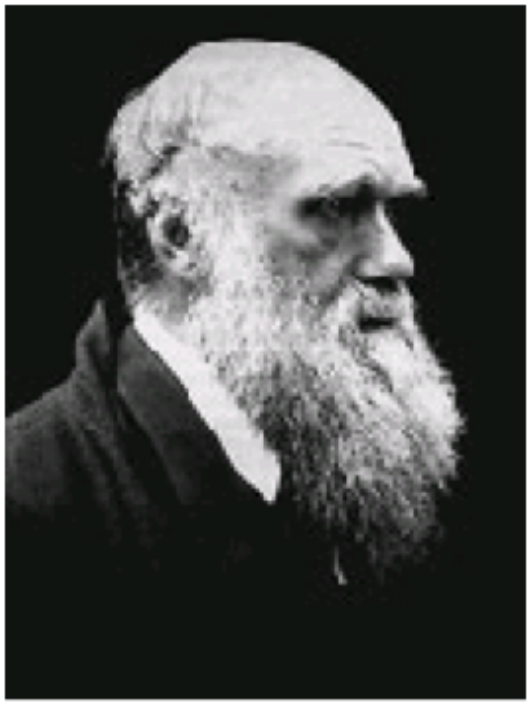
The Object of Study

Ferdinand de Saussure, Charles Darwin, Noam Chomsky

Language: "... A set of conventions … adopted by a social group to allow the use of the **language faculty** ...a social product of the language faculty..."

Language faculty: "...a faculty given to us by nature …a natural instinct ..."



"[Language]… is not a true instinct, as every language has to be learnt. It differs, however, widely from all ordinary arts, for man has an instinctive tendency to speak, as we see in the babble of our young children, while no child has an instinctive tendency to brew, bake, or write… [Language is] an instinctive tendency to acquire an art"

(C. Darwin Descent of Man 1871)

We could study: **The ability itself**

or

We could study**: What makes this ability possible.**

This ability is a biological property, a property of the body, mind, brain.

But why?

When we study human language, we are approaching what some might call the “human essence,” the distinctive qualities of mind that are, so far as we know, unique to man.

NOAM CHOMSKY, *Language and Mind*, 1968

How we study the ability to do something (the mental capacity)

rather than the product of this ability (languages)?

→ is a Reverse Engineering Problem

REVERSE ENGINEERING PROBLEM

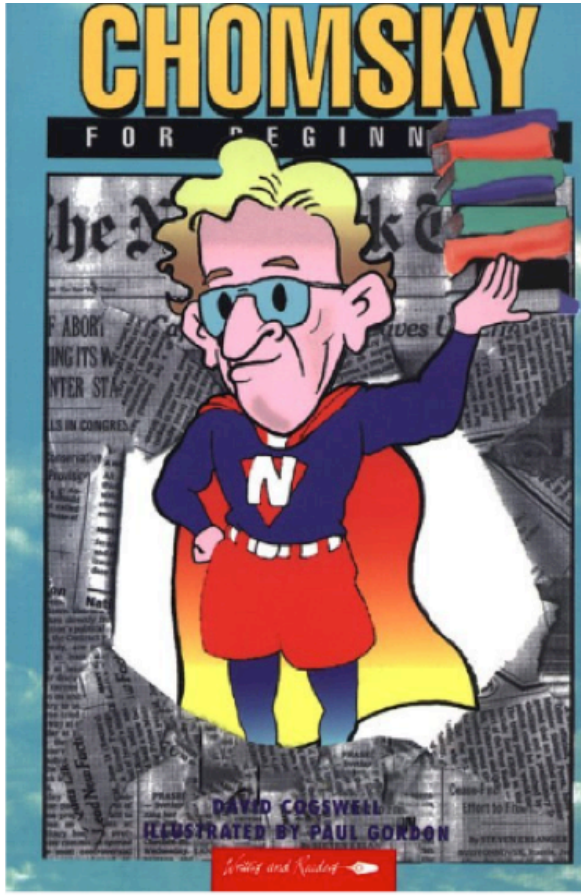
Production:

Input = meaning **Output** = physical signal

Perception:

Input = physical signal **Output** = meaning

A Triple Revolution



I. Mentalism: The object of study is a mental capacity.

II. Naturalism: The structure of this object can be inferred from an analysis of the (linguistic) behavior of speakers.

III. Formalism: Hypotheses about the structure of this object are explicit formal models supposed to predict speakers'(linguistic) behavior.

Study of **language faculty** as a window into **human cognition**

1. What is the **structure of the mental system** underlying an individual's knowledge of language?

2. How does this system **develop** in the mind of an individual?

3. How did this system arise in the species? Is this system species specific?

4. How is this system put to use when speaking and understanding?

5. How can this system vary from one individual/language to another?

6. Is this **system language specific**? What is the **relation with the other cognitive faculties?**

7. How is this system physically realized?

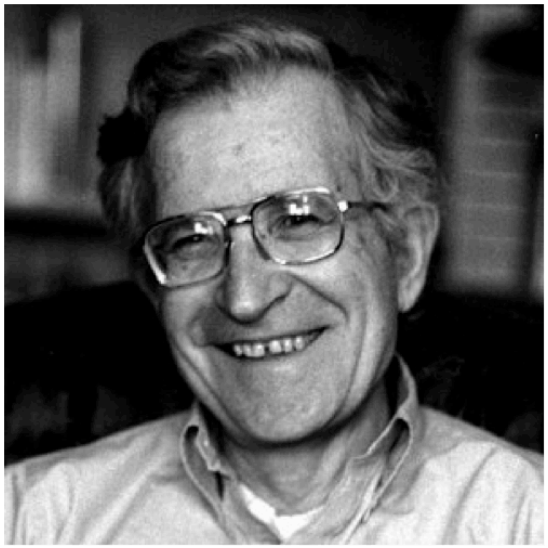
Linguistics

Narrow Goal: Construct theoretical models of linguistic computation and try to discover what is general about them

Main data here: Linguistic intuitions of native speakers

We are interested in how people actually behave (**descriptive grammars**), not how people are told to behave (~~**prescriptive grammars**~~).

What is the longest sentence of English?



The creative aspect of Language use

"The central fact to which any significant linguistic theory must address itself is this: a mature speaker can produce a new sentence of his language on the appropriate occasion, and other speakers can understand it immediately, though it is equally new to them. Most of our linguistic experience, both as speakers and hearers, is with new sentences; once we have mastered a language, the class of sentences with which we can operate … is so vast that… we can regard it as infinite"

N. Chomsky (Cartesian Linguistics, 1964)

The Miracle of Language

- a. John is asleep.
  b. The President is asleep.
  c. The chairman of the Linguistics Department is asleep.
- a. The rightmost person in the first row is asleep.
  b. The person immediately to the left of the rightmost person in the first row is asleep.
  c. The person behind the person immediately to the left of the rightmost person in the first row is asleep.
- a. John is asleep.
  b. Mary noticed that John is asleep.
  c. Nobody cares that Mary noticed that John is asleep.
  d. Sam knows that nobody cares that Mary noticed that John is asleep.

Recursion

a. **John is asleep**

→ Nobody claimed that **John is asleep**

b. **nobody claimed that John is asleep**

→ Nobody claimed that **nobody claimed that John left**

■ The Puzzle

(a) we can form infinitely many new sentences, and yet

(b) we are finite creatures.

■ The Solution: we know **Rules**

Recursion Rule:

If S is a sentence (for example S = John is asleep)

And S'= Nobody claimed that S

S'is also a sentence : A sentence can contain a sentence

☛What is the longest sentence of English?

Property of Recursion

The possibility of which in language has been argued to distinguish humans from all other animals.. (*Hauser*, *Chomsky* & *Fitch* 2002)

Universal?

The case of the **Pirahã**

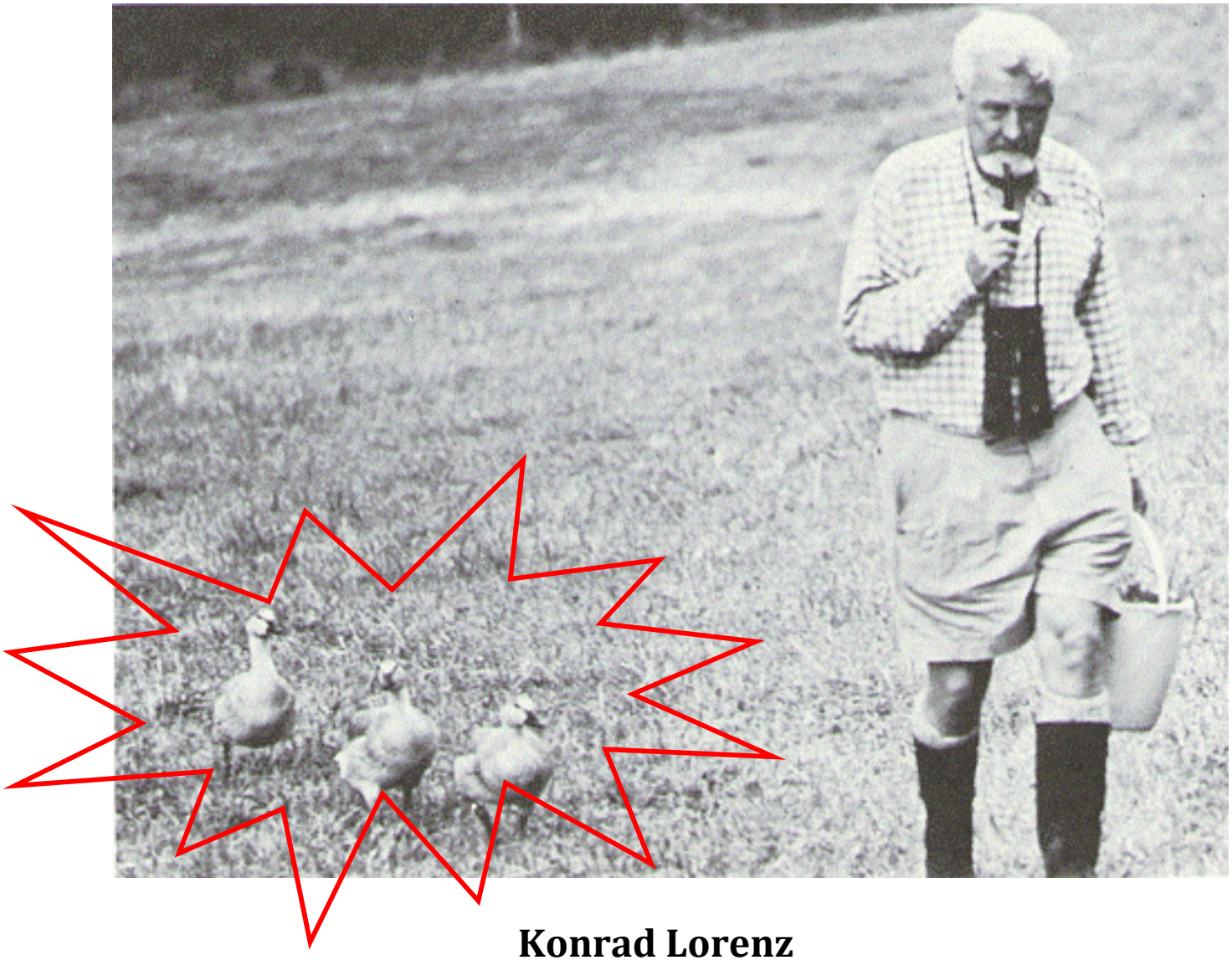
(Language isolate in Amazonia, claimed to have no grammatical recursion)

... but how do we LEARN the rules?

