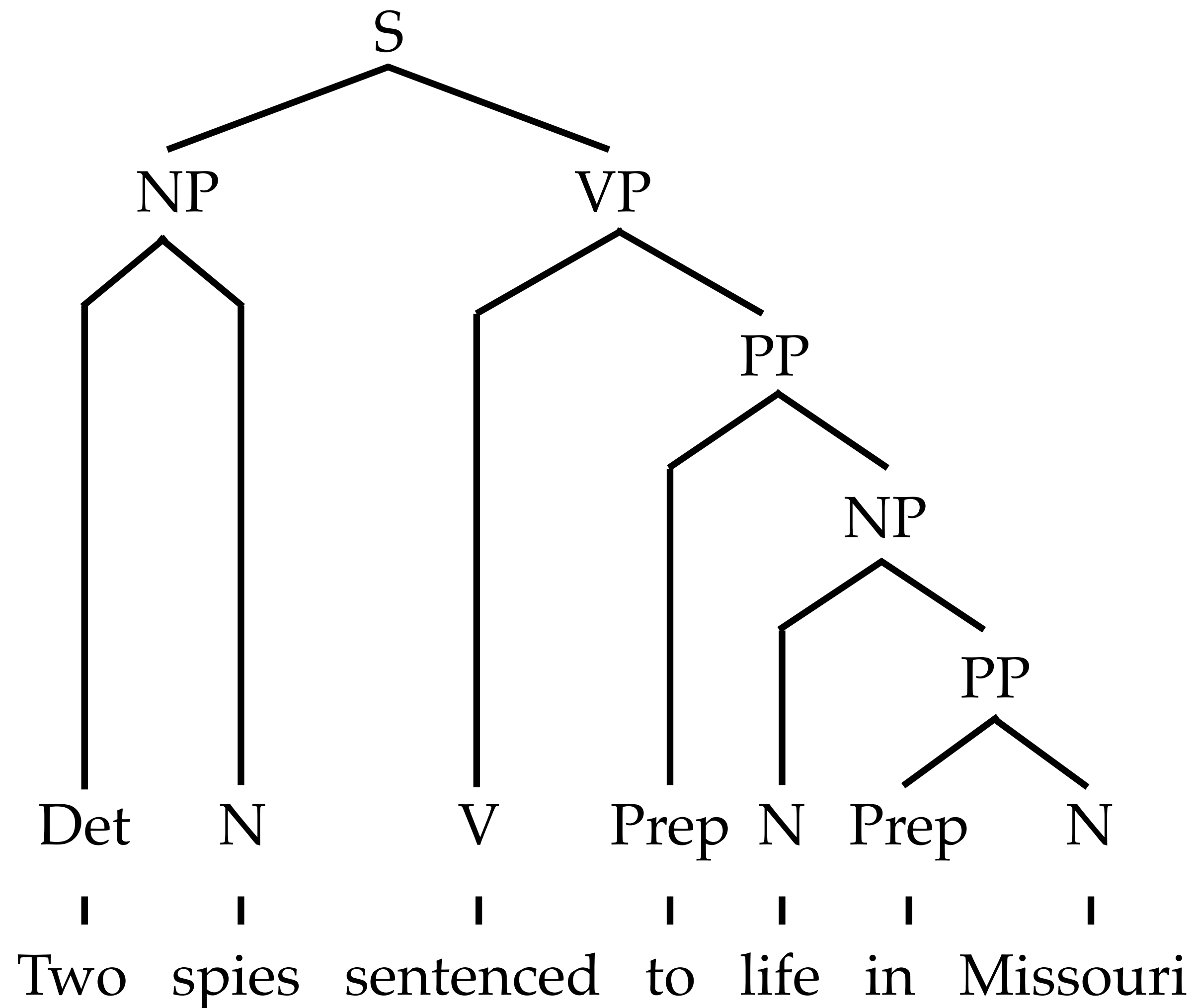
Structural Ambiguity



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Structural Ambiguity

The boy saw the man on the hill with the telescope

Structural Ambiguity

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Five interpretations

Phrase-Structure Rules

- These rules are called **Context-Free**: can apply regardless of what's around

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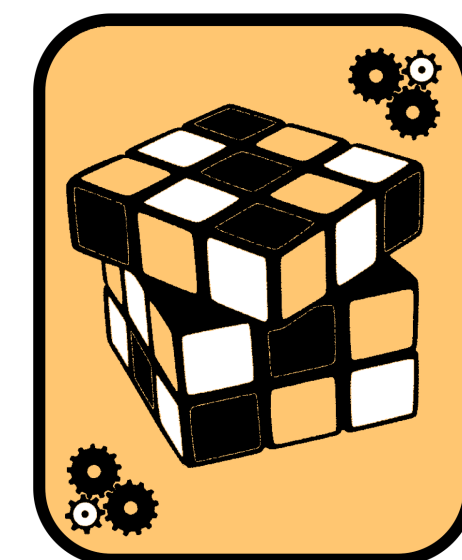
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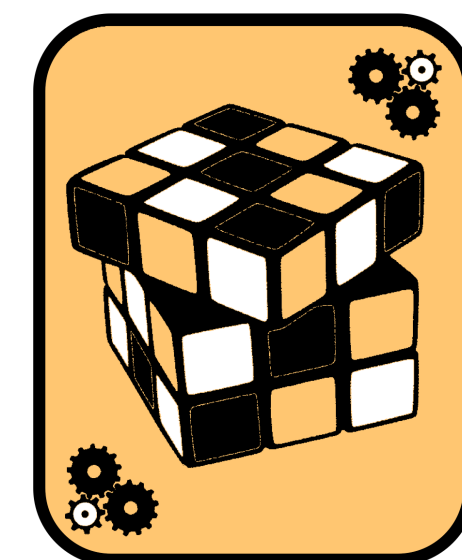
Phrase-Structure Rules

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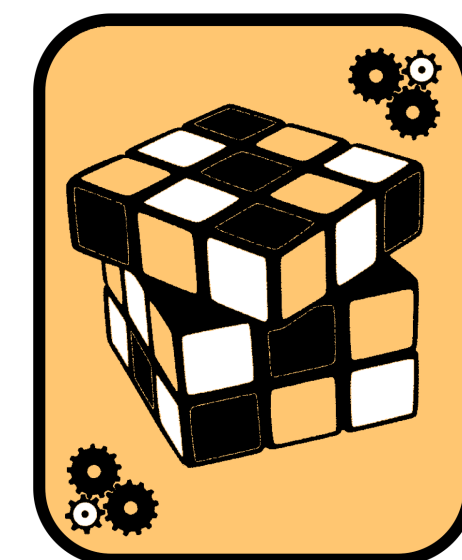
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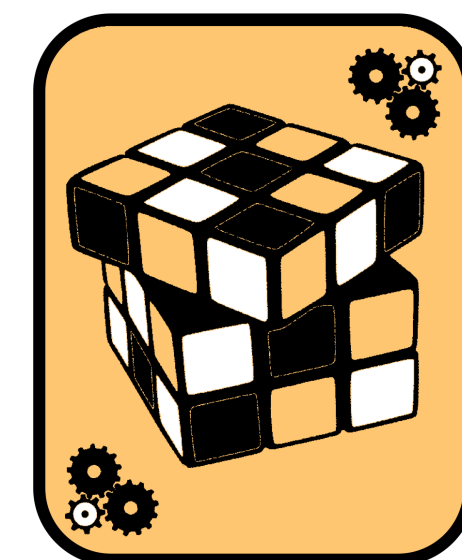
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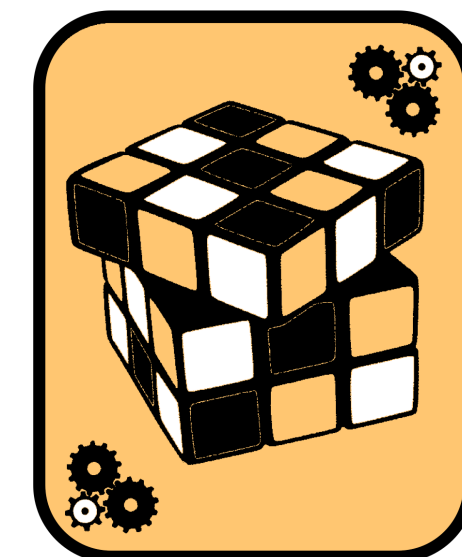
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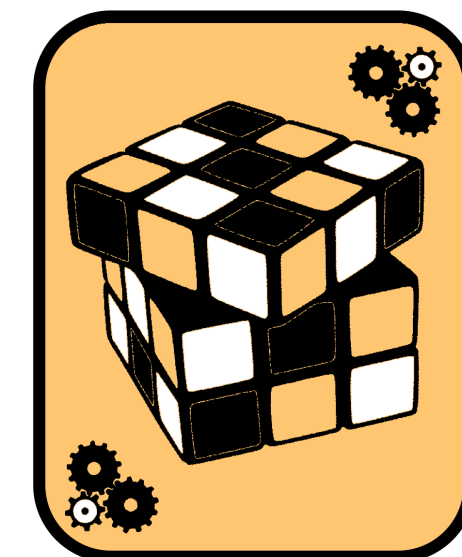
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Rather, we are claiming that the mind represents the groups that words form, treats these groups as belonging to different categories, and recognizes their hierarchical structure
 - ◉ Phrase structure rules are a broad characterization of the mental state-space of language users

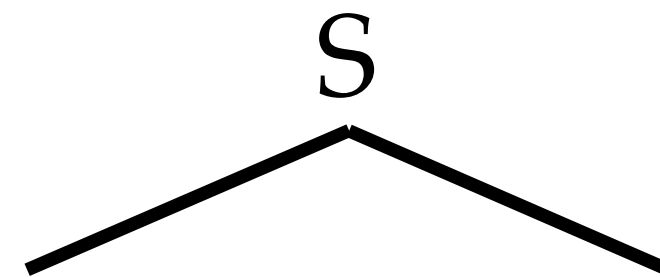


Why Posit Hierarchical Structure?

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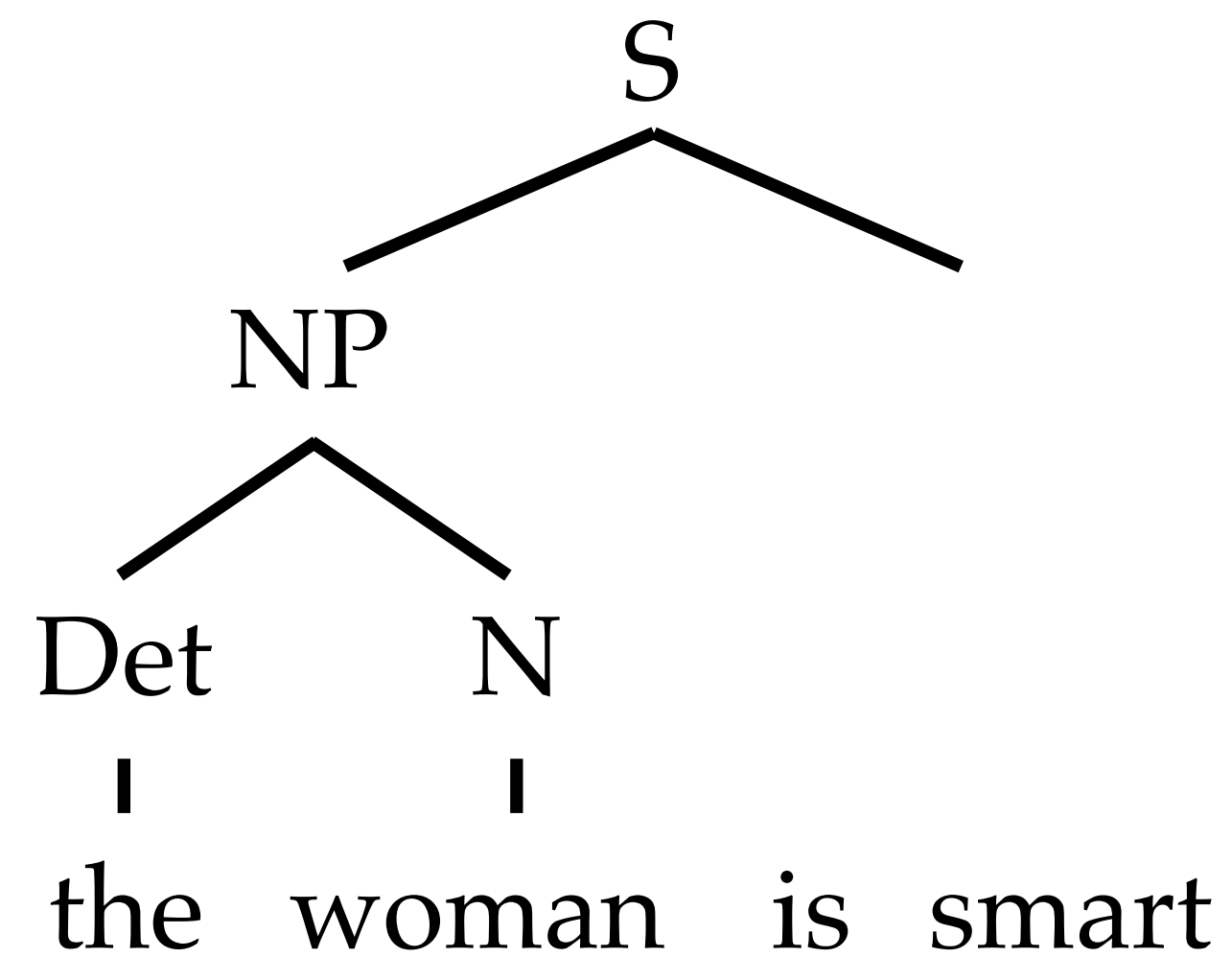
the woman is smart

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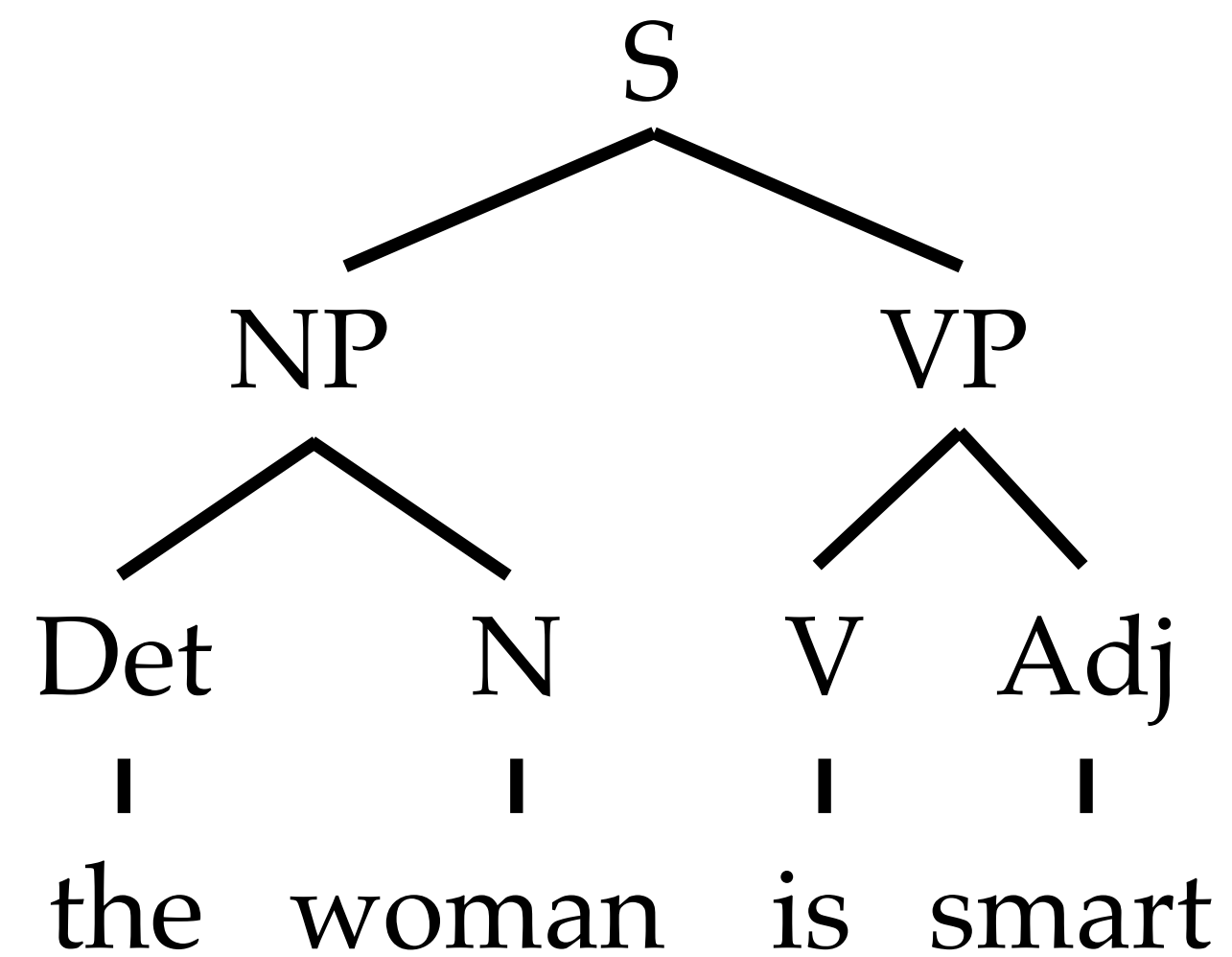