It's Instinct

Konrad Lorenz

[Credit: http://cas.bellarmine.edu/tietjen/Ethology/ethologyy_pix.htm]



Konrad Lorenz

[http://cas.bellarmine.edu/tietjen/Ethology/ethologyy_pix.htm]

no relevant stimulus !

The Problem of Induction

3 9 21

The Problem of Induction

3 9 21

18 ?

The Problem of Induction

3 9 21

17 ?

The Problem of Induction

3 9 21

18 ? 17 ?

Question Formation in English

John is in the garden →
Is John __ in the garden ?

A unicorn is in the garden →
Is a unicorn __ in the garden ?

Question Formation in English

John is in the garden →
Is John __ in the garden ?

A unicorn is in the garden →
Is a unicorn __ in the garden ?

A unicorn that is eating a flower is in the garden →
Is a unicorn that __ eating a flower is in the garden ?

?

Question Formation in English

John is in the garden →
Is John __ in the garden ?

A unicorn is in the garden →
Is a unicorn __ in the garden ?

?

A unicorn that is eating a flower is in the garden →
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Is a unicorn that __ eating a flower is in the garden ?

?

?

A unicorn that is eating a flower is in the garden →
Is a unicorn that is eating a flower __ in the garden ?

Question Formation

- a. A unicorn that is eating a flower is in the garden
  b. *Is a unicorn that __ eating a flower is in the garden?
  c. Is a unicorn that is eating a flower __ in the garden?

... move the last *is*?

Question Formation

- a. A unicorn that is eating a flower is in the garden
  b. *Is a unicorn that __ eating a flower is in the garden?
  c. Is a unicorn that is eating a flower __ in the garden?

- **... move the last *is*?**

- a. John is in the garden next to someone who is asleep.
  b. Is John __ in the garden next to someone who is asleep?
- c. *Is John is in the garden right next to someone who __ asleep?
- **... move the first *is*?**

The Problem of Induction

(i) There is no doubt that ***some* mechanism of induction** must exist prior to learning.

Induction: any process by which one infers from some observed data a rule that applies beyond these data

(ii) There are two possibilities:

Theory A: All-purpose mechanism (general intelligence)

Theory B: Specific Mechanism, constrained by...
Universal Grammar

Universal Grammar: Basic design underlying the grammars of all human languages.

- Move the first *is* to the front of the sentence?
  NO
- Move the second *is* to the front of the sentence?
  NO

Not quite! The simple rule fails
The rule turns out to be simple, once we have understood basic hierarchical structure, as we will see shortly
Lesson: what counts for linguistic phenomena: hierarchical structure, never linear structure.

The 'Poverty of the Stimulus' Argument

Chomsky's Argument

Children are not *taught* language. They pick it up in a normal speaking environment; they observe people speaking it and acquire it.
But the data that they have access to are much less complex than the rules they end up acquiring.
This makes it extremely unlikely that an all-purpose learning mechanism could be at play.

Claim: Most of language is innate
(= present at birth)

Question Formation and the Poverty of the Stimulus

Julie Legate and Charles Yang *Empirical re-assessment of stimulus poverty arguments The Linguistic Review* 19 (2002), 151Ð162.
Here is no child directed speech that would allow a child to deduce the question rule.
The knowledge reflects the rule system of UG.

Study of **language faculty** as a window into **human cognition**

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Inside the Black box

REVERSE ENGINEERING PROBLEM

Input = ?

Output = language

REVERSE ENGINEERING PROBLEM

Perception:
Input= physical signal **Output** = meaning

Production:
Input = meaning **Output** = physical signal (sound, sign)

Tom's cats were tasting Kate's crabs

PHONETIC: OUTPUT 1

ˈtʰɑ̃mp̚sˈkʰætsʷwəɾˈtʰestĩŋˈkʰetˈkʰɹæbz

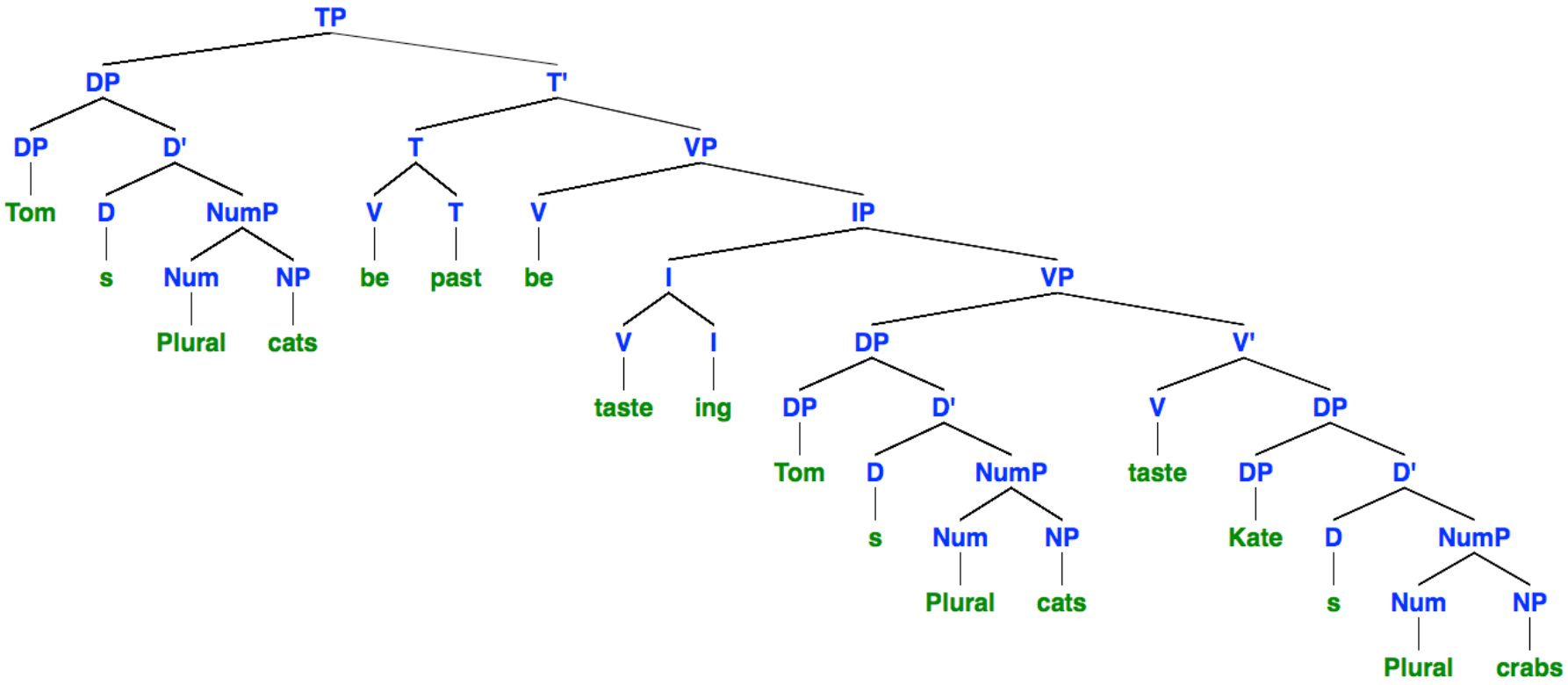
PHONOLOGY: OUTPUT 2

ˈtʰɑ̃mp̚sˈkʰætsʷwəɾˈtʰestĩŋˈkʰetˈkʰɹæbs

MORPHOLOGY: OUTPUT 3

Tom+Possessive+cat+plural+Be+
past+plural+taste+progressive+Kate+
Possessive+crab+plural

SYNTAX: OUTPUT 4



SEMANTIC: OUTPUT 5

A formula based on the syntactic structure and the meaning of individual pieces (words) yielding the **Literal Meaning**

Syntactic Knowledge

- The elementary parts seem to be **words**
  (in fact they are smaller parts)

- How are they put together?
  There is more **structure** than meets the eye...

- Uncovering this structure is the role of **Syntax**

- a. John is sick.
  b. Nobody cares that John is sick.
  c. Nobody cares that nobody cares that John is sick.

- a. *Sick is John
  b. *Cares nobody that John is sick
  c. *That cares nobody nobody cares that John is sick

How Language Works: Syntax

Mary will meet the President

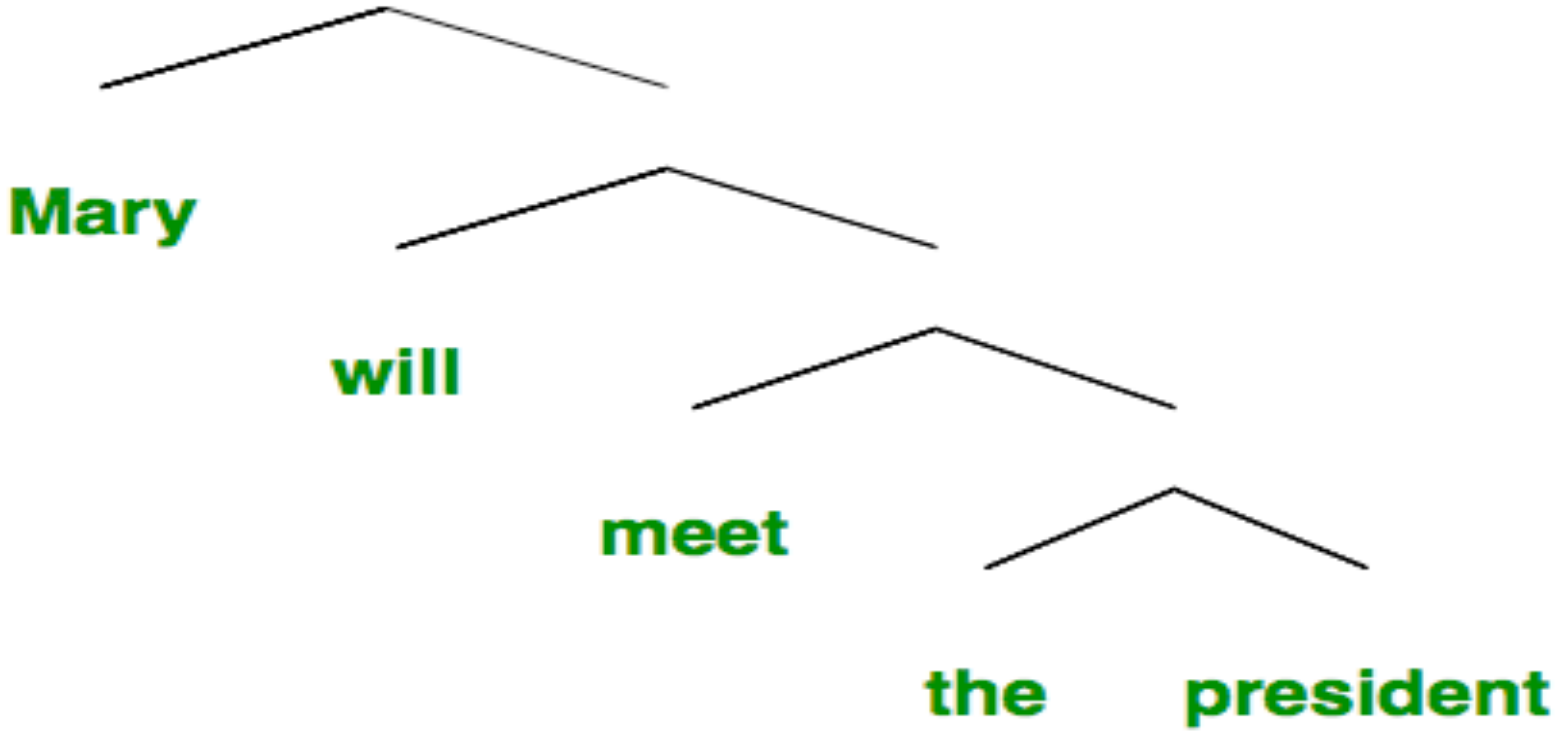
Hypothesis 1: Flat Structure

Mary will meet the president

How Language Works: Syntax

Mary will meet the President

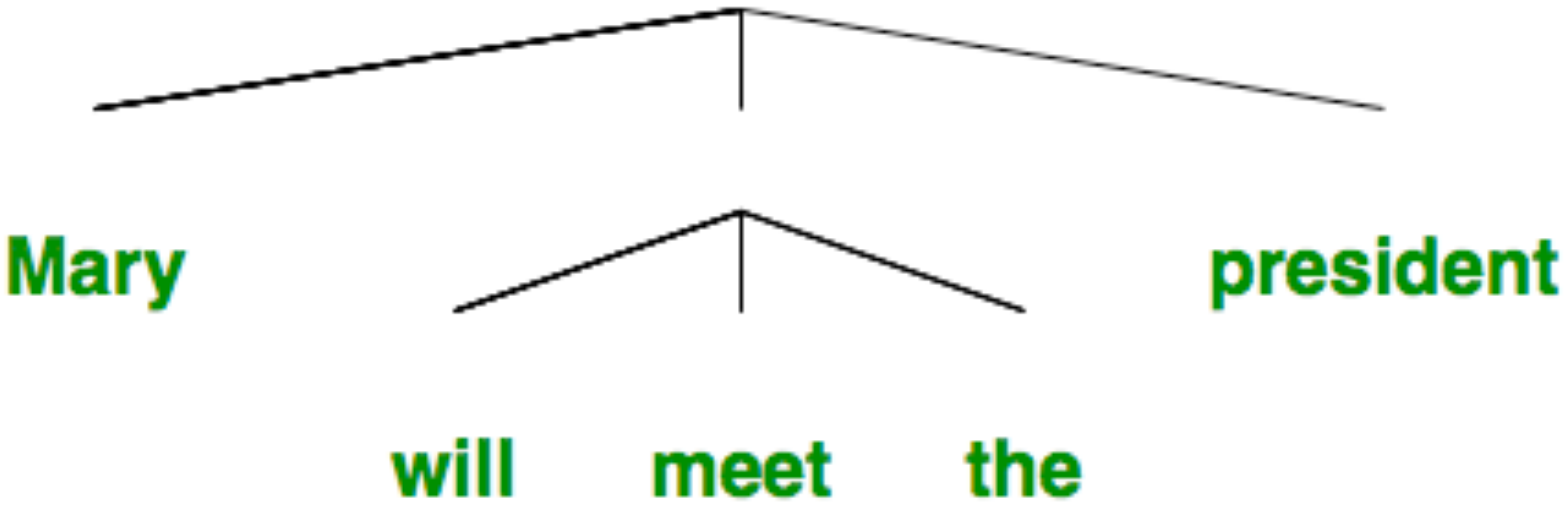
Hypothesis 2: Tree Structure



How Language Works: Syntax

Mary will meet the President

Hypothesis 3: Tree Structure



Arguing for Hypothesis 2

= showing that there is **structure** in a sentence,
i.e. that words are grouped together into **subtrees**.

= showing that the **subtrees** are those indicated in **hypothesis 2**

Two or more words **form a constituent**
if there is a sub-tree that contains them and
nothing else (i.e. they form a natural unit).

→ **Constituency tests**: tests showing that certain groups of contiguous words behave as natural units, i.e. are constituents

Two words or groups of words that form a constituent are **contiguous**.

But the converse is not true: some words or groups of words which are contiguous do not form a constituent.

Constituency Tests

Test 1**: Ability to stand alone as an **answer to a question

Constituency Tests

Test 1: Ability to stand alone as an answer to a question

- (1) a. Mary will meet [the President]
  b. Who will Mary meet?
  - The President
- (2) a. Mary will [meet the President]
  b. What will Mary do?
  - Meet the President
- (3) a. [Your friend] will meet the President
  b. Who will meet the President?
  -Your friend
- (4) a. *will meet
  b. *meet the
  c. *friend will

Constituency Tests

Test 2**: Ability to be **moved as a unit

Constituency Tests

Test 2: Ability to be moved as a unit

- a. Mary will meet [the President]
  b. **[The President]**, Mary will meet
- a. Mary will [meet [the President]]
  b. **[Meet the President]**, Mary will
  e.g. in the following context: John told you that Mary will meet the President, and [meet the President], Mary (certainly) will.
- a. [Your friend] will meet the President
  b. **[Your friend]**, **she** will meet the President.]
- a. *Will meet, Mary __ the President
  b. *Meet the, Mary will __ President
  b. *Friend will, your __ meet the President

Constituency Tests

Test 3**: ability to be **replaced by a pronoun

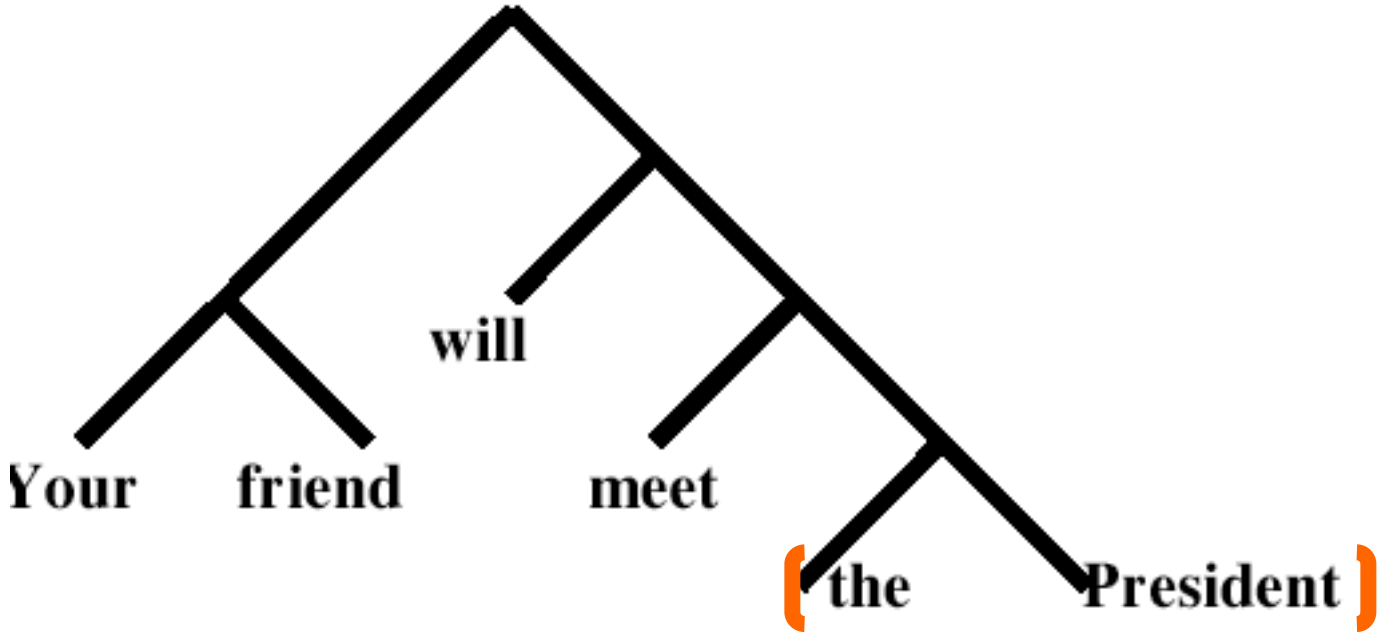
Constituency Tests

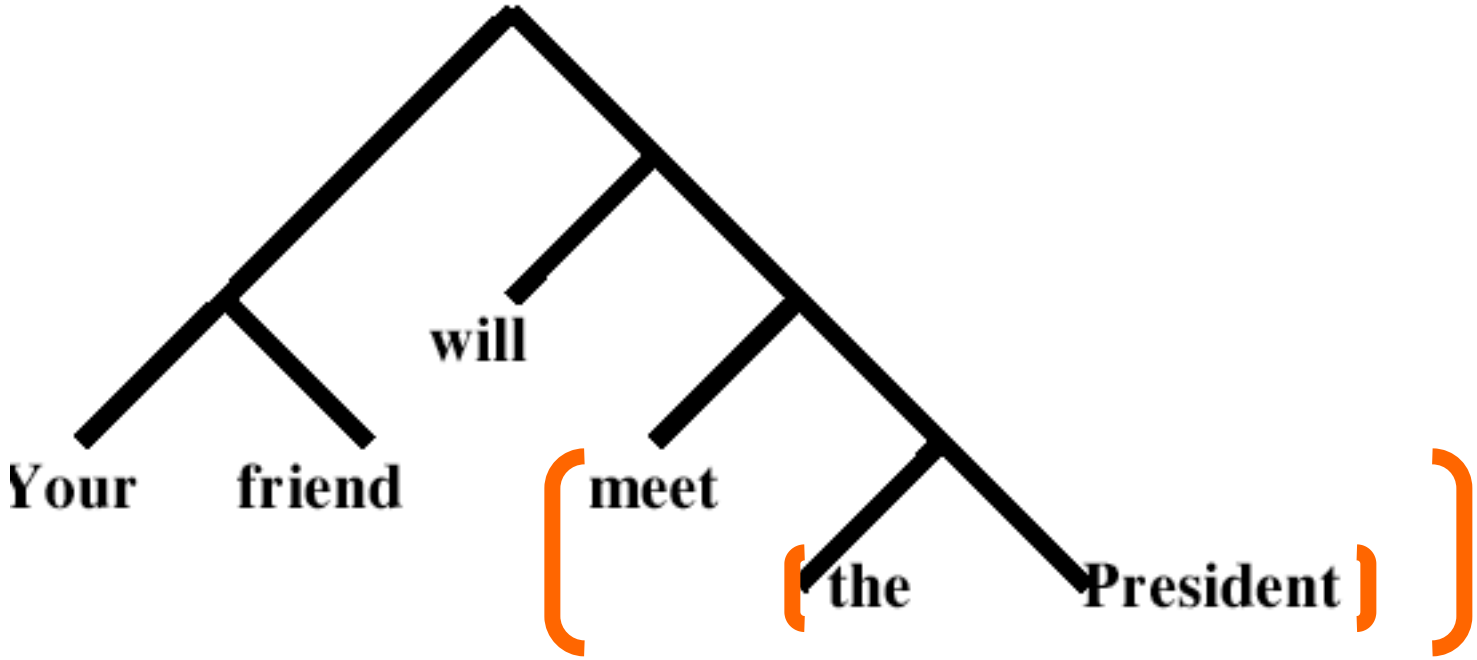
*Test 3: ability to be **replaced by a pronoun***