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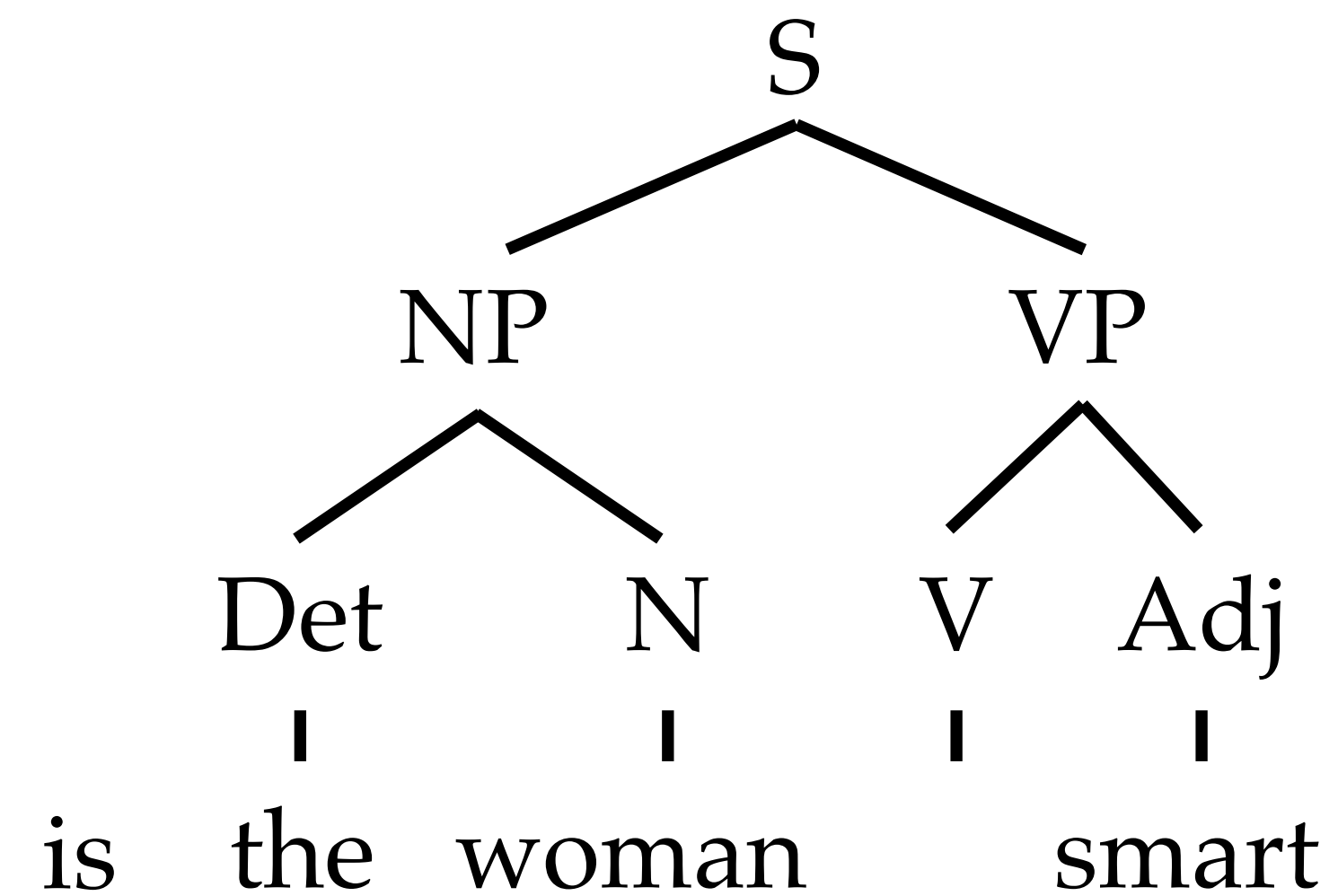
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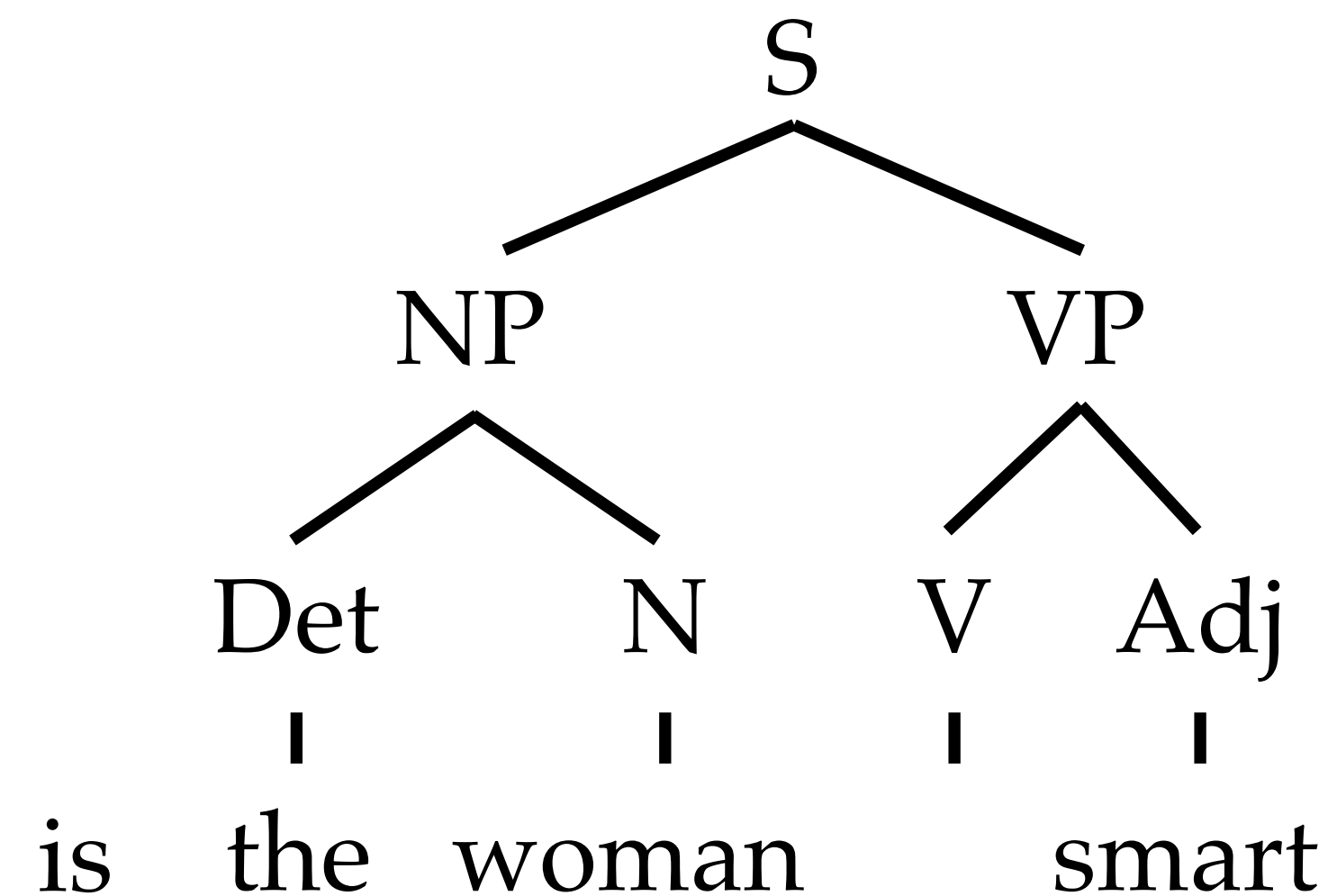
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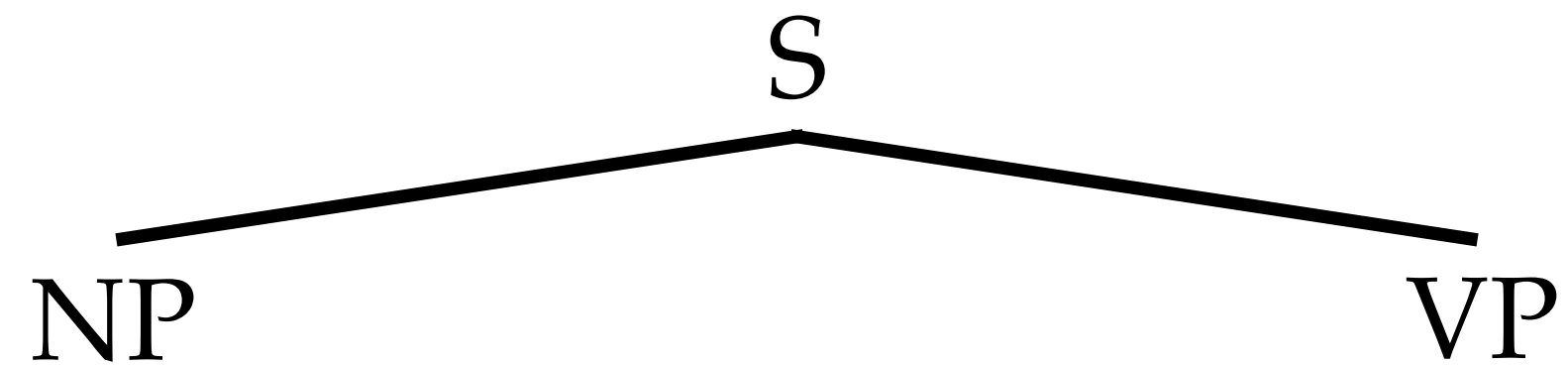
What is the regularity underlying question formation?

Why Posit Hierarchical Structure?

the woman who is your boss is smart

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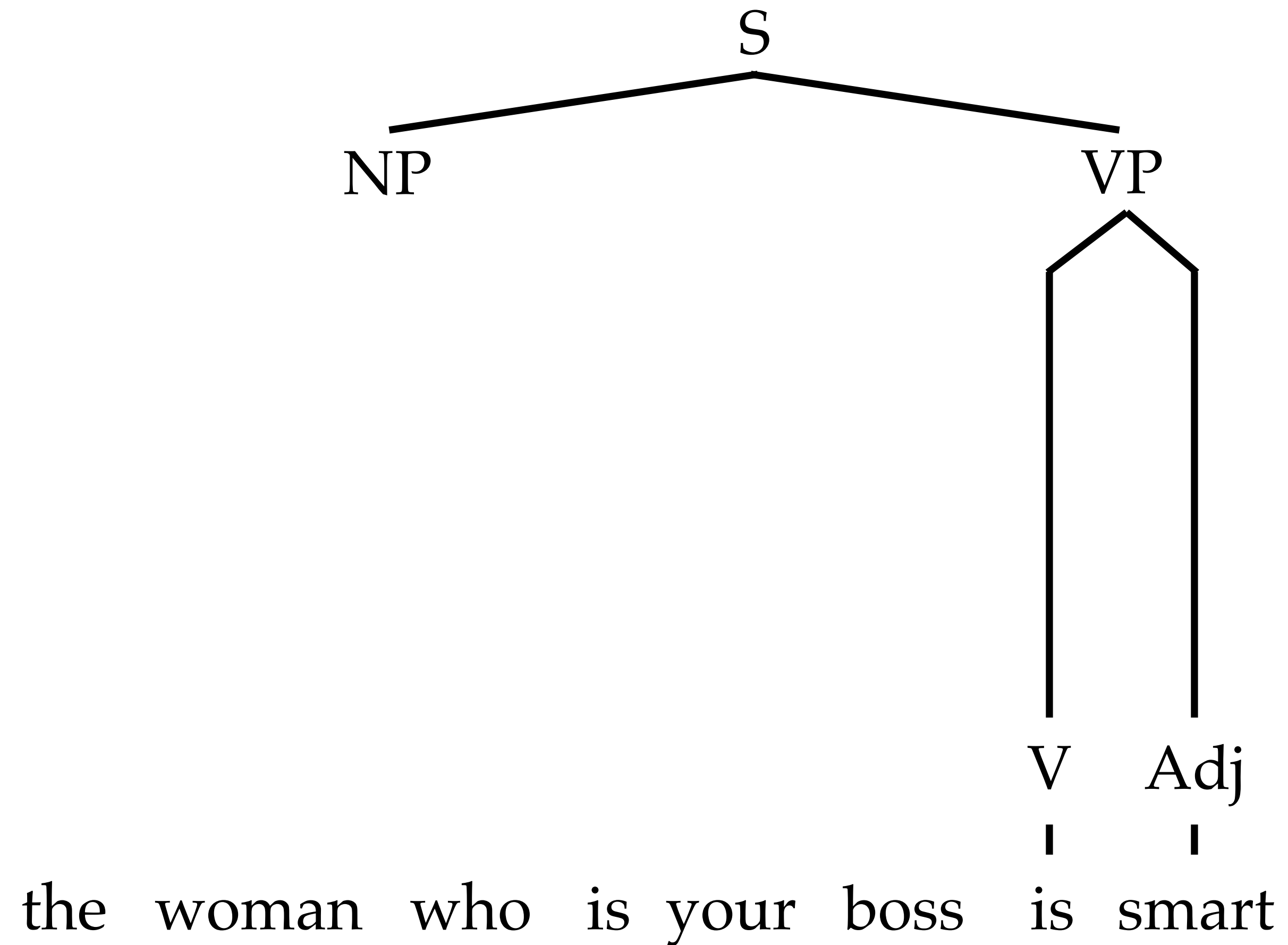
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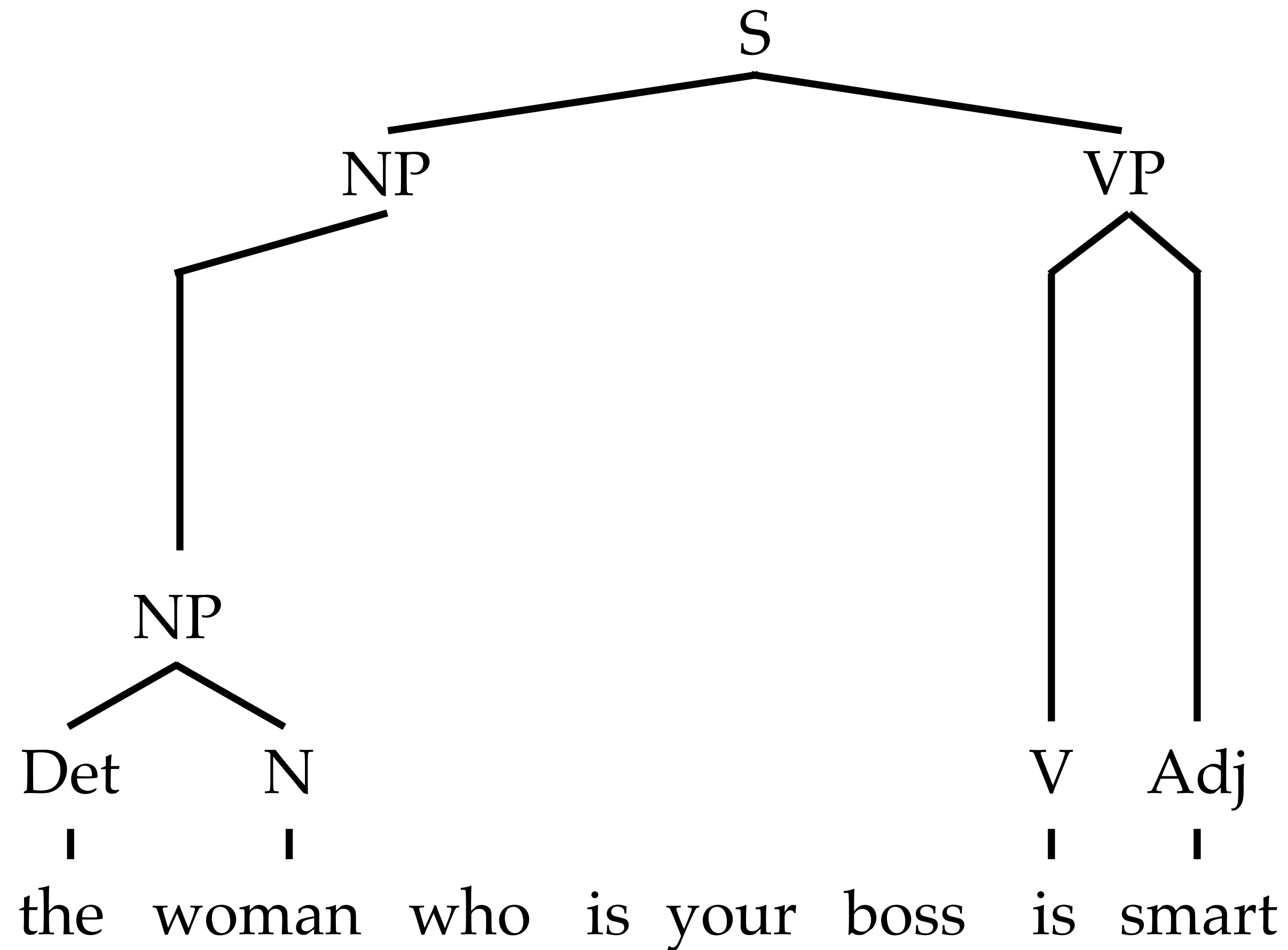
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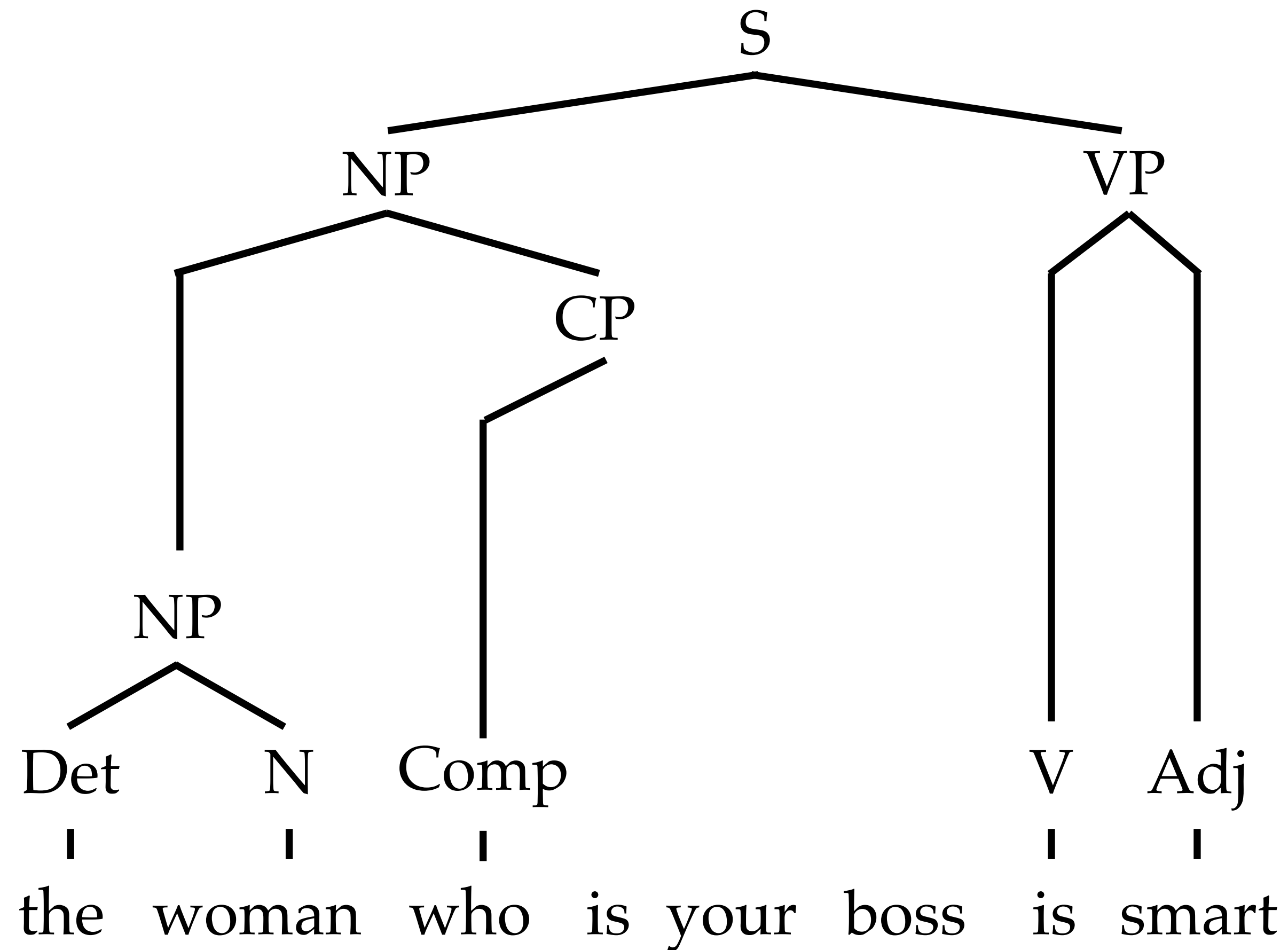
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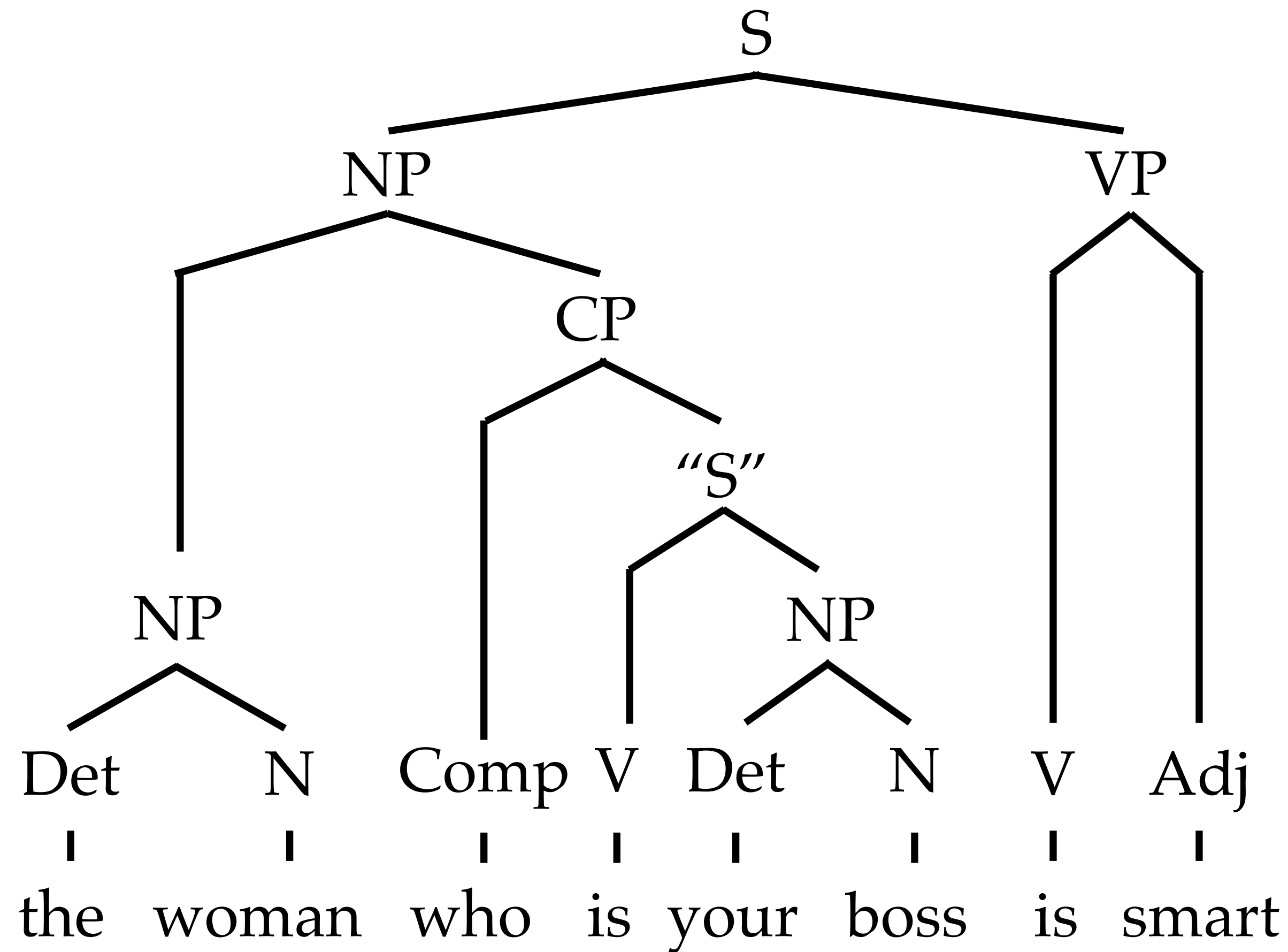
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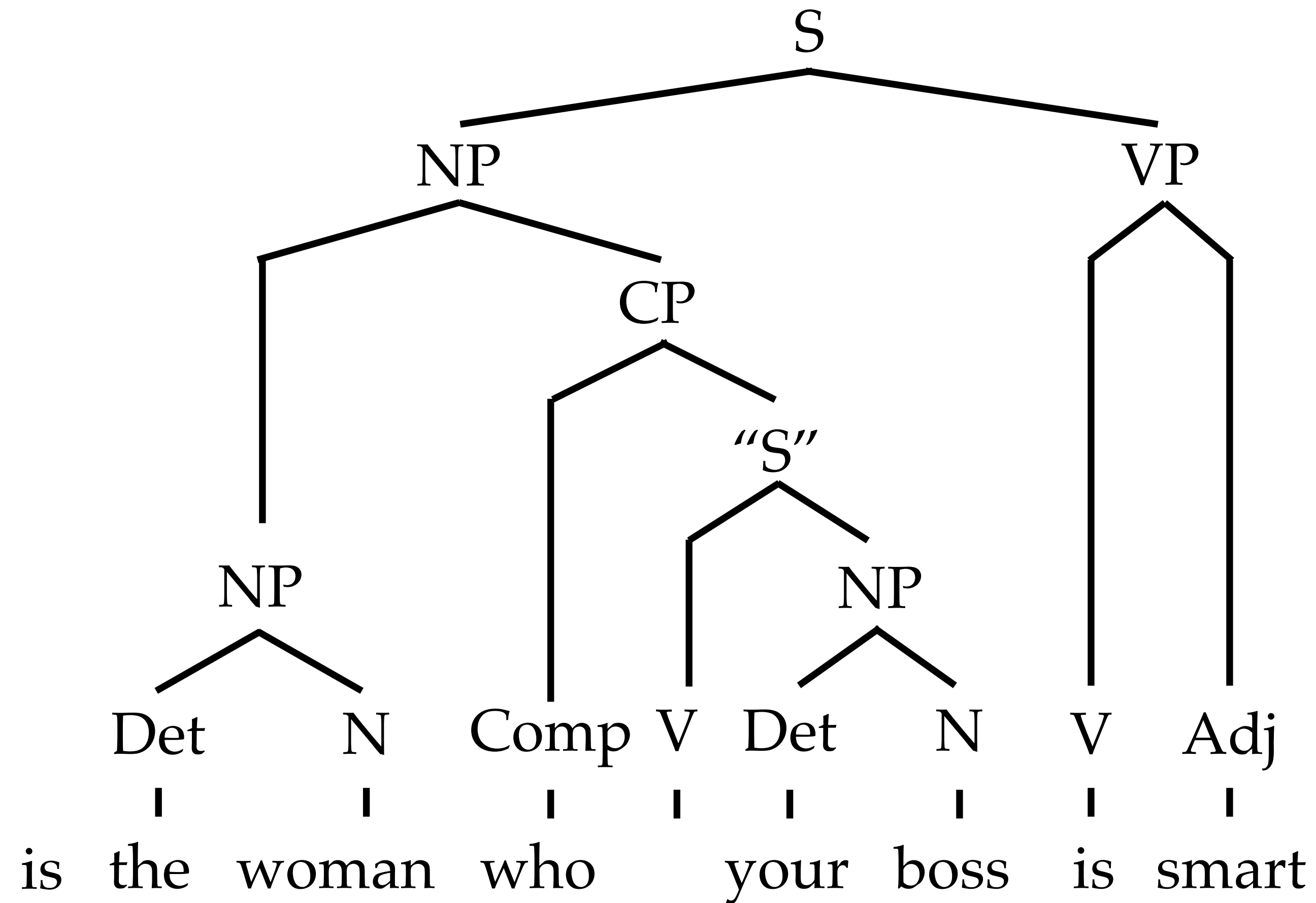
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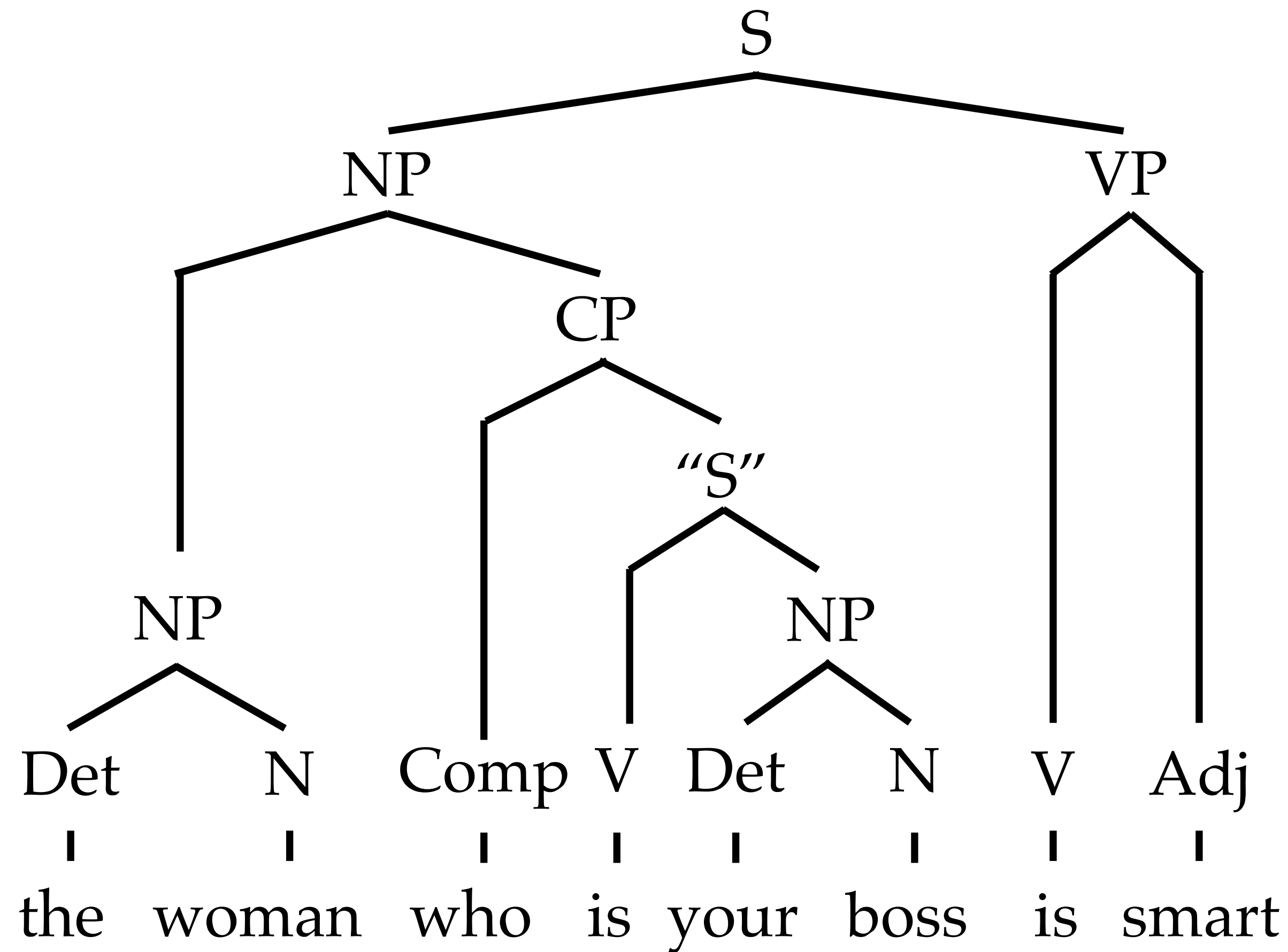
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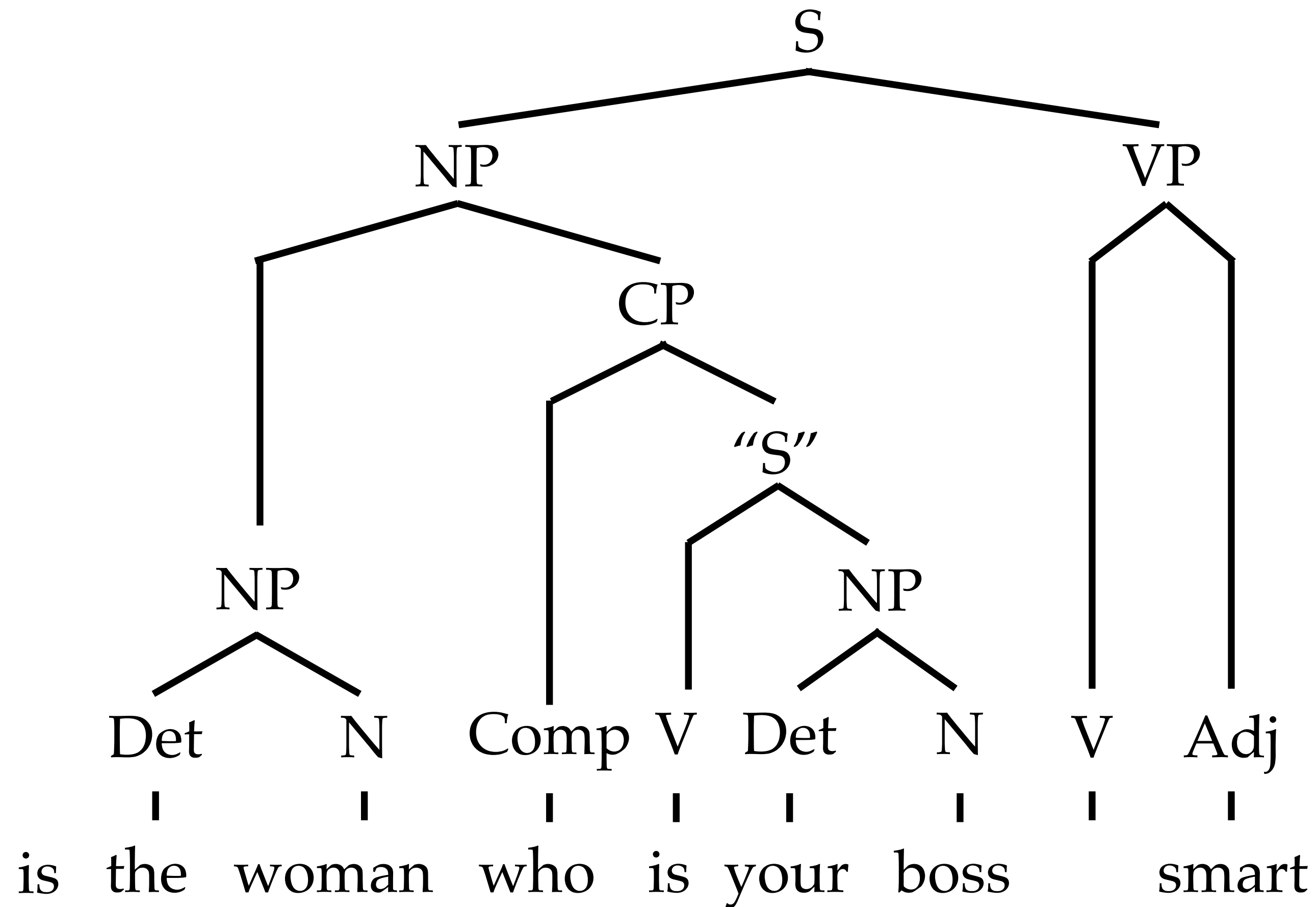
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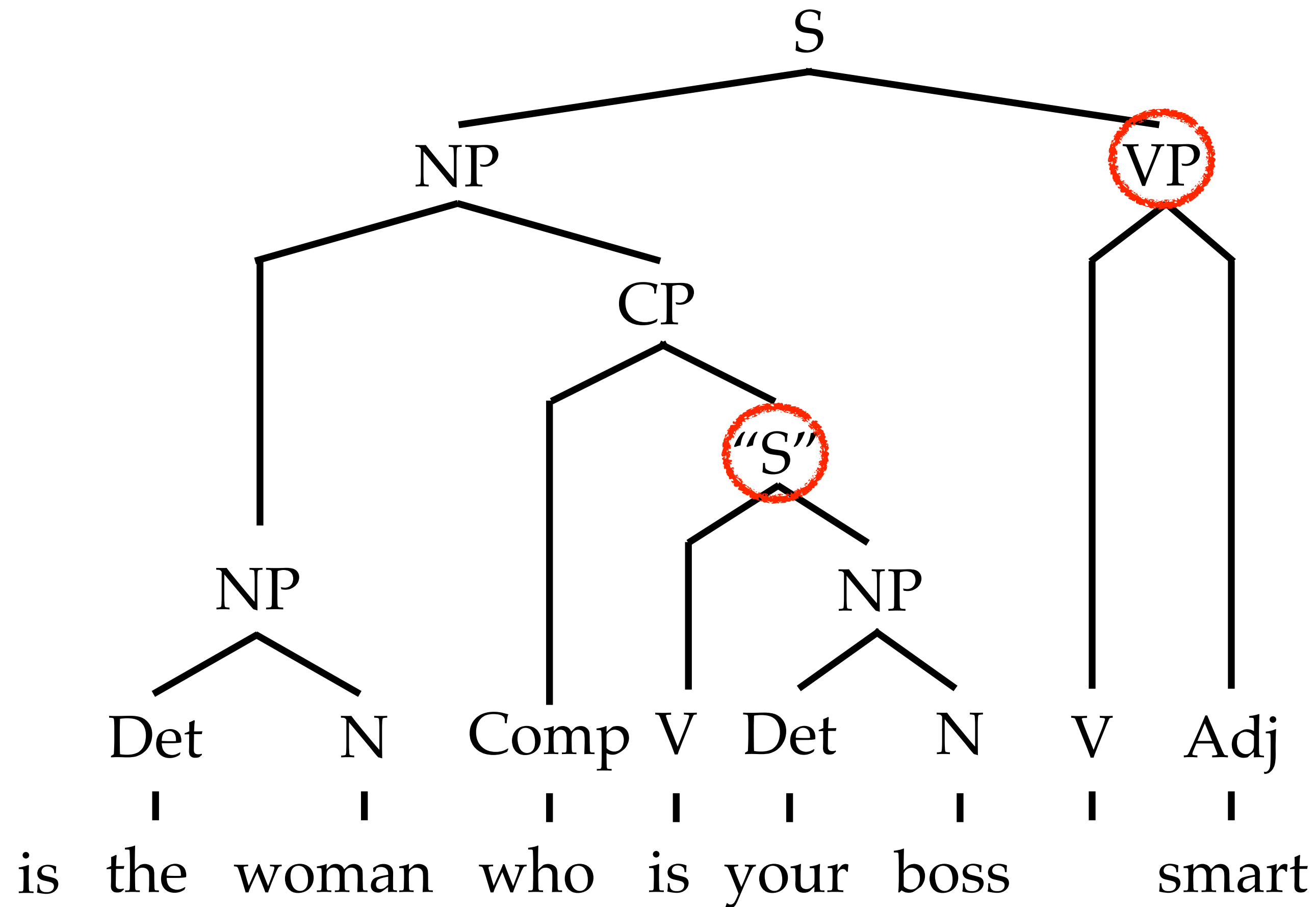
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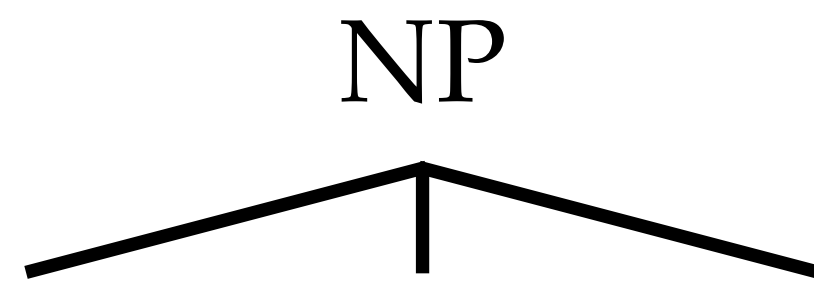