- a. Mary will meet [the President]
  b. Mary will meet **him**

- a. Mary will [meet the President]
  b. -No, she won't do **it**

- a. [Your friend] will meet the President
  b. **She** will meet the President


will
Your
friend
meet
the
President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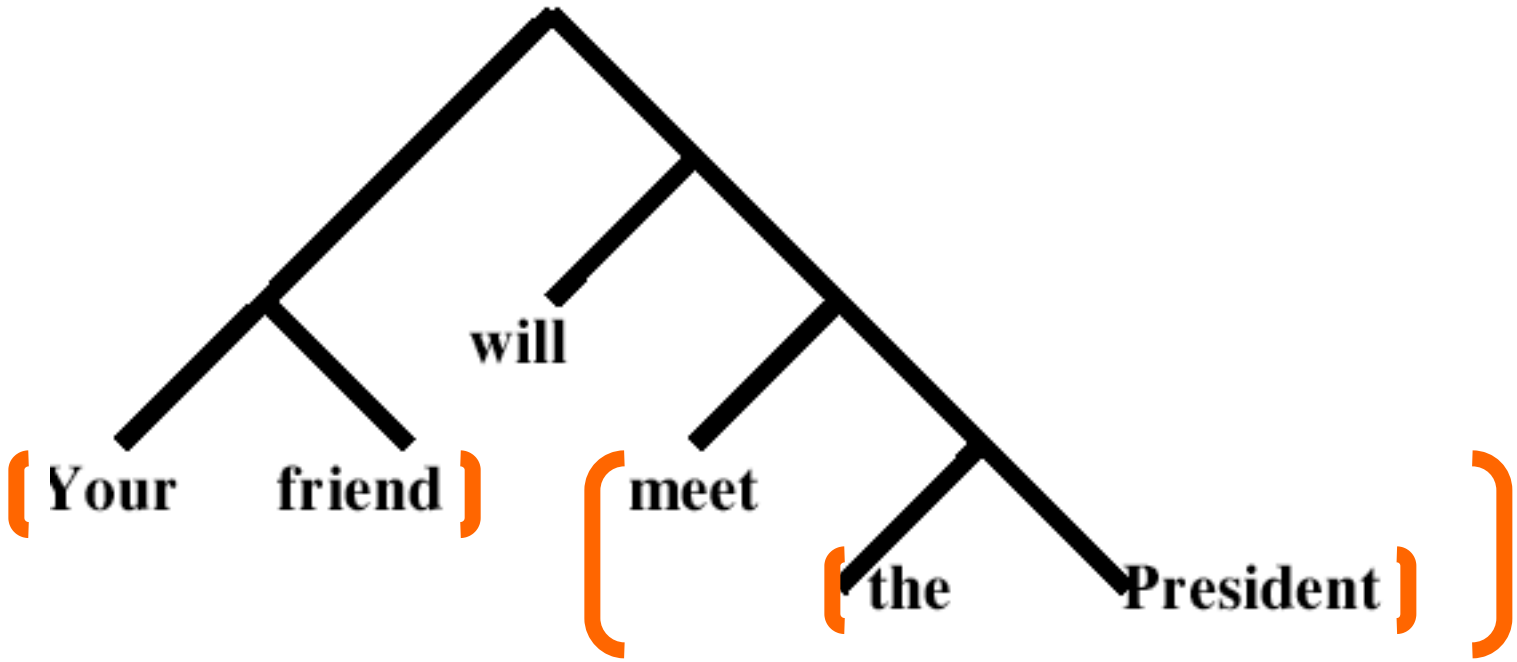
will
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friend
meet
the
President

Constituency Tests

1. If a group of words can **stand alone as an answer to a question**, they form a constituent.

2. If a group of words can **be moved as a unit**, they form a constituent

3. If a group of words can **be replaced by a pronoun**, they form a constituent.

Important Note:

A group of words may be a constituent *without* satisfying some of the tests.

Failing some isolated test is not necessarily informative!

Ambiguities: 2 or more meanings

- **Ambiguities of type 1**

(1) John is sitting near the bank.

a. Meaning 1:

b. Meaning 2:

- **Ambiguities of type 2**

(2) Lucy will hit the student with the book.

a. Meaning 1:

b. Meaning 2:

Ambiguities: 2 or more meanings

Ambiguities of type 1

(1) John is sitting near the bank.

a. Meaning 1: bank = financial institution

b. Meaning 2: bank = slope at the side of a river

Ambiguities of type 2

(2) Lucy will hit the student with the book

a. Meaning 1: Lucy will hit the student. She'll do so with the book. (= The hitting is done with the book)

b. Meaning 2: Lucy will hit the student who is holding the book. (= The student is holding the book)

How do we explain ambiguities?

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How do we explain ambiguities?

Lexical Ambiguities

(1) John is sitting near the **bank**.

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Structural Ambiguities

(2) Lucy will hit the student with the book

a. Meaning 1: Lucy will hit the student. She'll do so with the book. (= **The hitting is done with the book**)

b. Meaning 2: Lucy will hit the student who is holding the book. (= **The student is holding the book**)

Ambiguities in Perception

Perception:
Input= physical signal **Output** = **TWO** meanings

Ambiguities
Structural Ambiguities

(2) Lucy will hit the student with the book

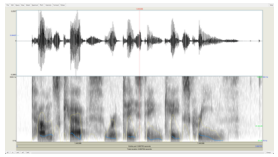
a. **Meaning 1**: Lucy will hit the student. She'll do so with the book. (= **The hitting is done with the book**)

b. **Meaning 2**: Lucy will hit the student who is holding the book. (= **The student is holding the book**)

Explanation

- The sentences in question can be given **two distinct syntactic trees.**
- The meaning (if there is one) is calculated on the basis of the syntactic tree
- Each tree correspond to a meaning

Explanation



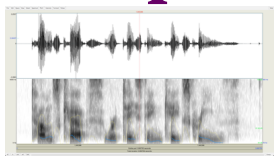
PHONETIC
PHONOLOGY
MORPHOLOGY

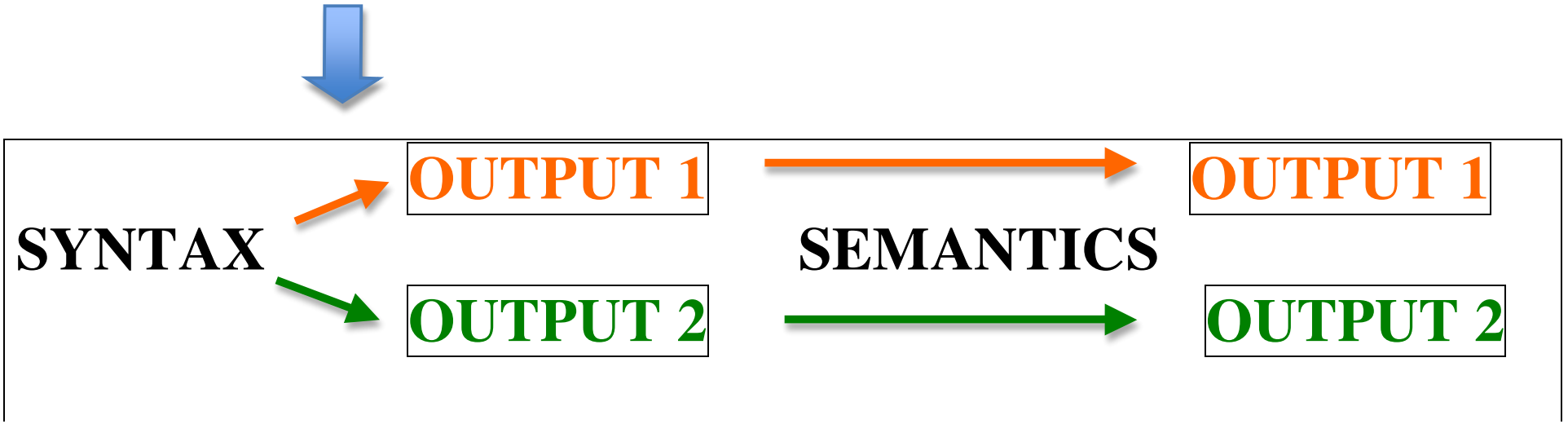
SYNTAX

SEMANTICS

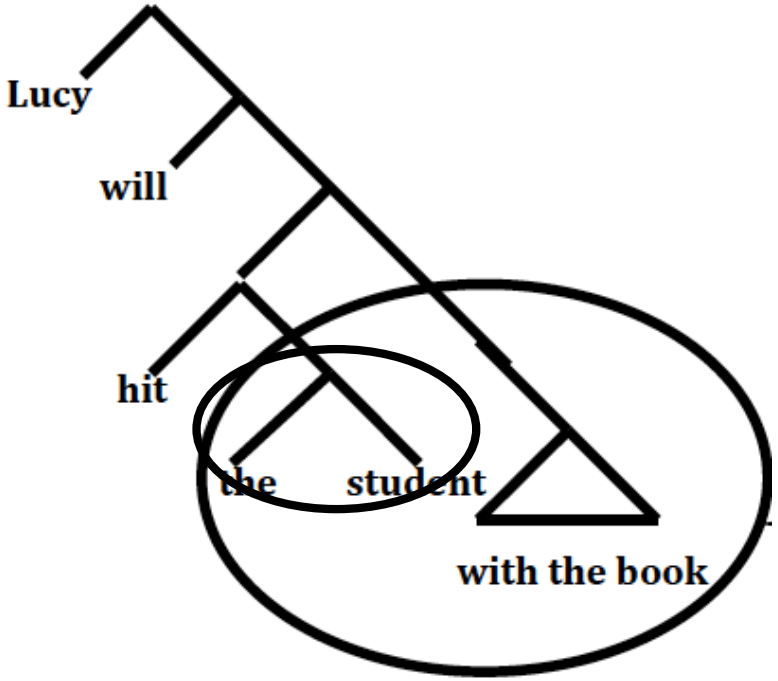
GRAMMAR OF AN ENGLISH SPEAKER

Explanation

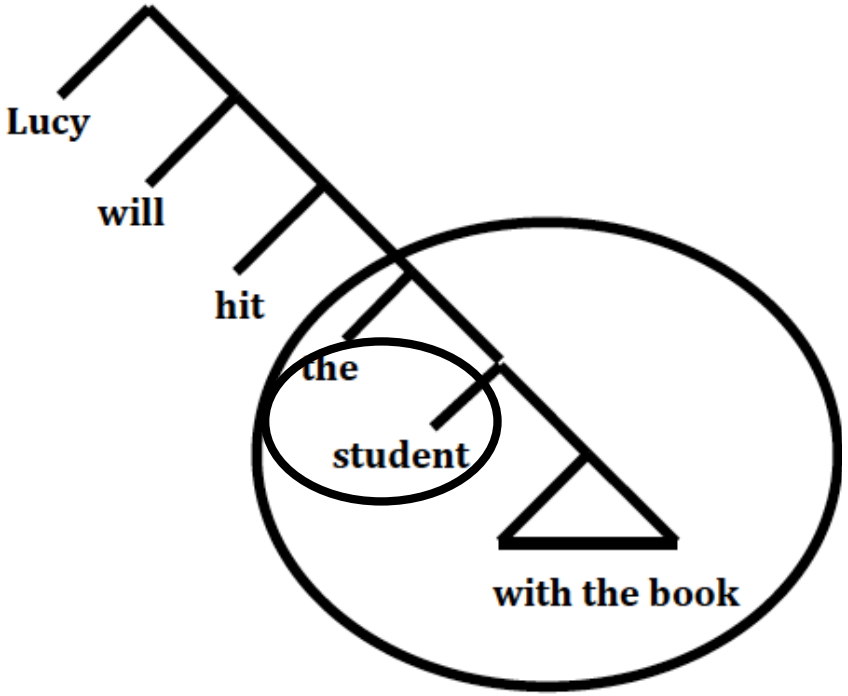




TWO TREES → TWO MEANINGS



Meaning 1: The hitting is done with the book.



Meaning 2: The student is holding the book.

Can we show this is indeed the case?

How can we show it?

Disambiguating an Ambiguous Sentence

AMBIGUOUS:

Lucy will hit **the student with the book.**

The student with the book, Lucy will hit

STILL AMBIGUOUS? ?

WHAT MEANING?