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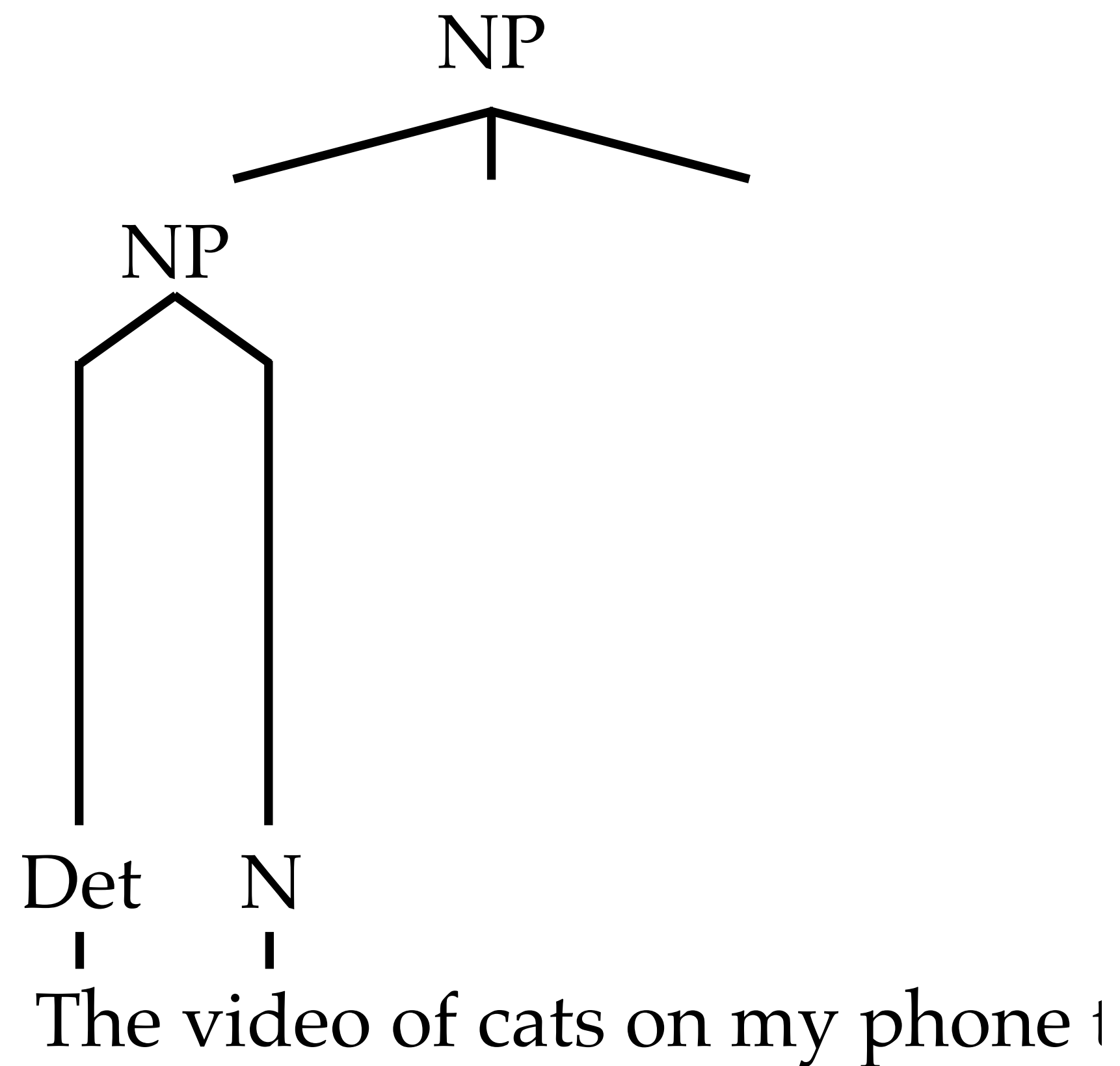
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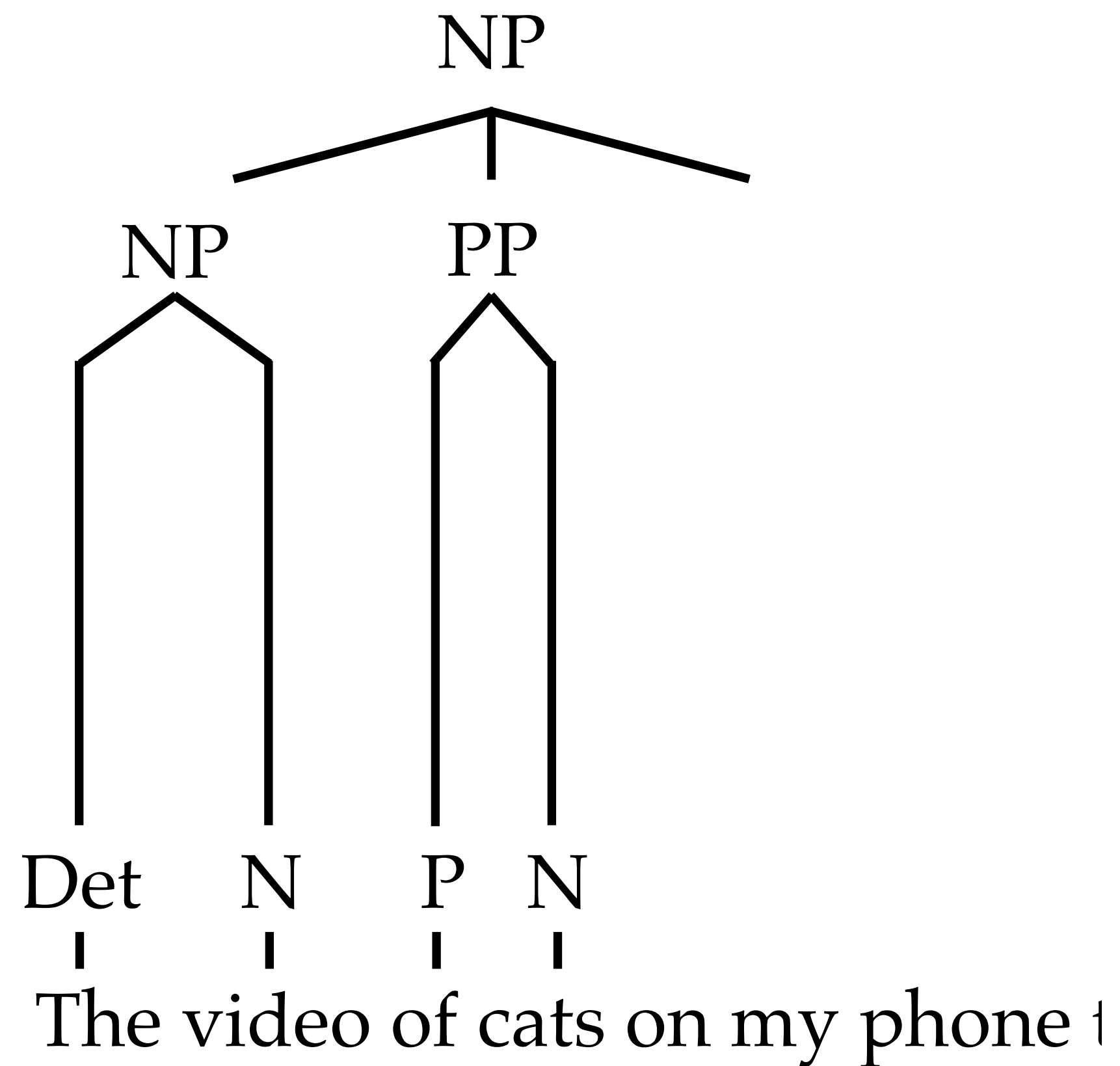