Disambiguating an Ambiguous Sentence

AMBIGUOUS:

Lucy will hit **the student with the book.**

The student with the book, Lucy will hit

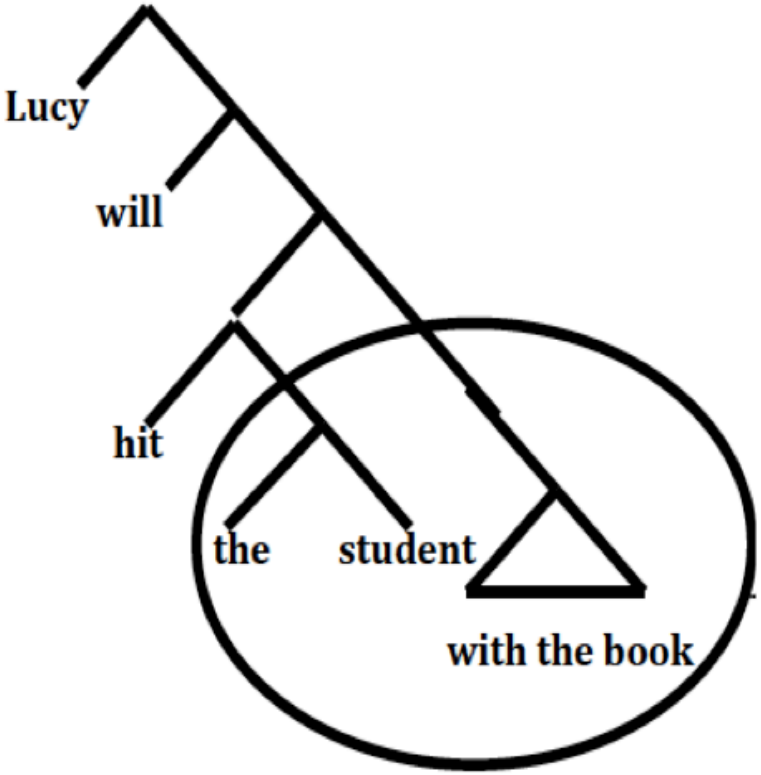
STILL AMBIGUOUS? ?

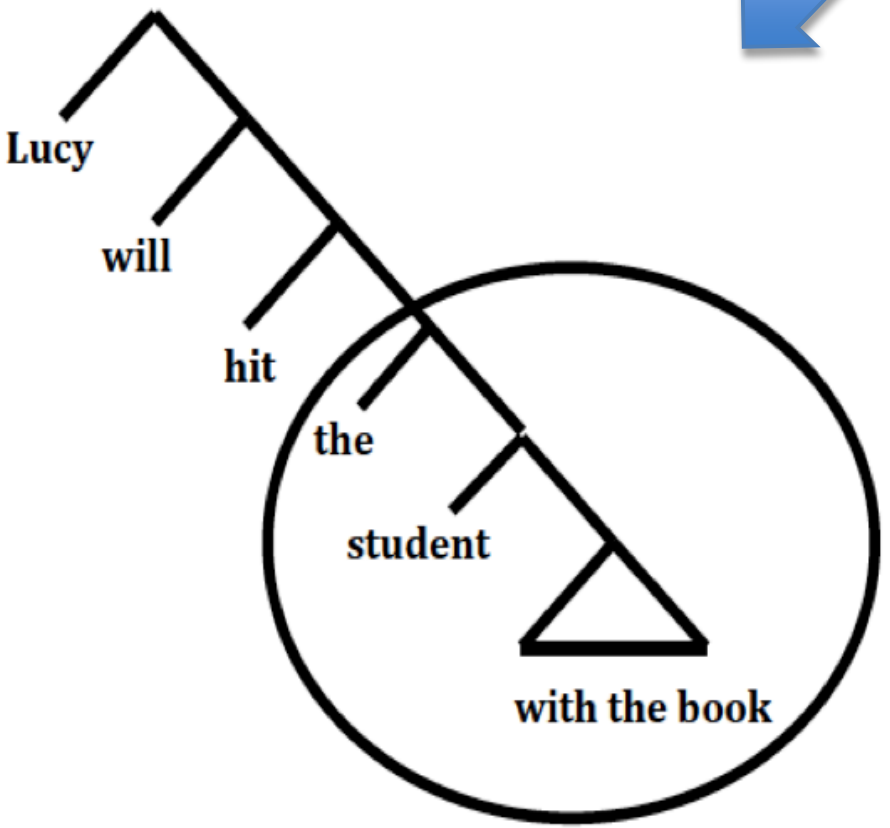
WHAT MEANING?

THE STUDENT IS WITH THE BOOK

THE STUDENT HAS A BOOK

WHICH STRUCTURE?





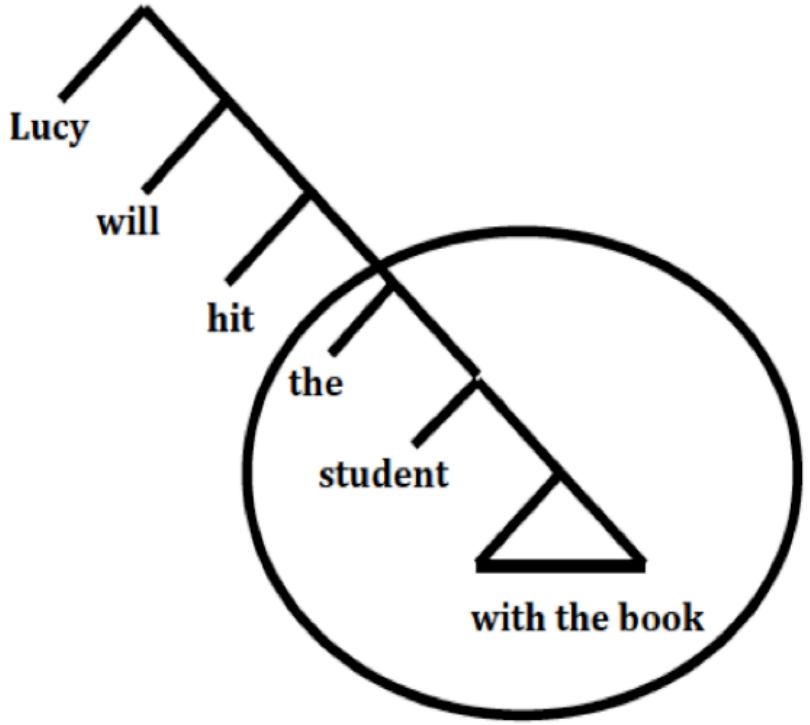
THE STUDENT WITH A BOOK IS A CONSTITUENT

MUST BE THIS ONE

WHICH STRUCTURE: CONCLUSION?

In the meaning associated with this structure, the student is with the book

Notice how with the book forms a constituent with the student.



Disambiguating an Ambiguous Sentence

AMBIGUOUS:

Lucy will hit **the student with the book.**

What can we do to get the other meaning only?

Disambiguating an Ambiguous Sentence

AMBIGUOUS:

Lucy will hit **the student with the book.**

Lucy will hit **HIM** with the book

STILL AMBIGUOUS? ?

WHAT MEANING?

Disambiguating an Ambiguous Sentence

AMBIGUOUS:

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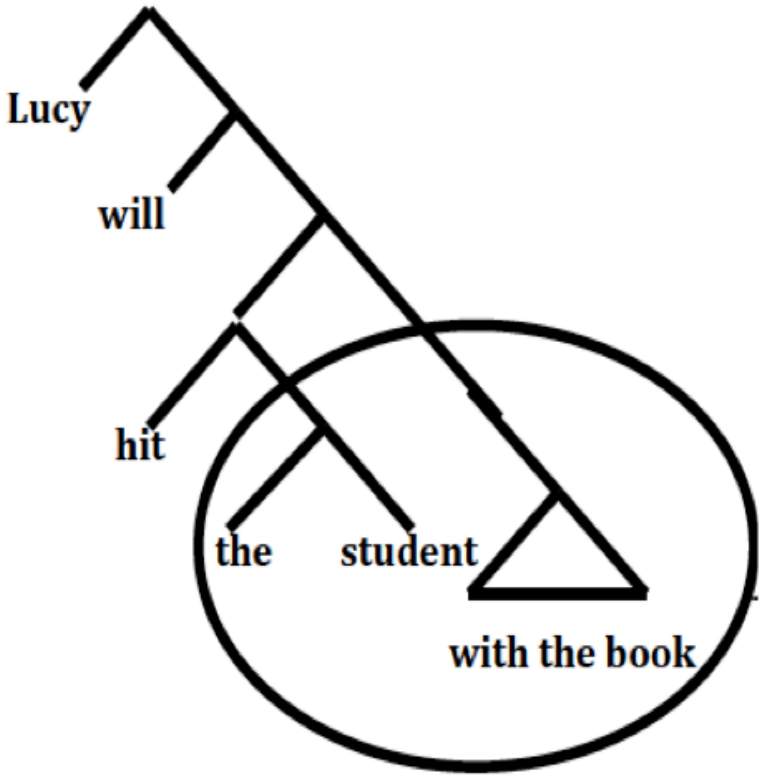
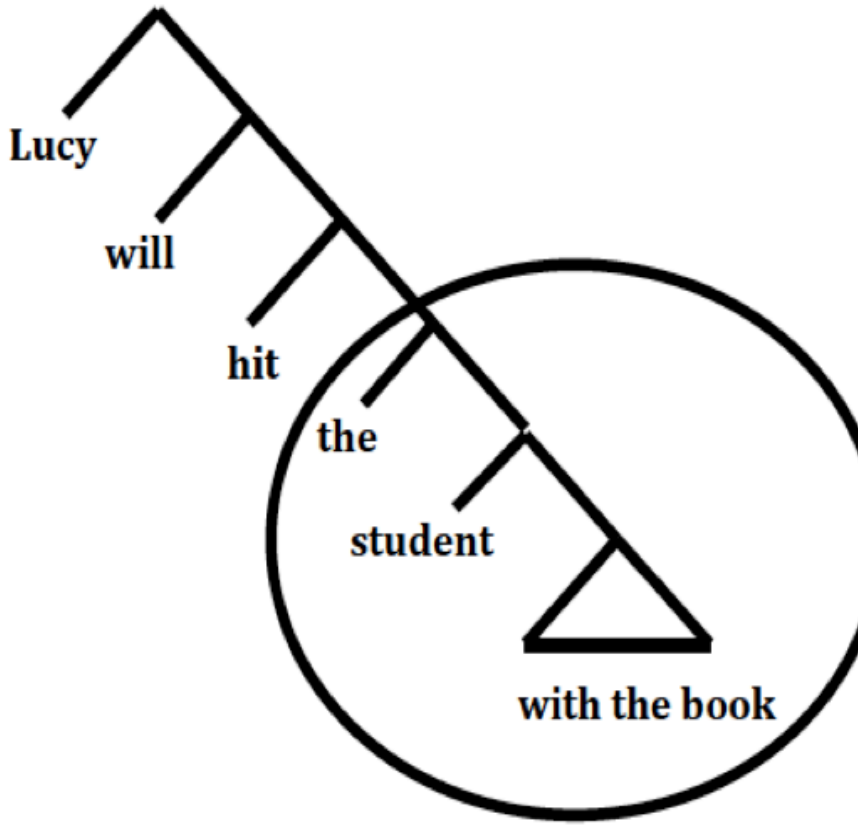
STILL AMBIGUOUS? ?

WHAT MEANING?

THE HITTING IS WITH THE BOOK

WHICH STRUCTURE?





THE STUDENT IS A CONSTITUENT

MUST BE THIS ONE..

Disambiguating an Ambiguous Sentence

AMBIGUOUS:

Lucy will hit **the student with the book.**

Hit the student, Lucy will with the book

STILL AMBIGUOUS? ?

WHAT MEANING?

Disambiguating an Ambiguous Sentence

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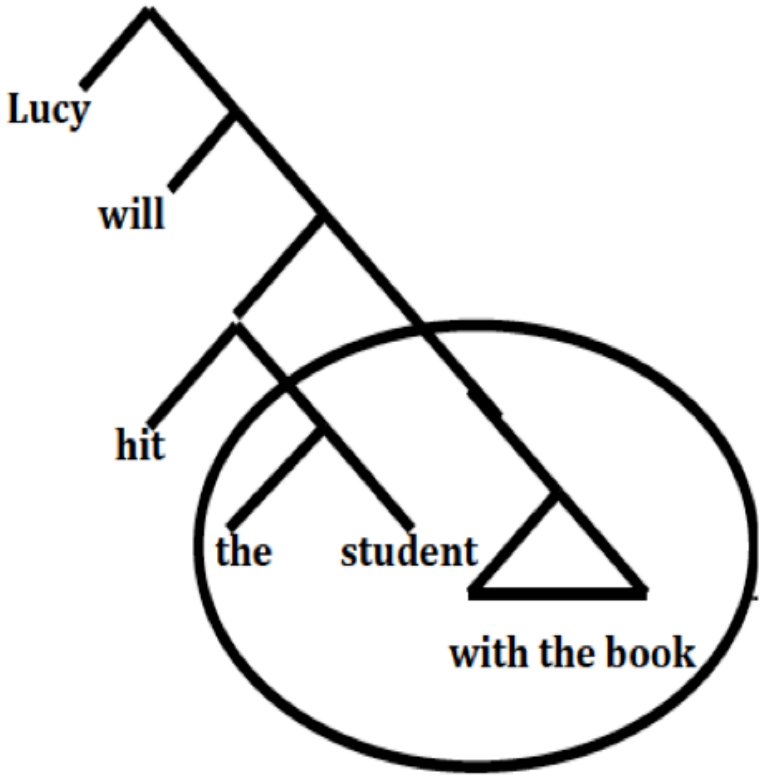
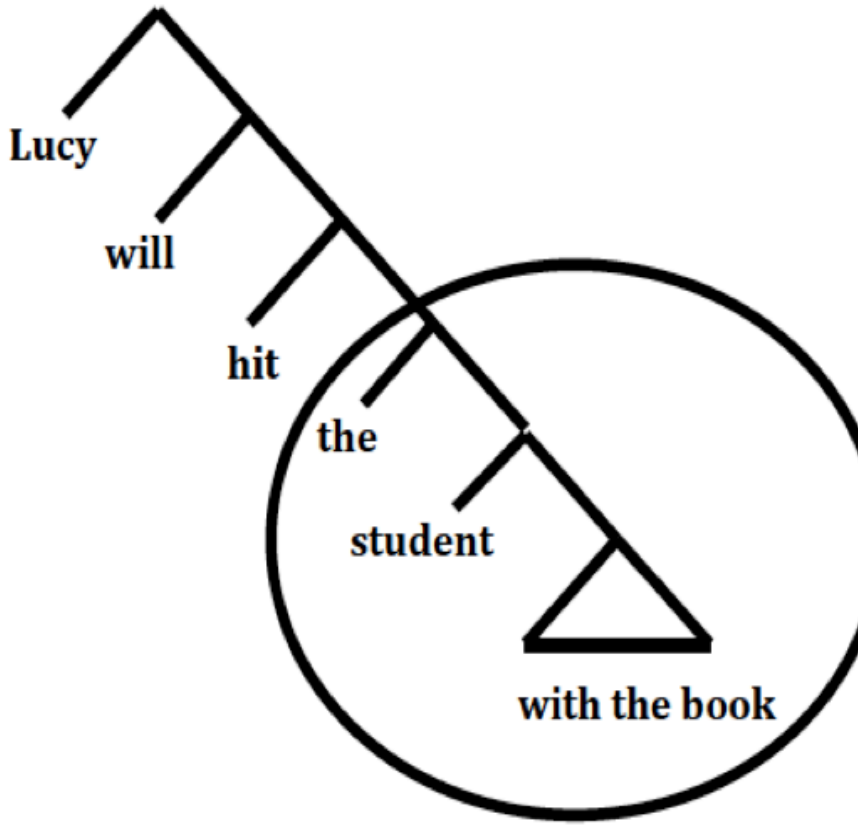
WHICH STRUCTURE?

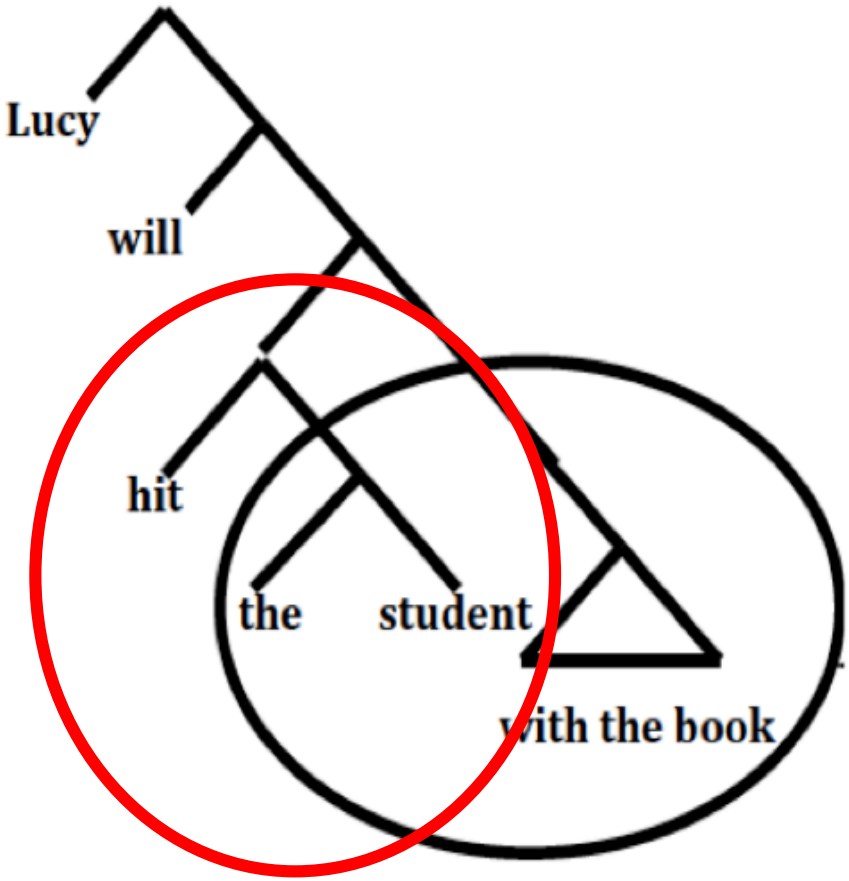




HIT THE STUDENT IS A CONSTITUENT

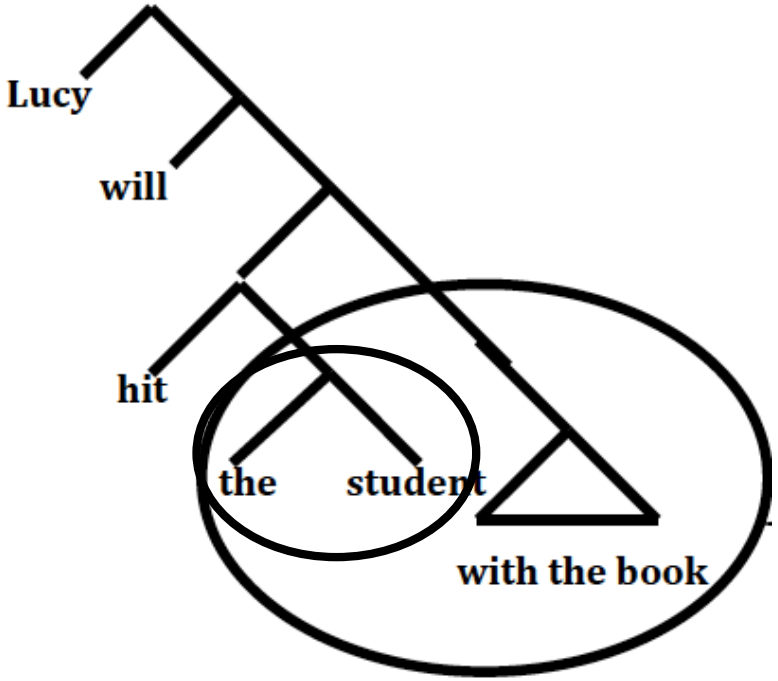
MUST BE THIS ONE!!

WHICH STRUCTURE? CONCLUSION

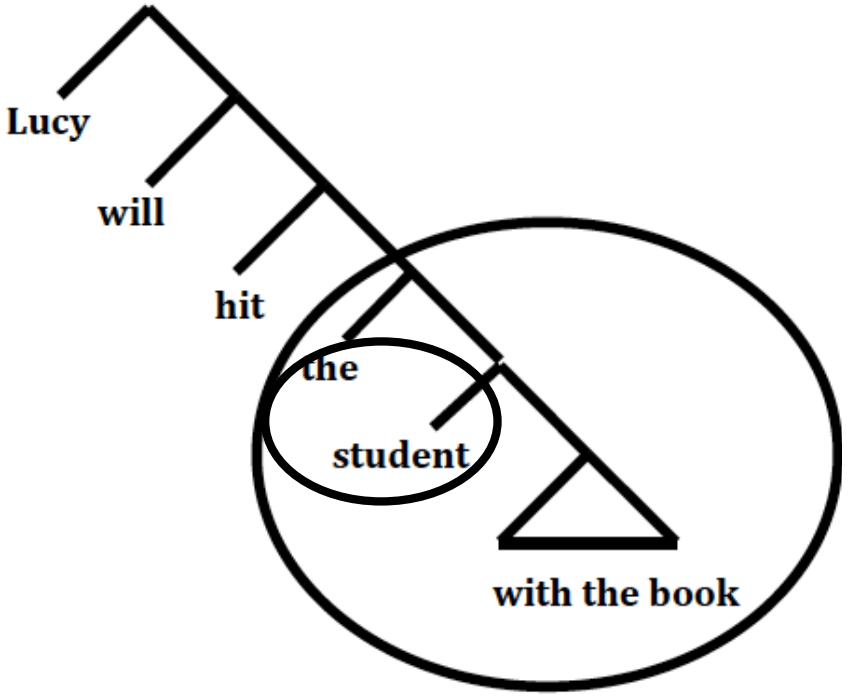


In the meaning associated with this structure, hitting the student is with the book

Notice how with the book forms a constituent with hit the student.



Meaning 1: The hitting is done with the book.



Meaning 2: The student is holding the book.