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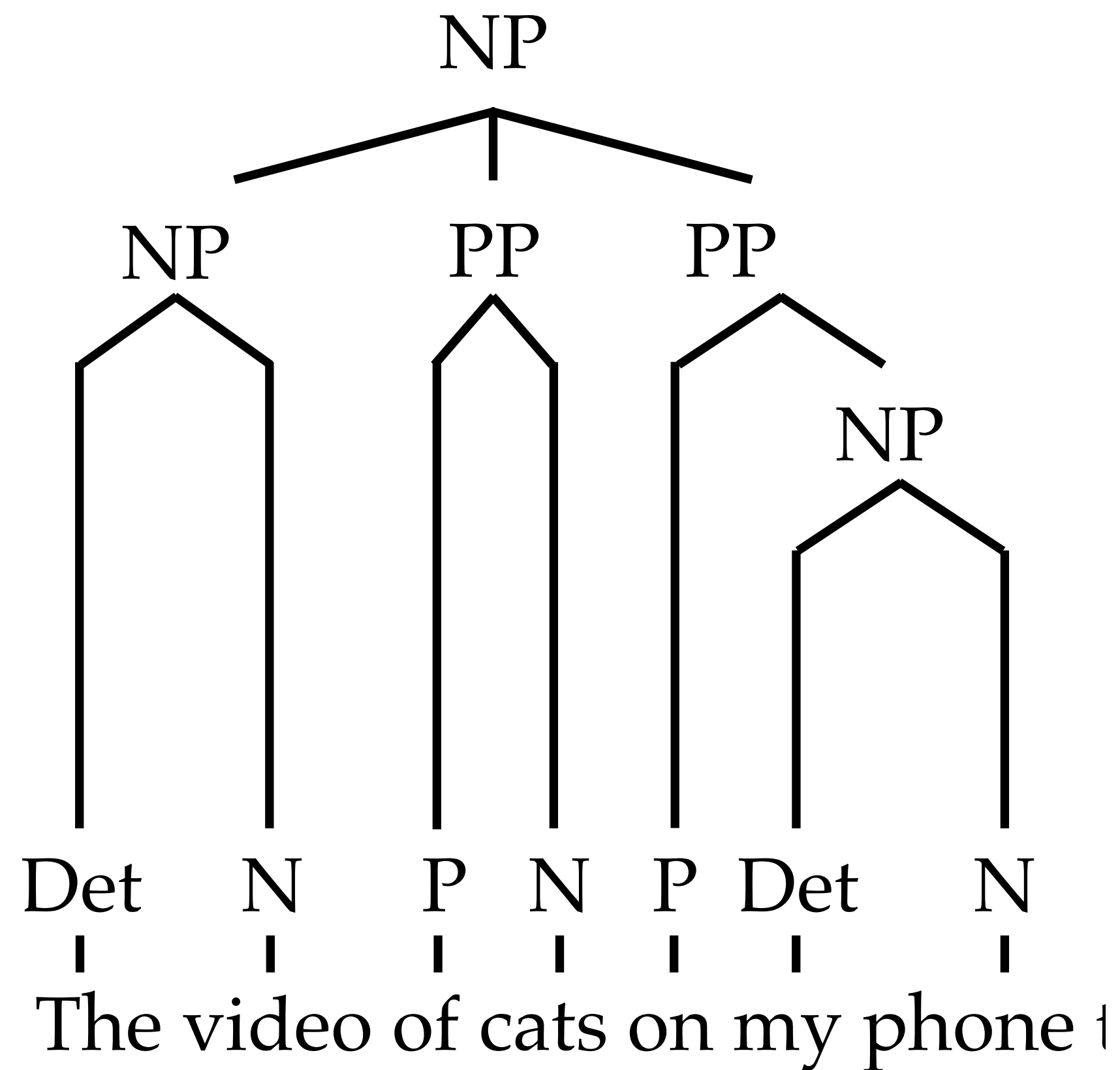
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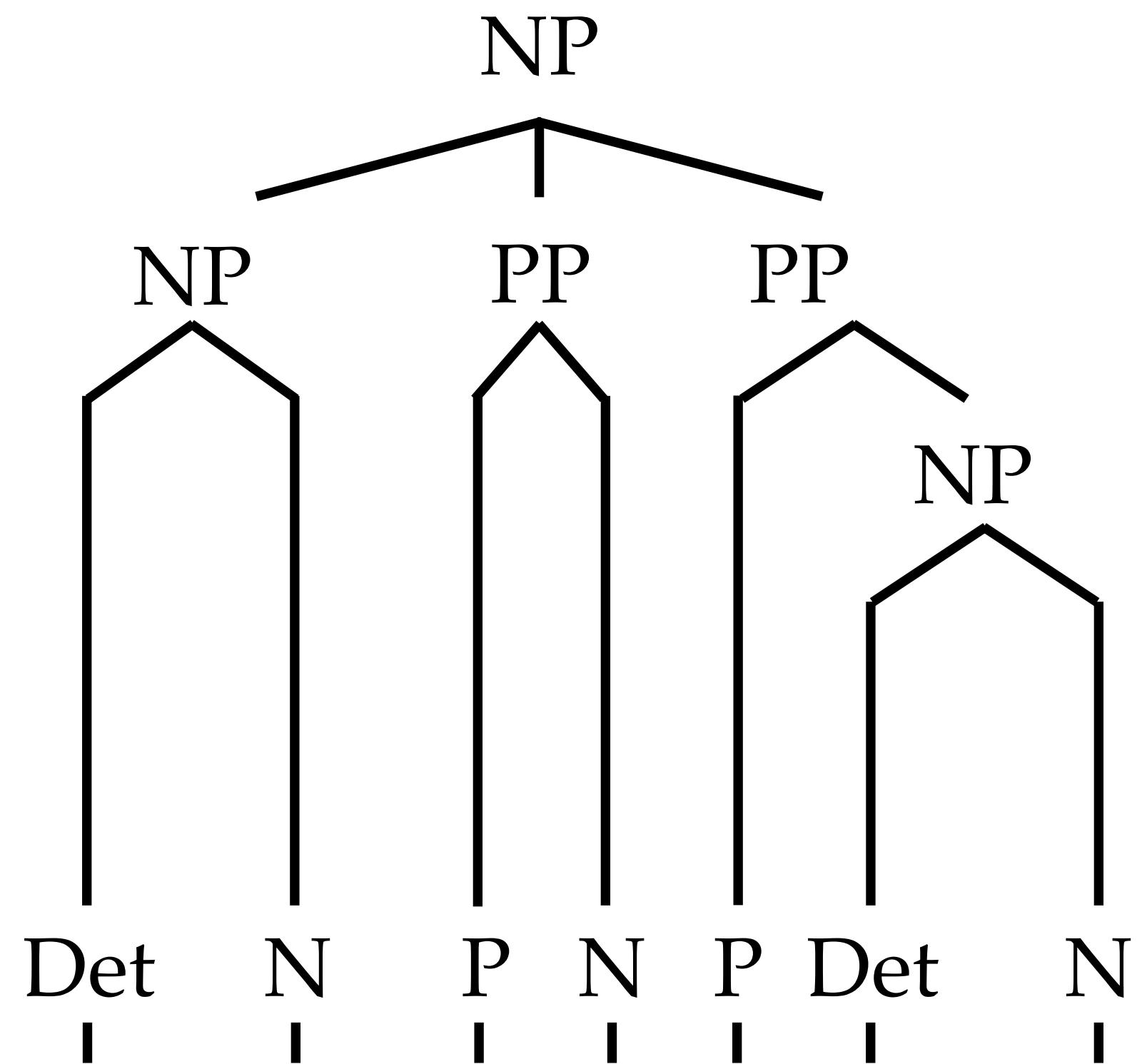
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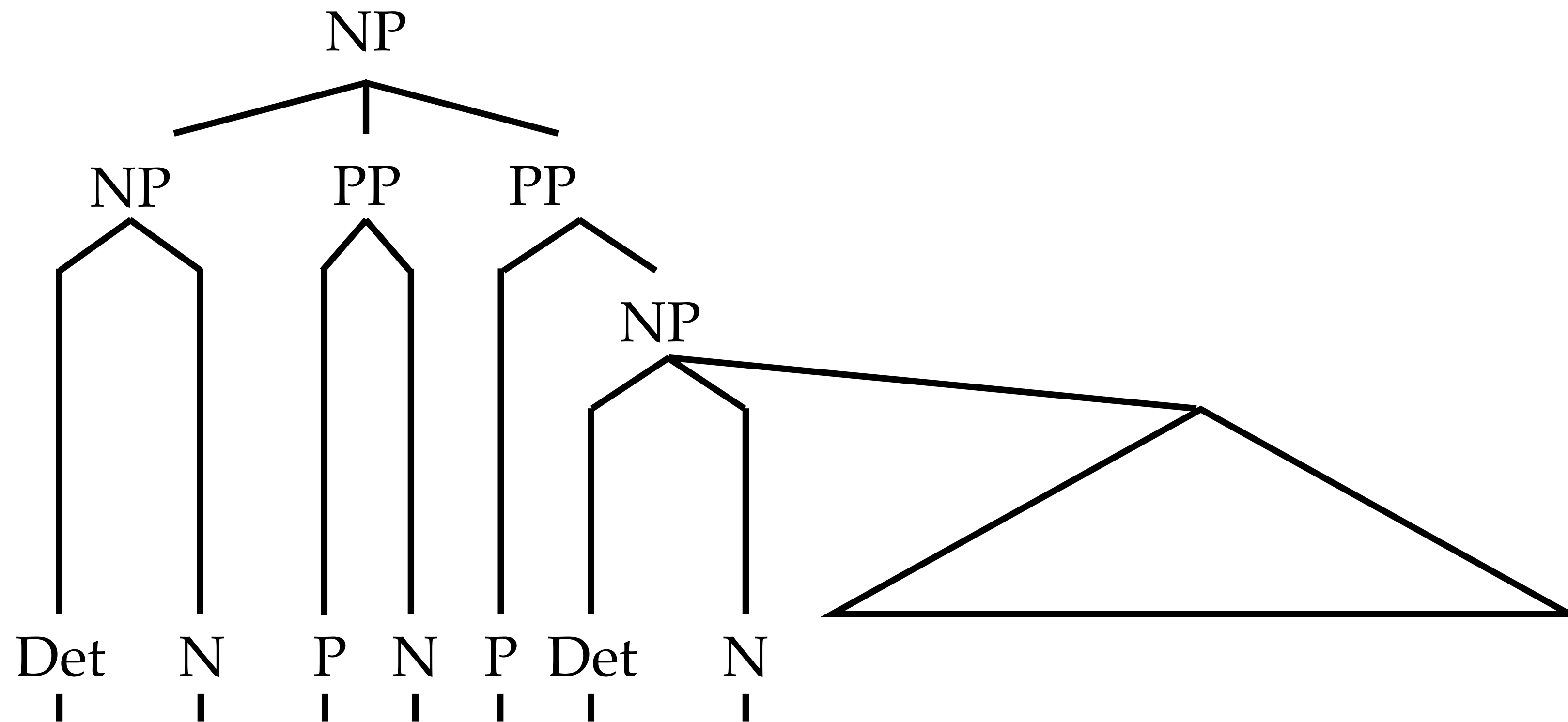


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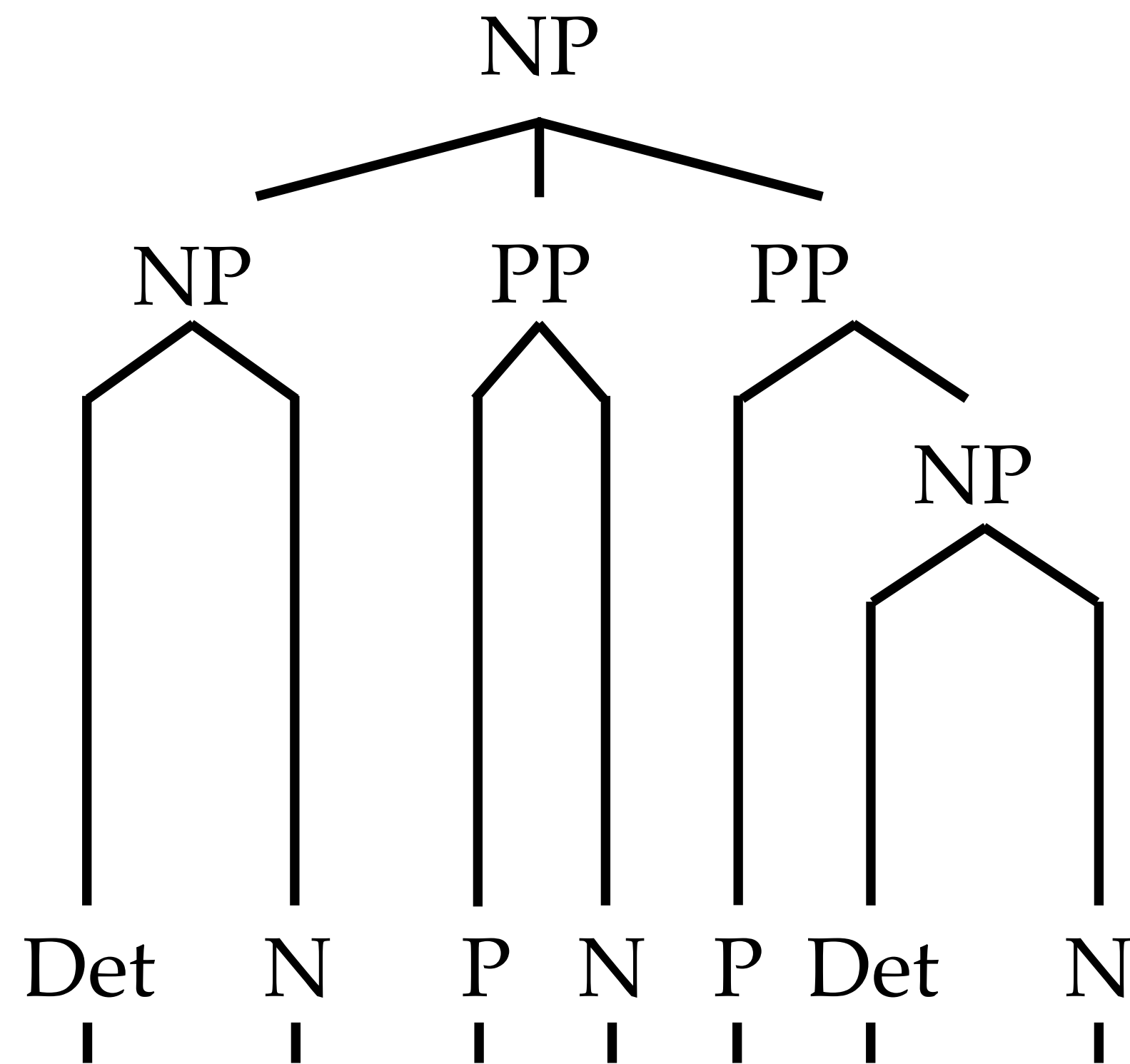
The video of cats on my phone that is running out of battery...