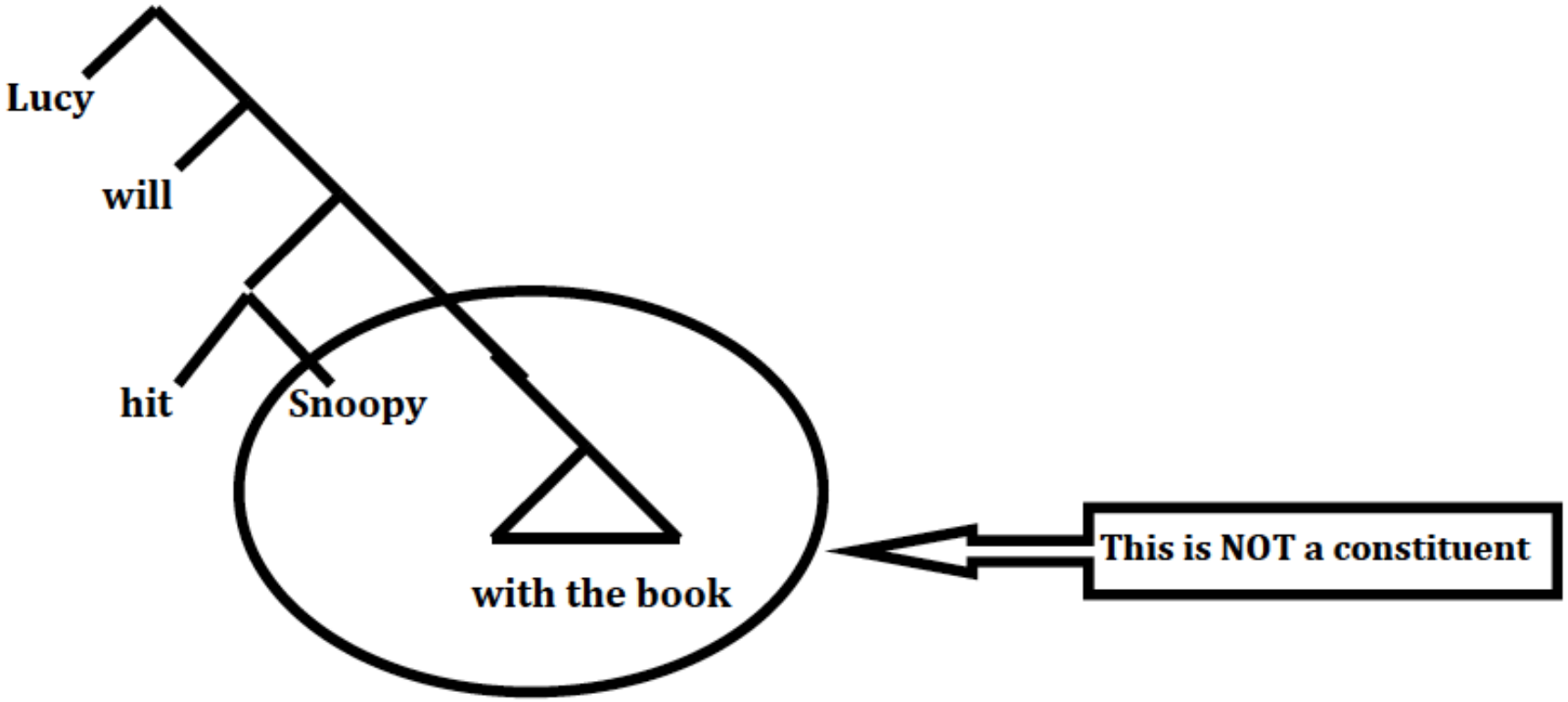
This is what we have demonstrated.

Testing With Unambiguous Sentences

(1) Lucy will hit Snoopy with the book.

Unambiguous Sentences

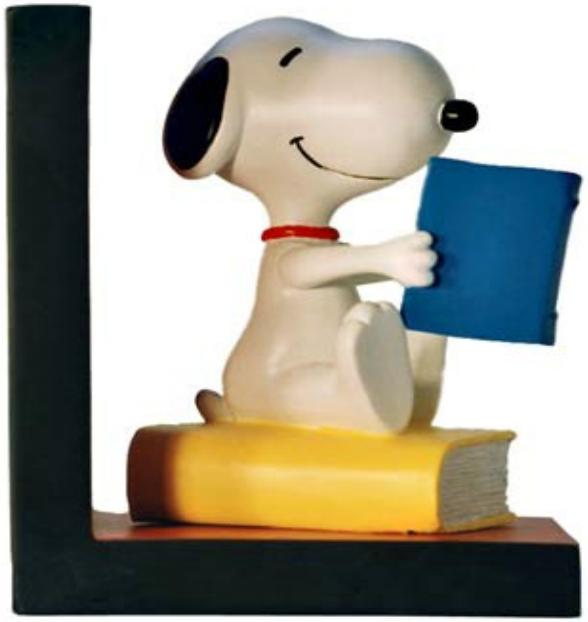
(1) a. Lucy will hit Snoopy with the book.
b. *Snoopy with the book, Lucy will hit.
c. Lucy will hit him → (wrong meaning)
c. Hit Snoopy with the book Mary will.

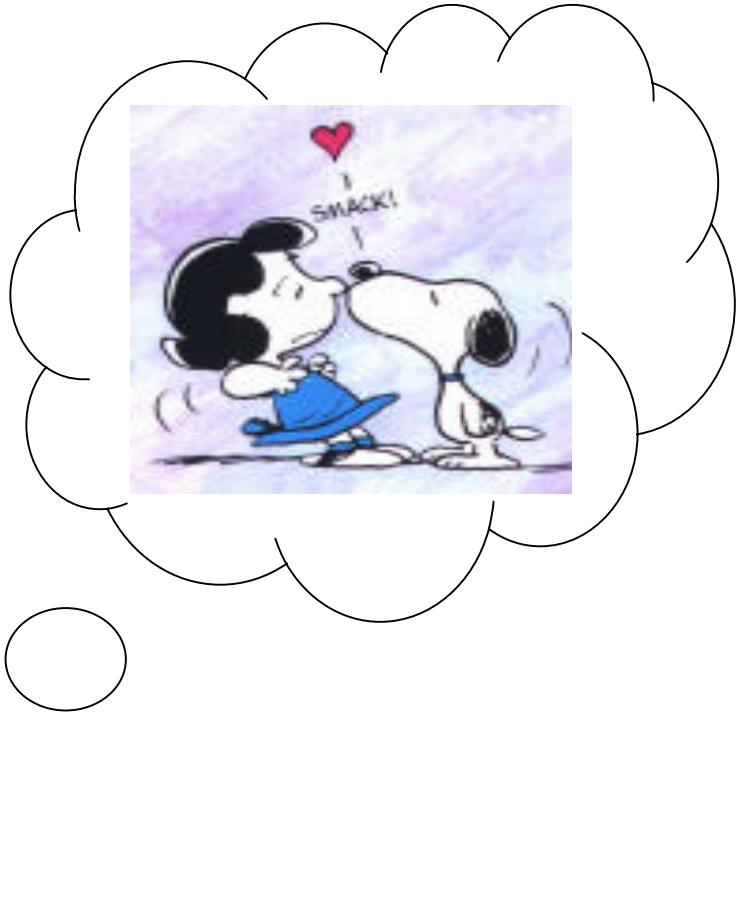


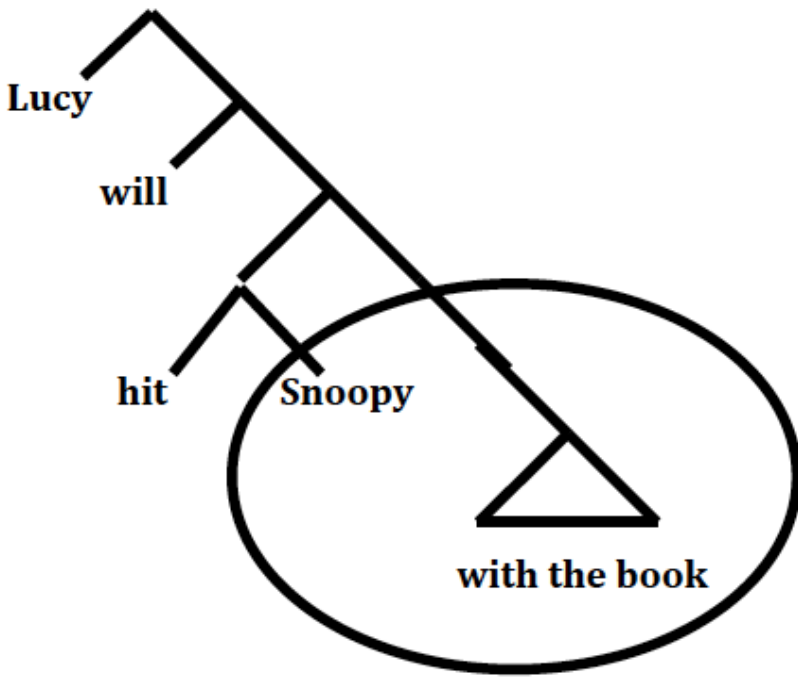
The hitting is done with the book!

Unambiguous Sentences

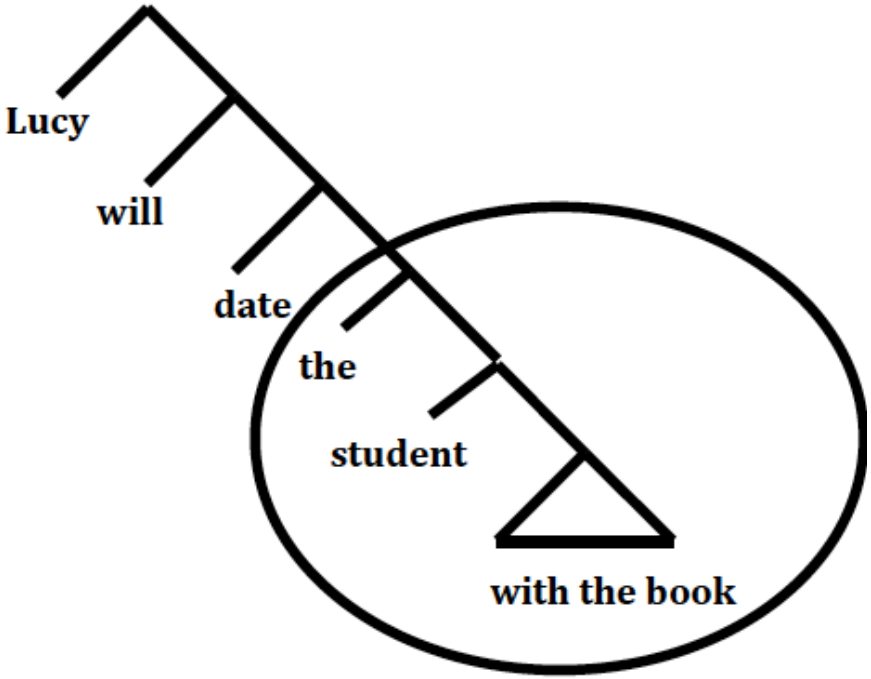
(2) Lucy will date the student with the book.







The hitting is done with the book.



The student is holding the book.