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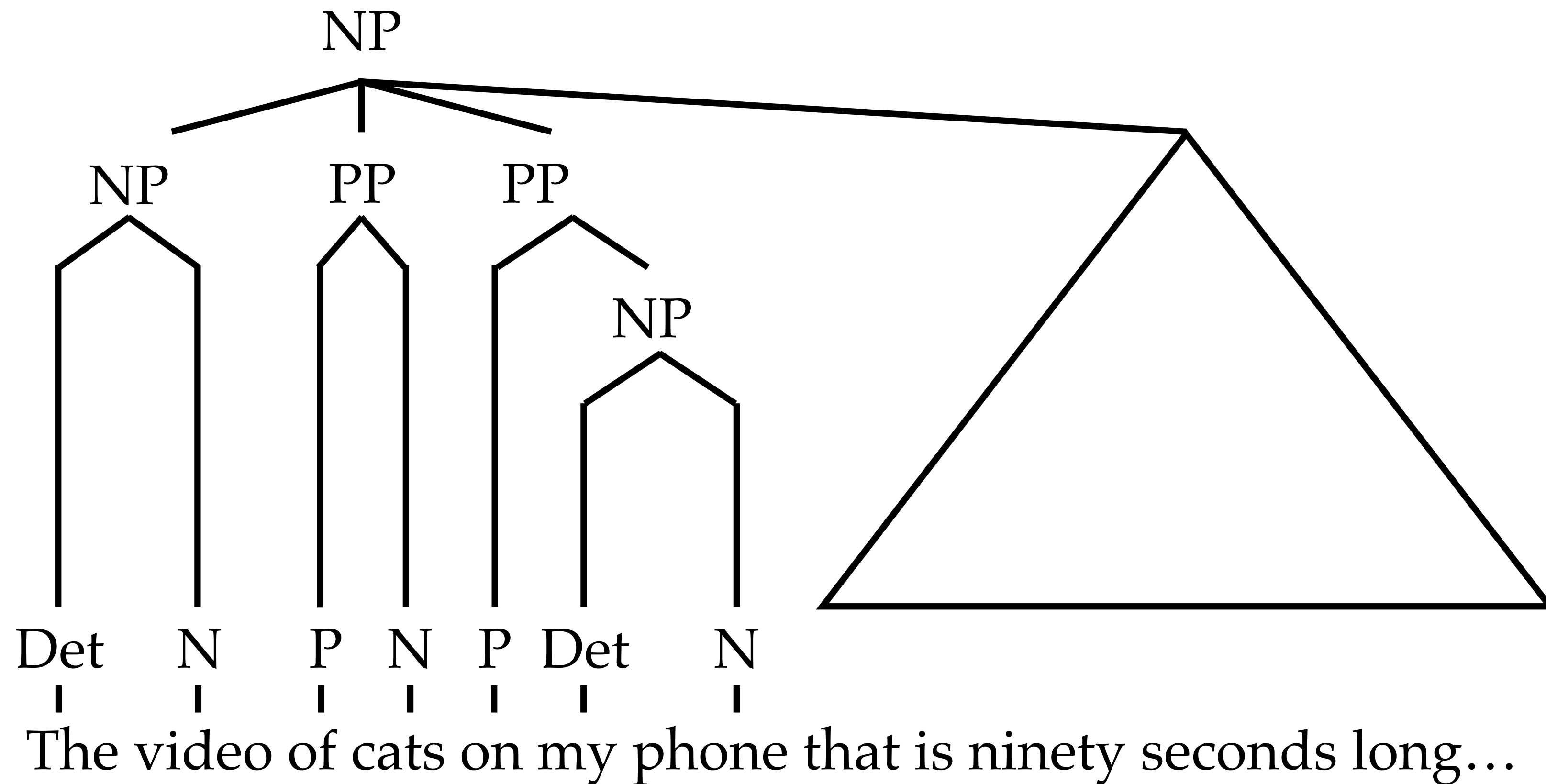
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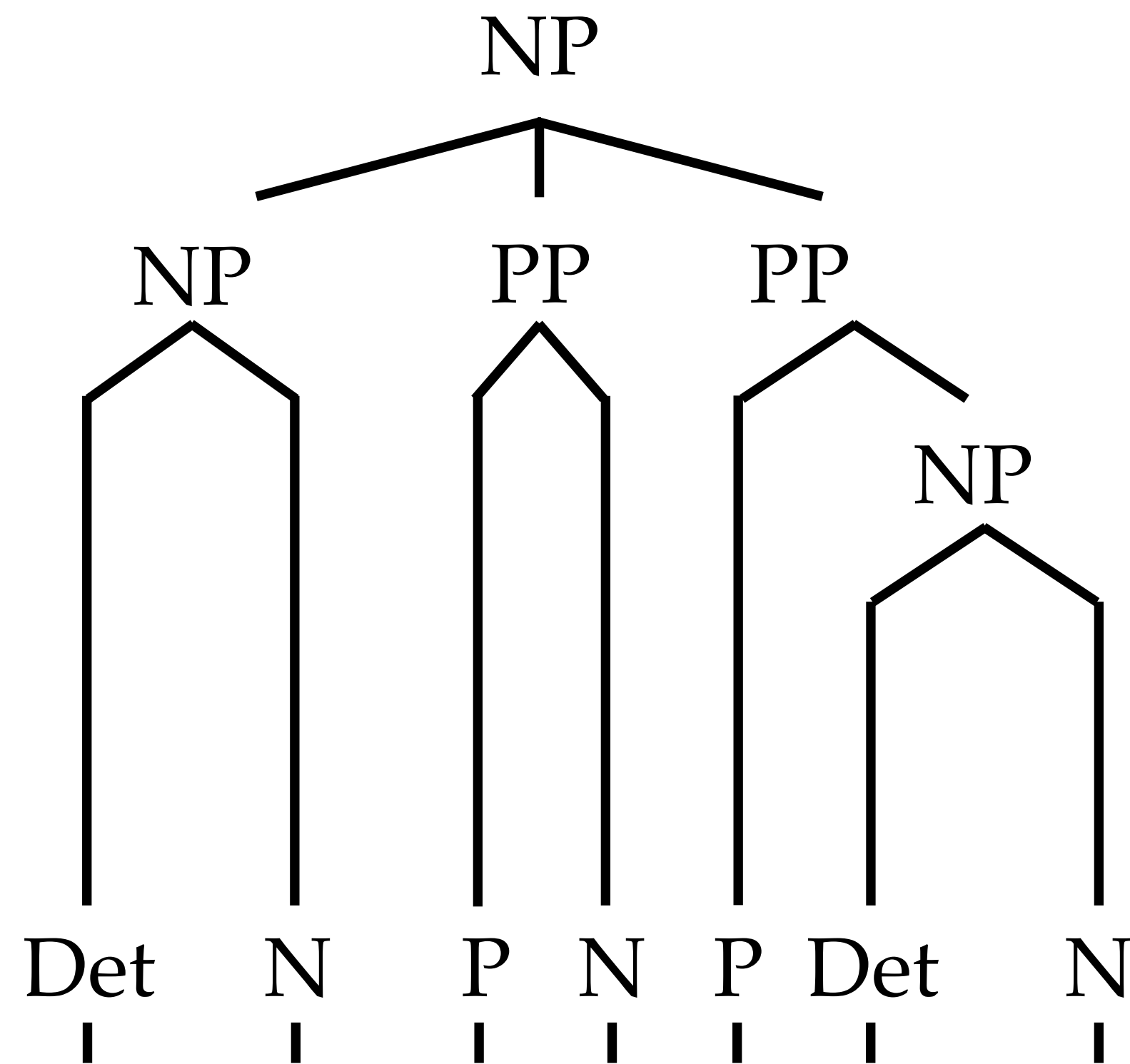


The video of cats on my phone that is ninety seconds long...

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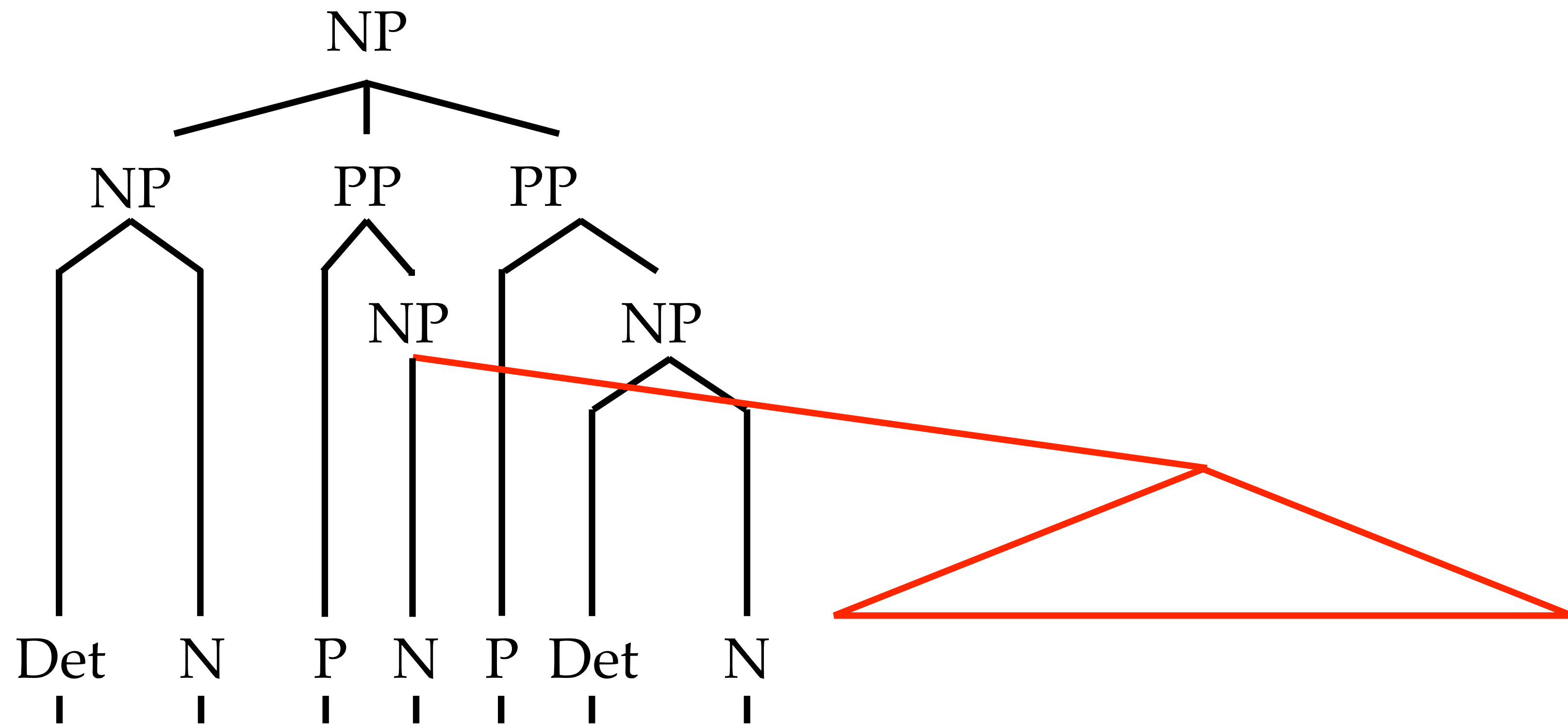


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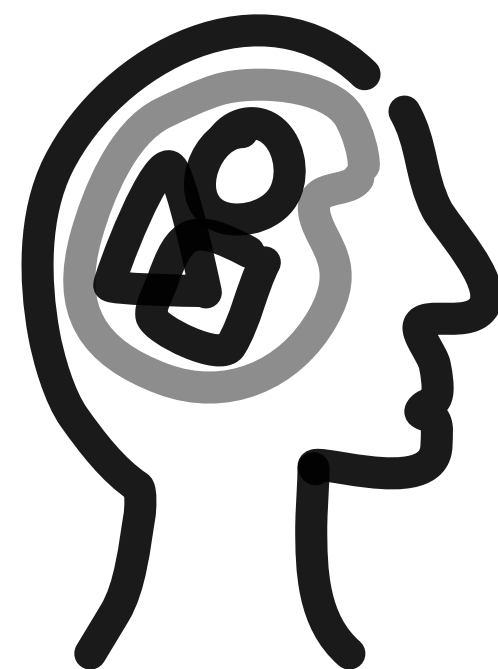
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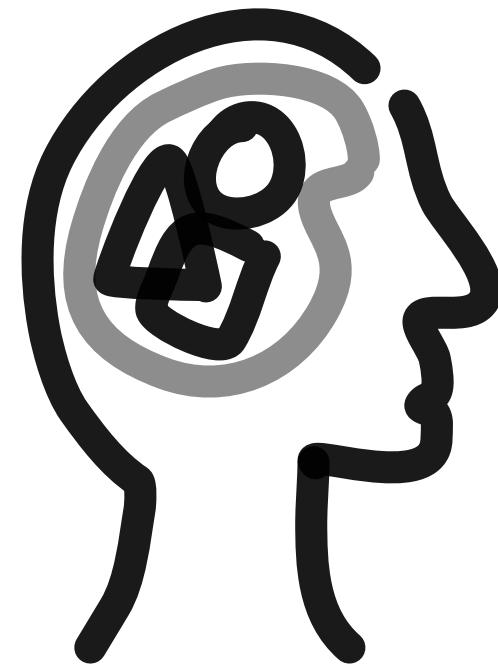
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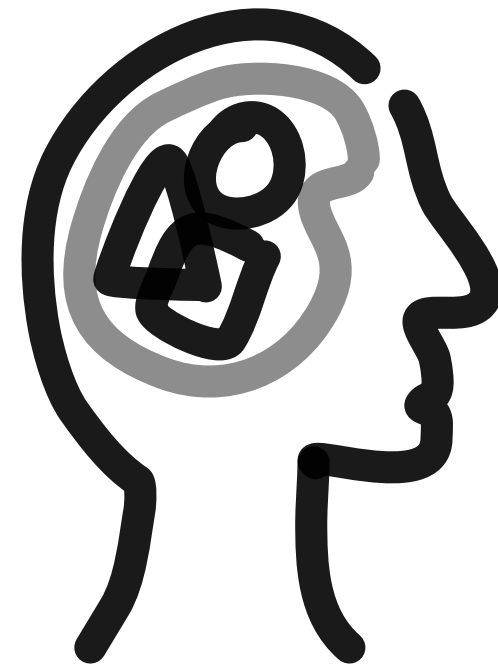
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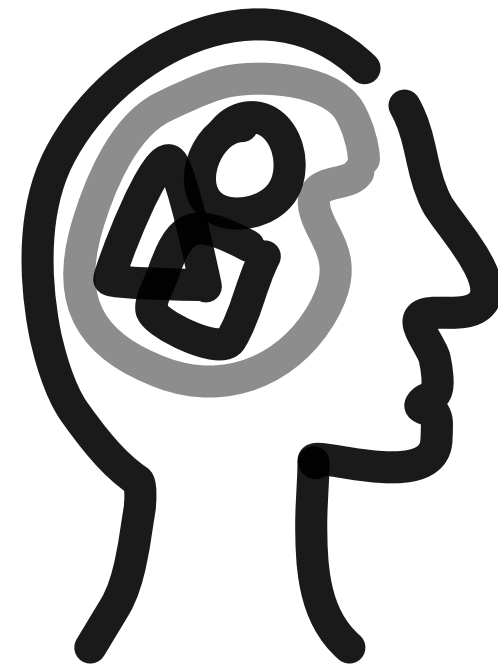


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Jessy broke the vase!

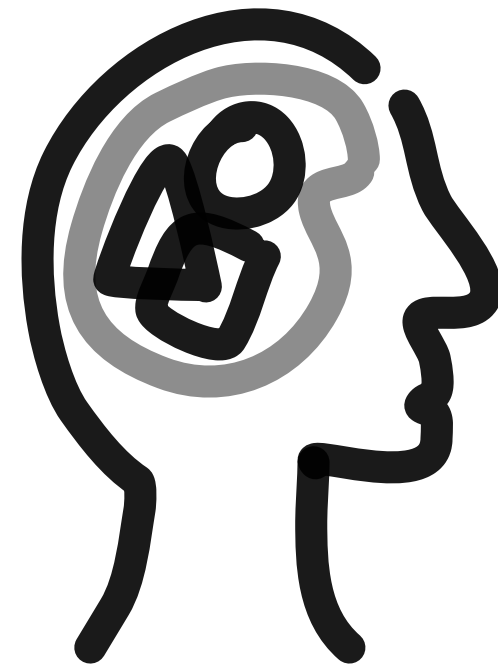


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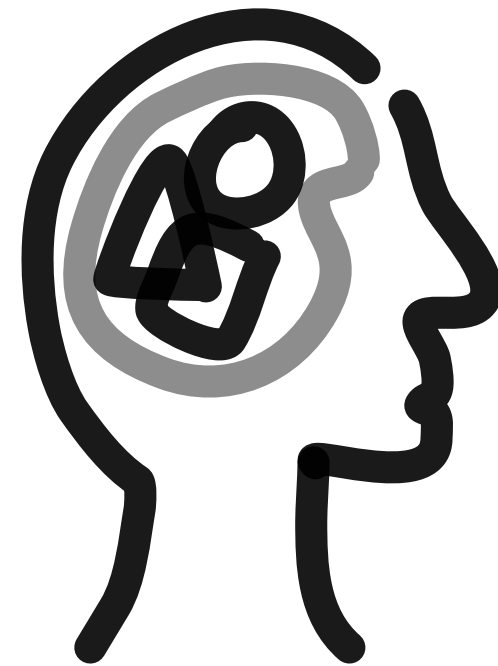
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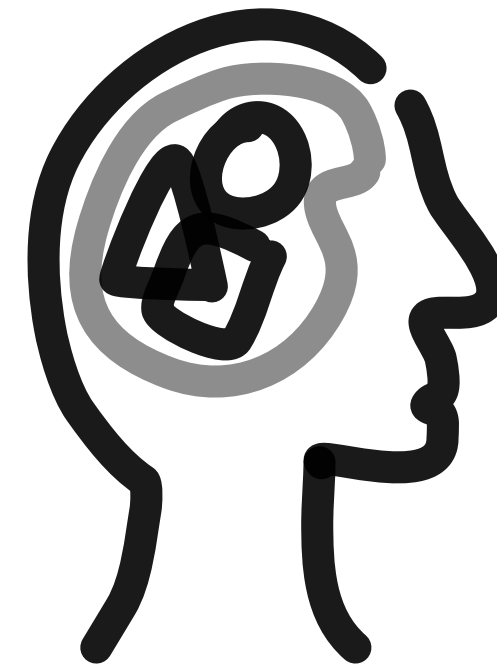
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*The baby **giggled**.*
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*The ticket **cost** 5 dollars.*
5 dollars were **cost by the ticket.*

Answer from Statistical Learning?

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***People with PhDs take forever to understand this idea!*

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Question: What allows the language learner to conclude that “X giggled Y” is incorrect?

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Statistical Preemption: Every time I could have heard “X giggled Y”, I instead heard “X made Y giggle” — the same meaning was almost always conveyed using “X made Y giggle”

***People with PhDs take forever to understand this idea!*

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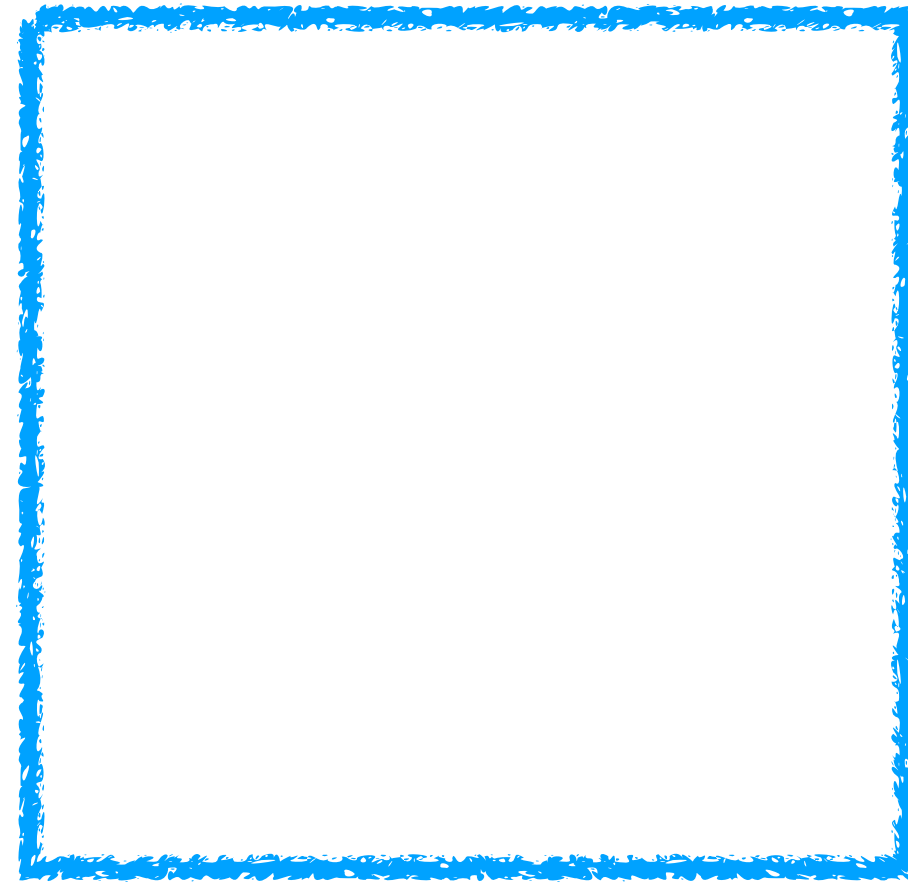
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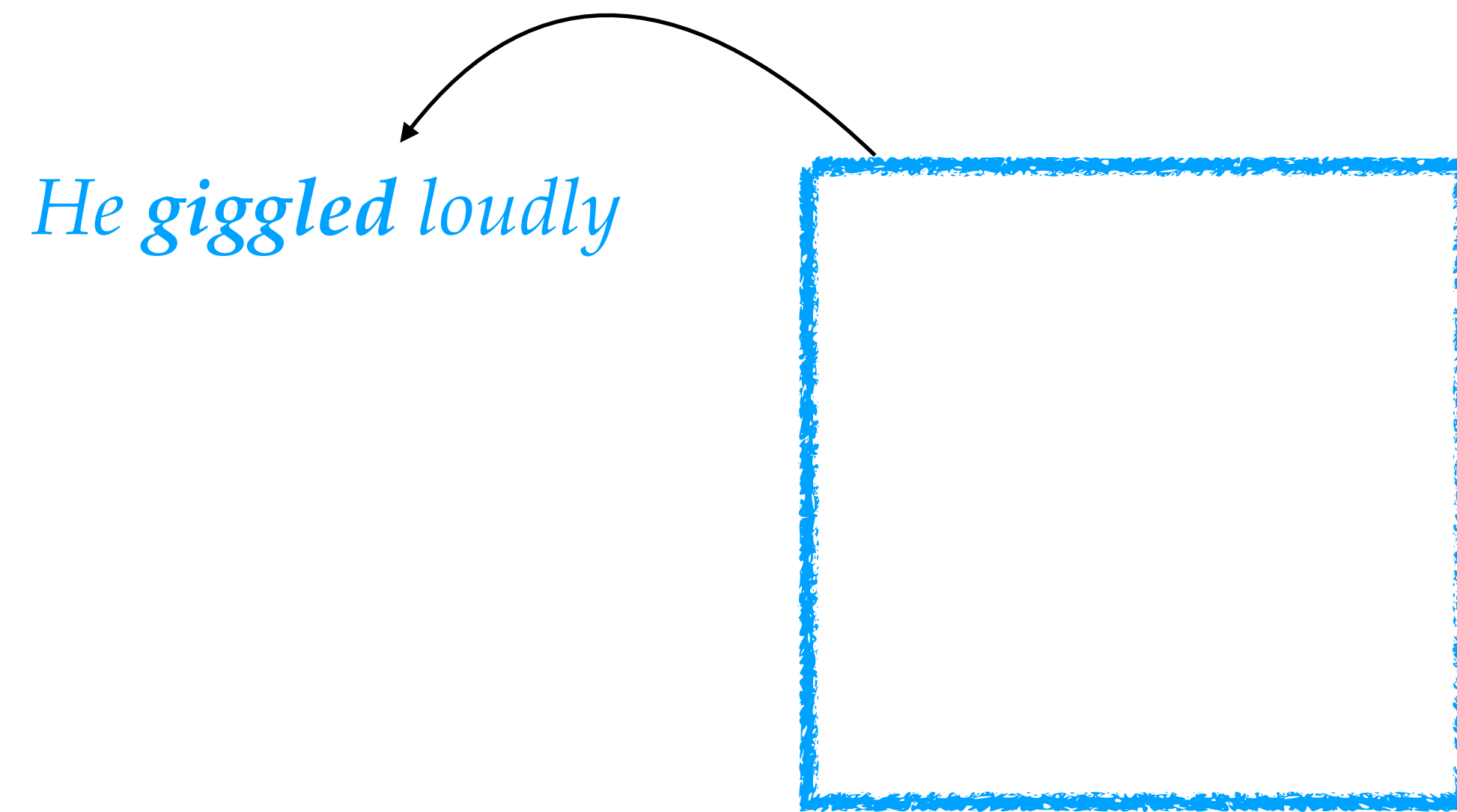
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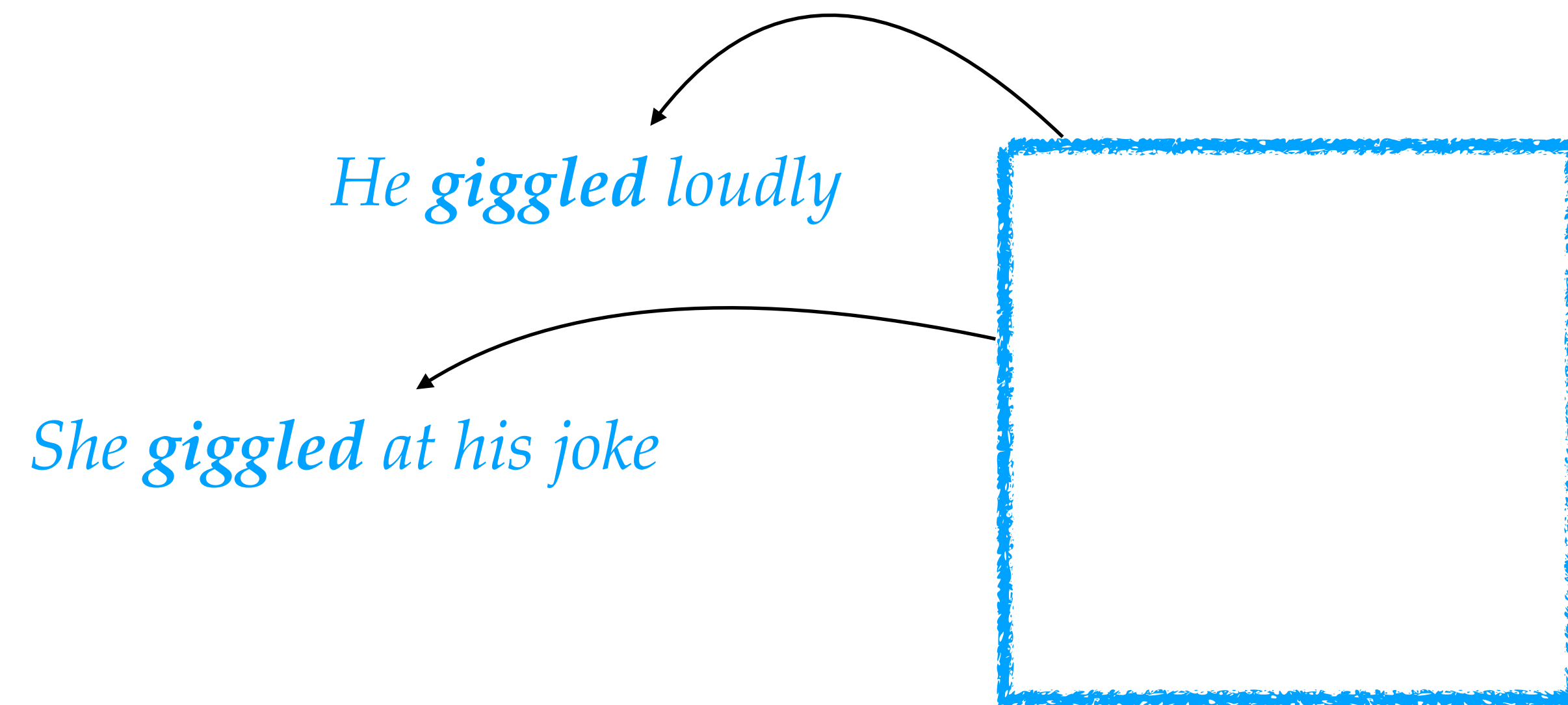
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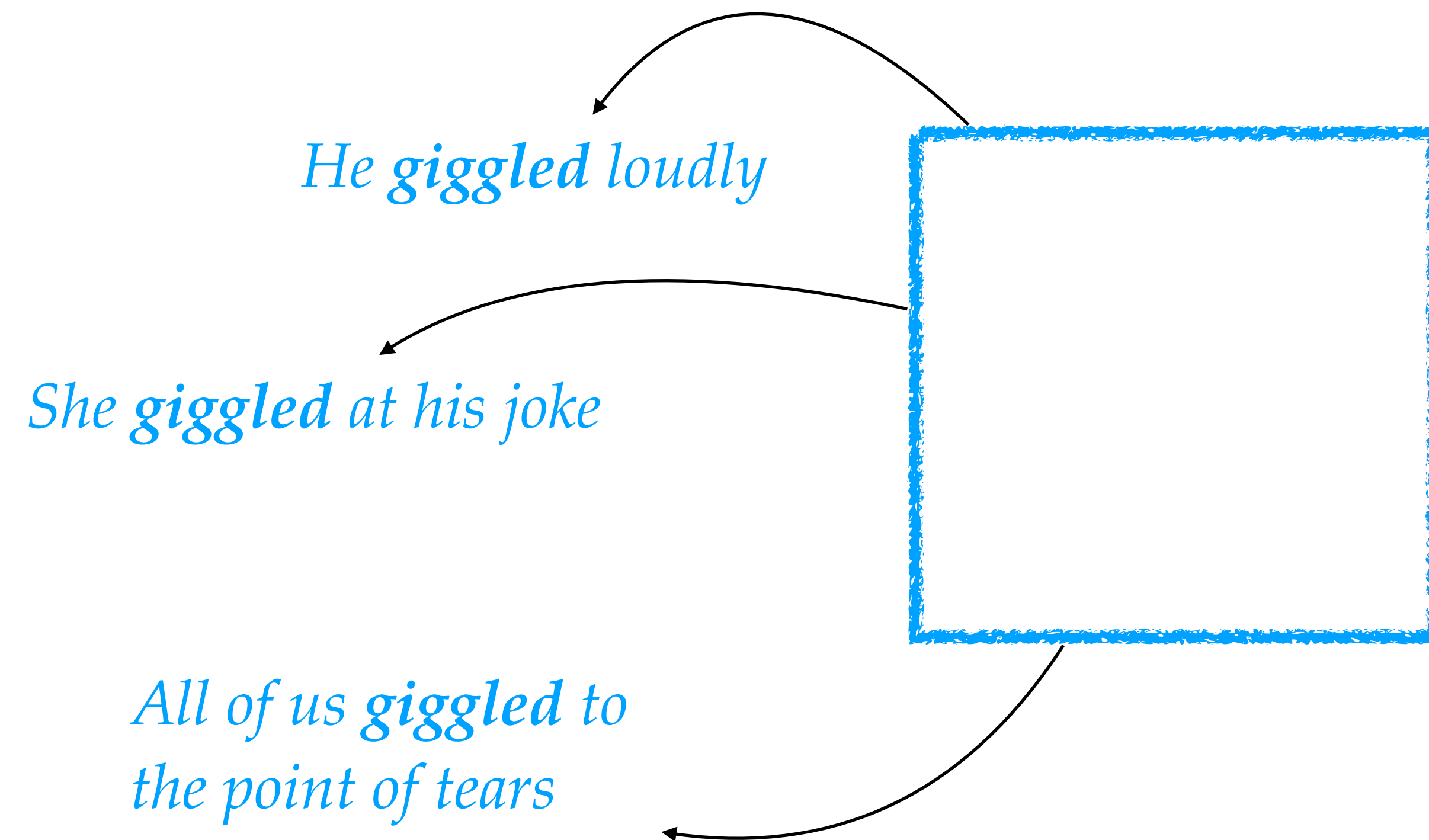
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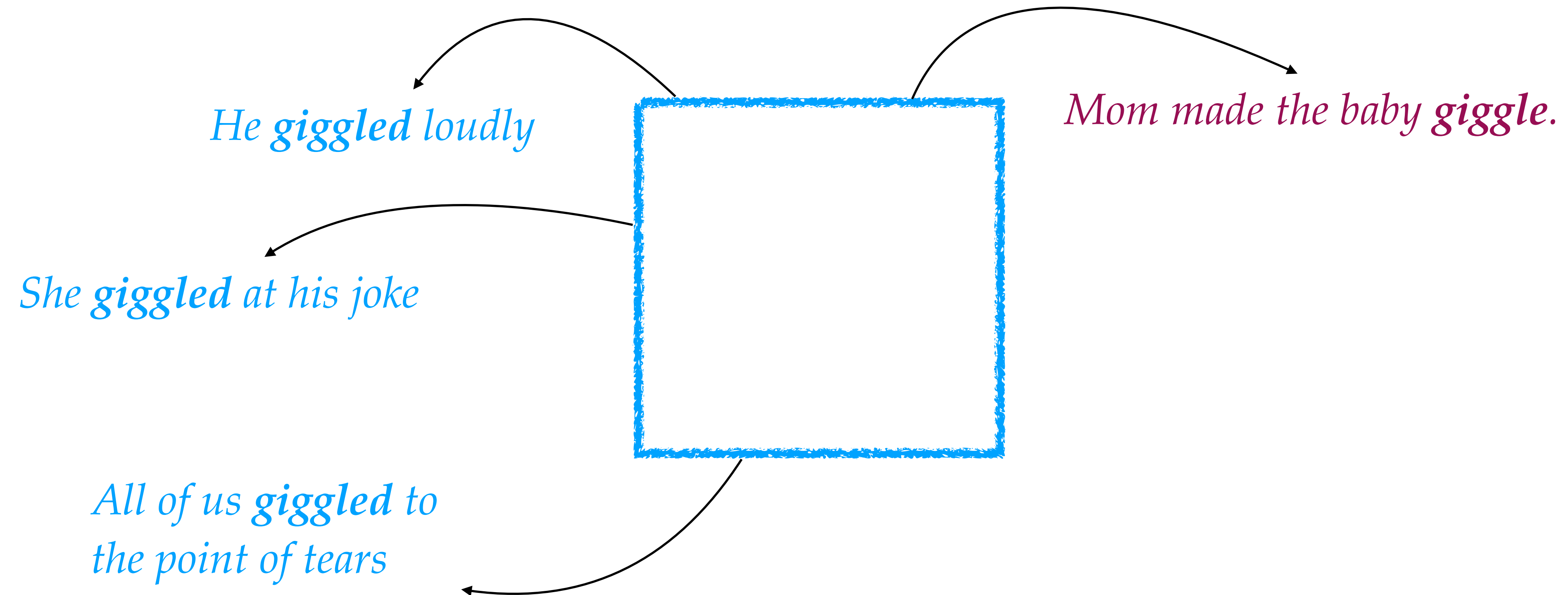
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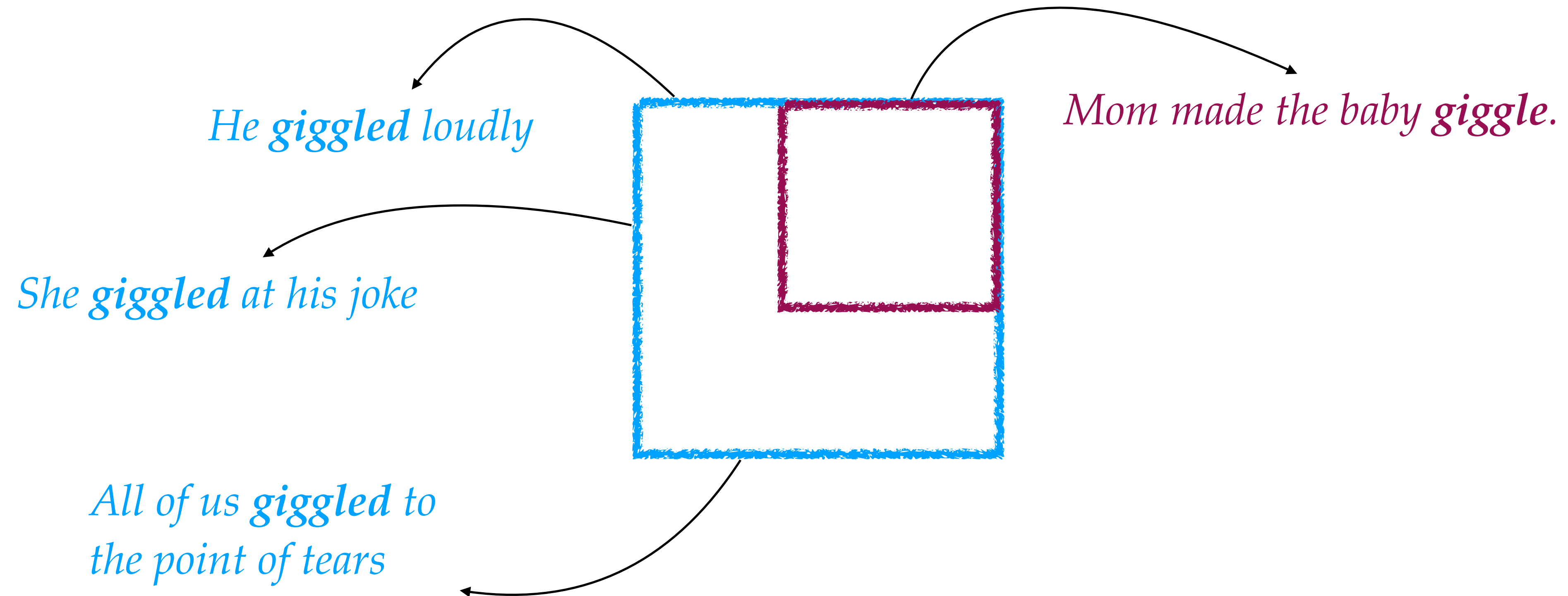
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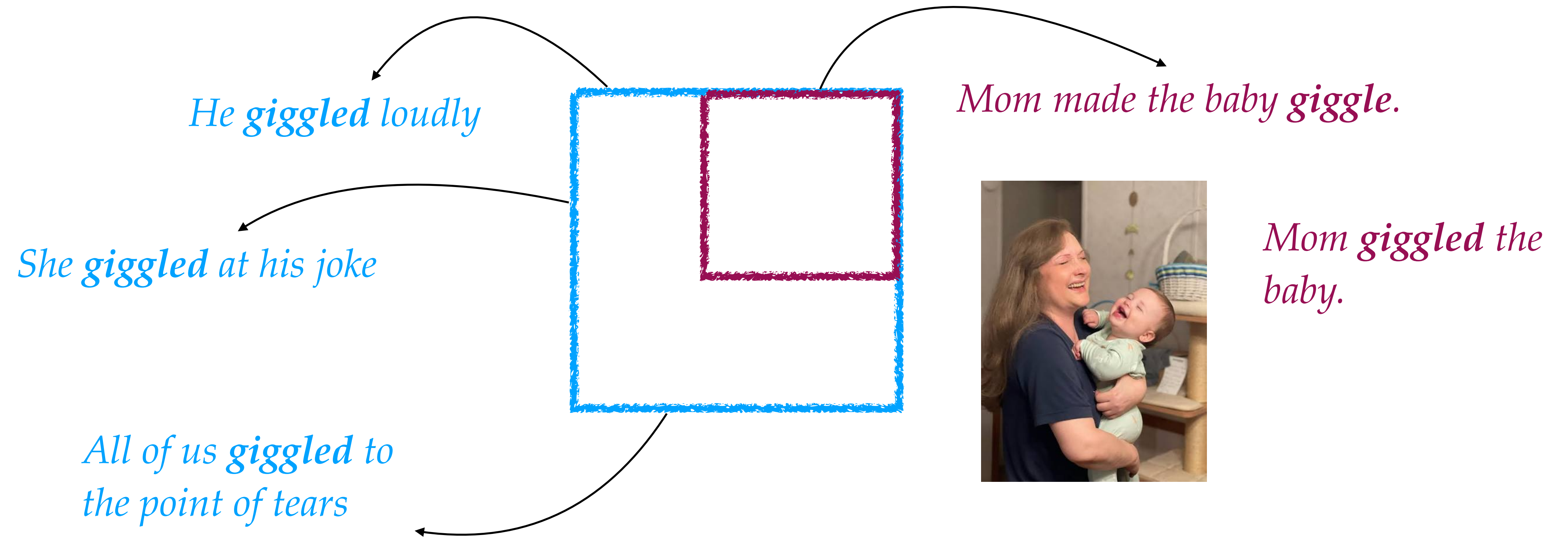
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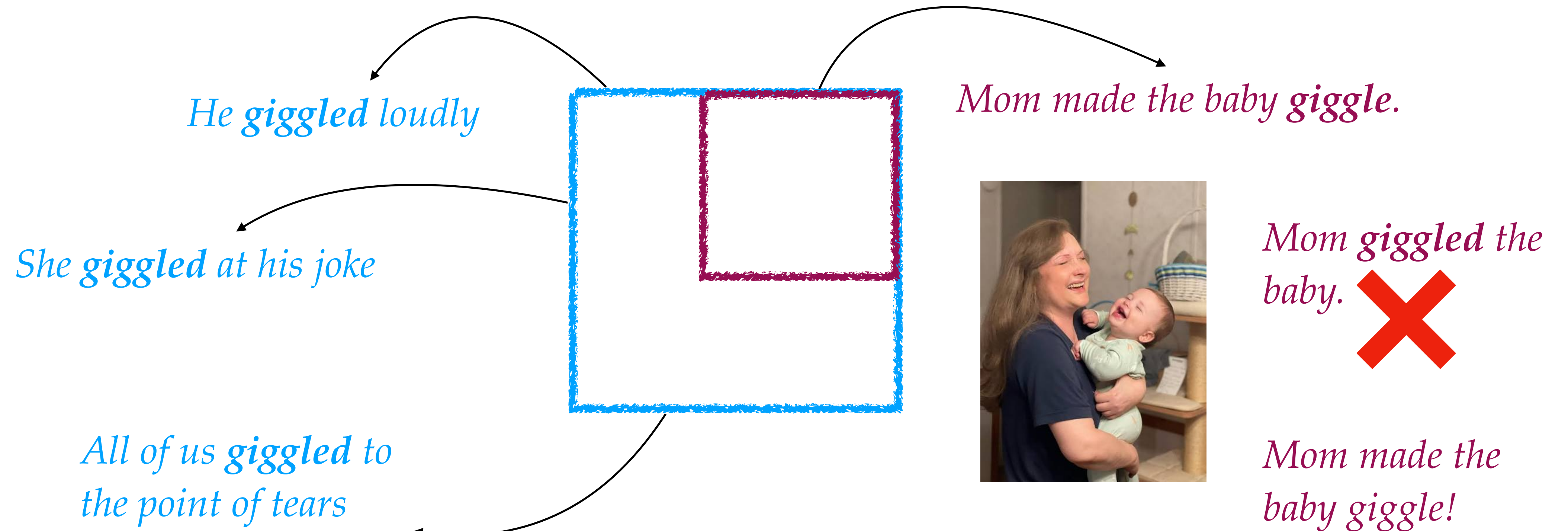
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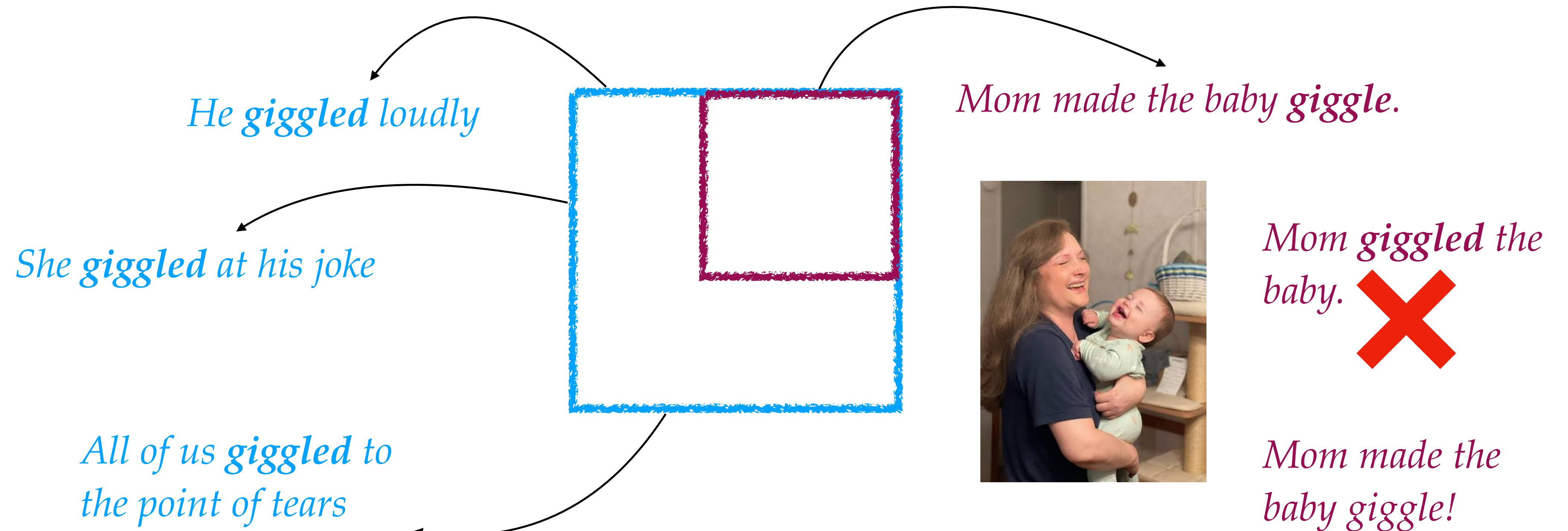
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Child: He wiped him.

Adult: He wiped himself.

Child: Yes, he wiped himself.

(Saxton, 2000)

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