Constituency Tests

1. If a group of words can **stand alone as an answer to a question**, they form a constituent.

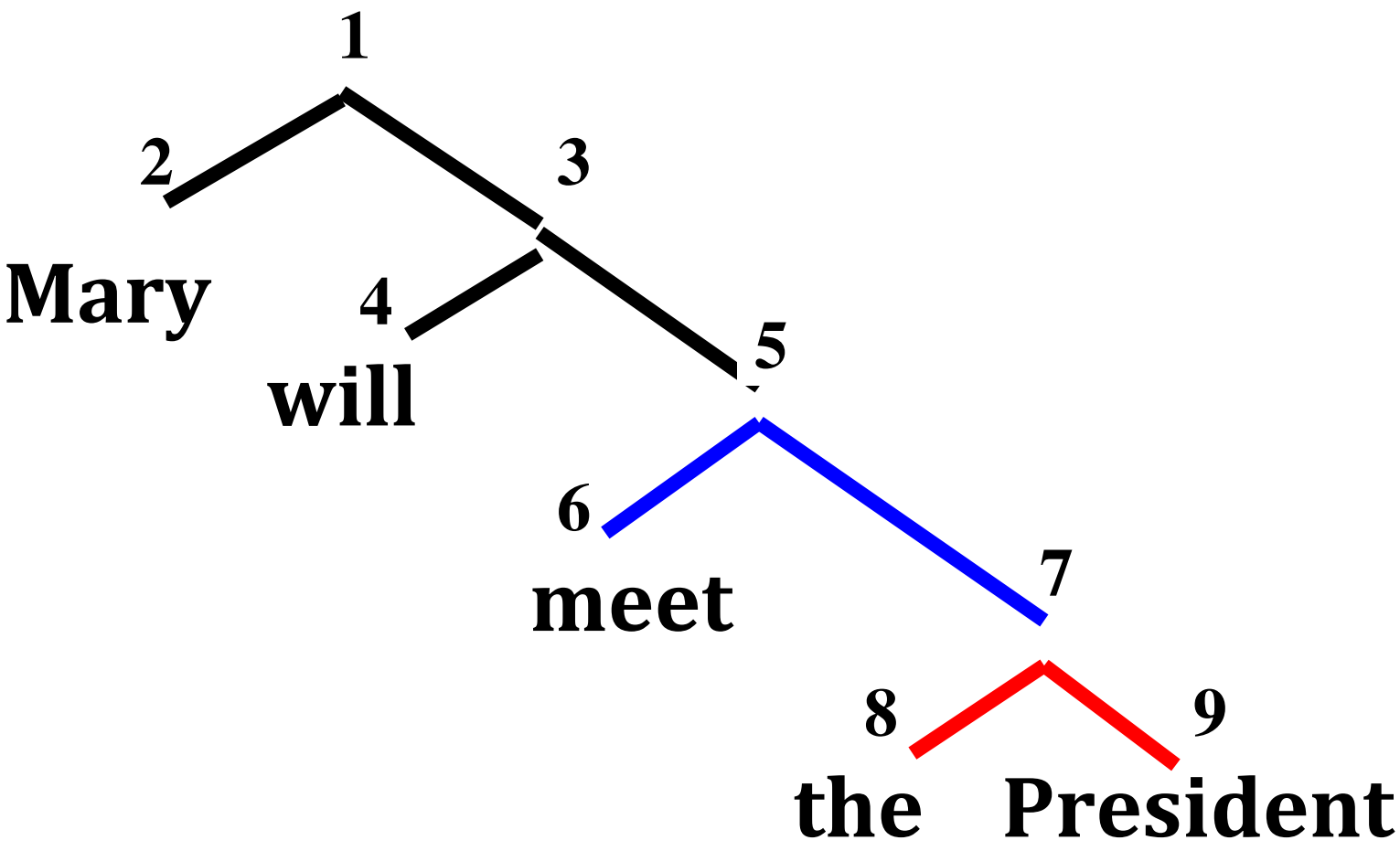
2. If a group of words can **be moved as a unit**, they form a constituent

3. If a group of words can **be replaced by a pronoun**, they form a constituent.

Important Note:
A group of words may fail a test even though it is a constituent.

Talking About Trees

- **root**, **node**, terminal nodes
- **mother**, **daughter**, **sister**
+ **containment** [= **domination**]



Roadmap

1. The object of study, why and how do we study it? Reverse engineering problem
2. We know rules..
3. What counts is abstract hierarchical structure (not linear order)
   - (example 1: yes no question formation) Point: poverty of the stimulus and language acquisition
4. Inside the black box: Words form constituents
   - concrete illustration: (a few) constituency tests.
5. Structure encodes meaning.
   Probing structural ambiguity. $\rightarrow$ structure encodes meaning: different meanings imply different structure.
   point: constituent structure encodes meaning (iwhich is build up compositionally)

Roadmap *continued*

1. The recipe for structure building: how to form phrases?
   - finite state grammar? (*problems..*)
   - phrase structure grammar? (*yes, more like it*), but plus movement, and beyond:
   - X-bar theory? *good for parameters*(head, complement, subject/specifier)
   - The head parameter and word order parameters. Greenberg's (1966 Universals) and exploration on Terraling.
2. How heads and phrases get around: Movement (with exploration in Terraling)
   - question formation 2 (and parameter) yes no questions: structure *and head* movement.
3. Structure and referential dependencies (needed for Baker chapter 4))

LINGUISTIC RULES DEPEND ON STRUCTURE

Question formation
Subject verb agreement

Condition C (he, John)

Parameters

A Puzzle explained: Question Formation

John is in the garden →
Is John __ in the garden ?

A unicorn is in the garden →
Is a unicorn __ in the garden ?

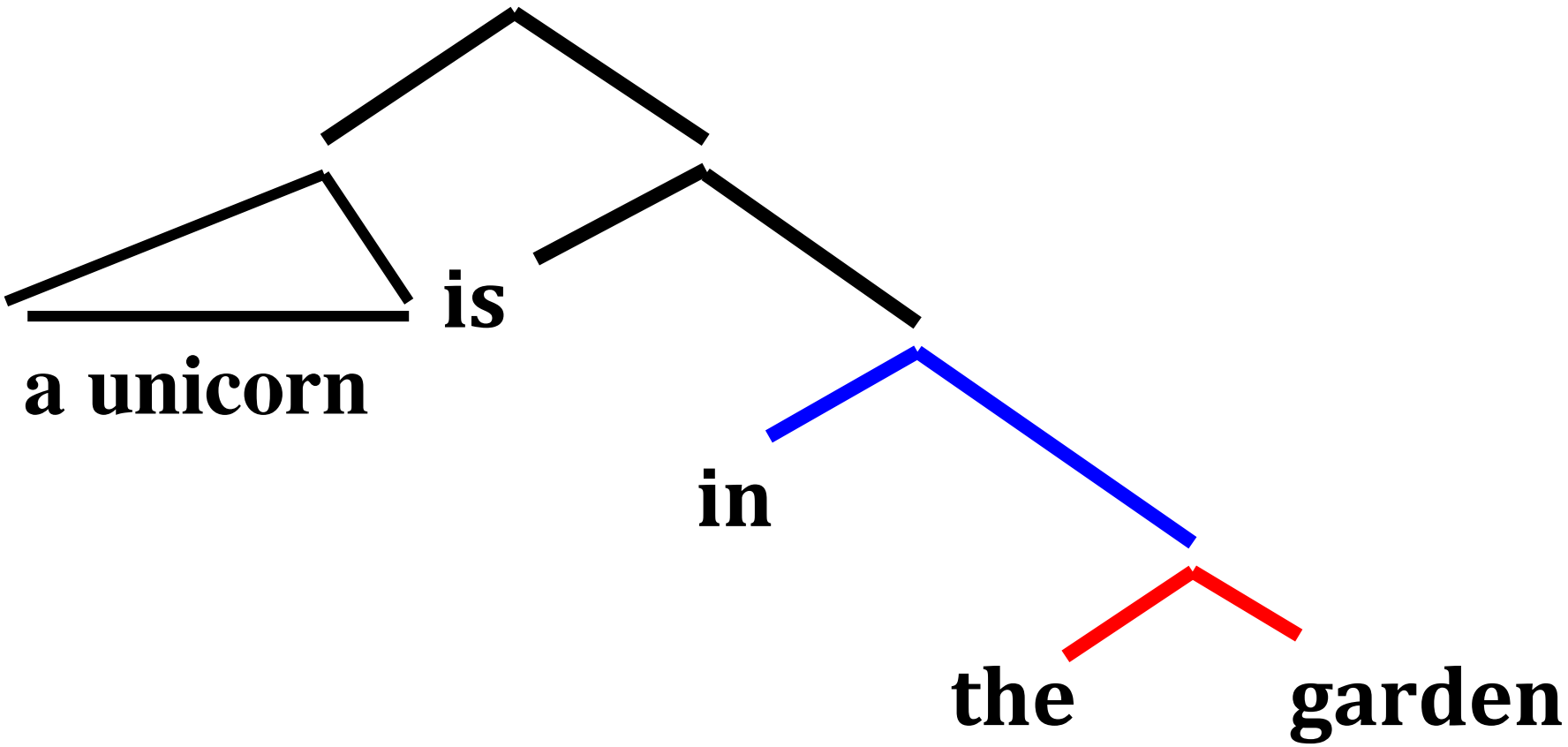
A unicorn that is eating a flower is in the garden →
Is a unicorn that __ eating a flower is in the garden ?

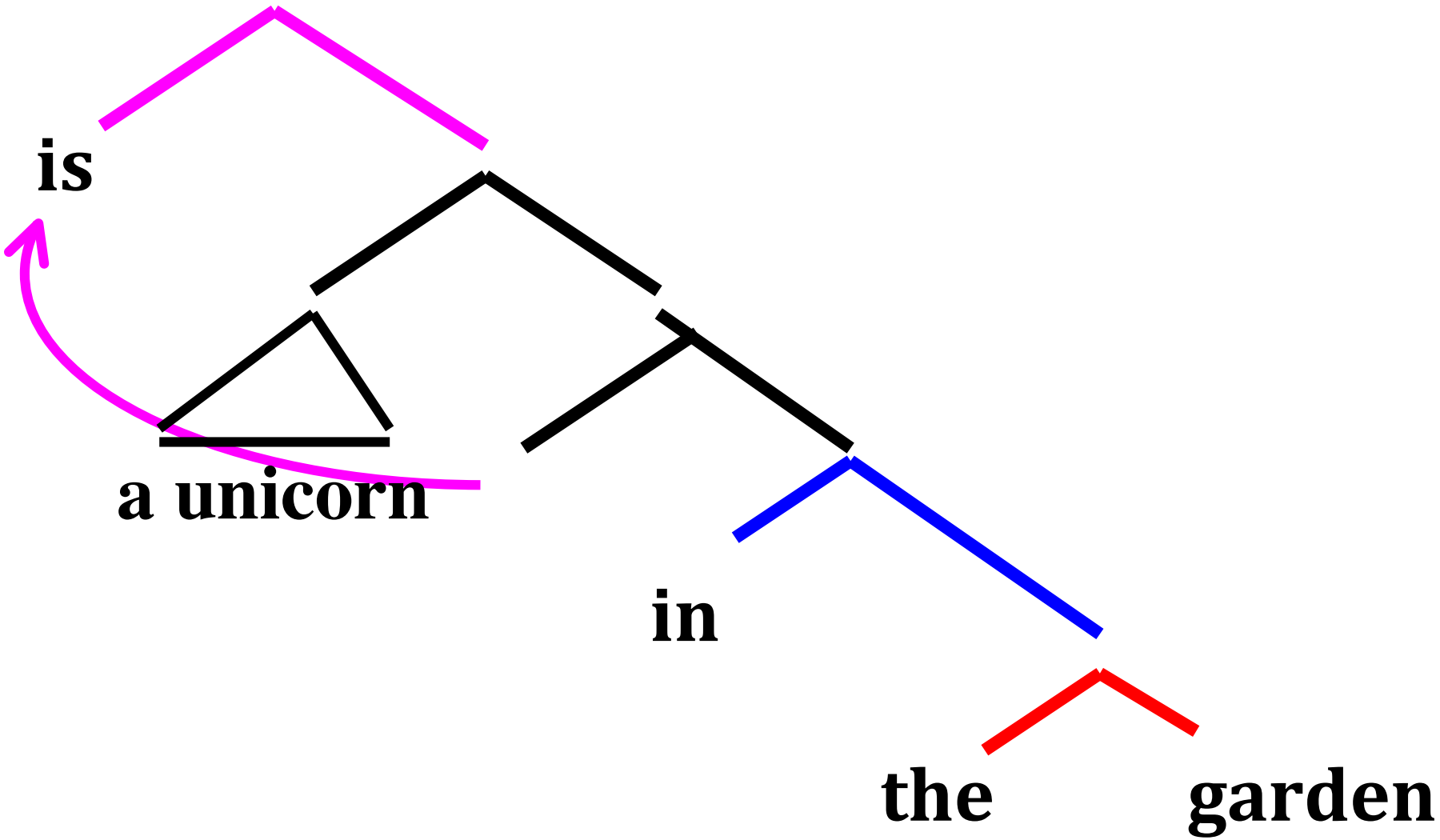
?

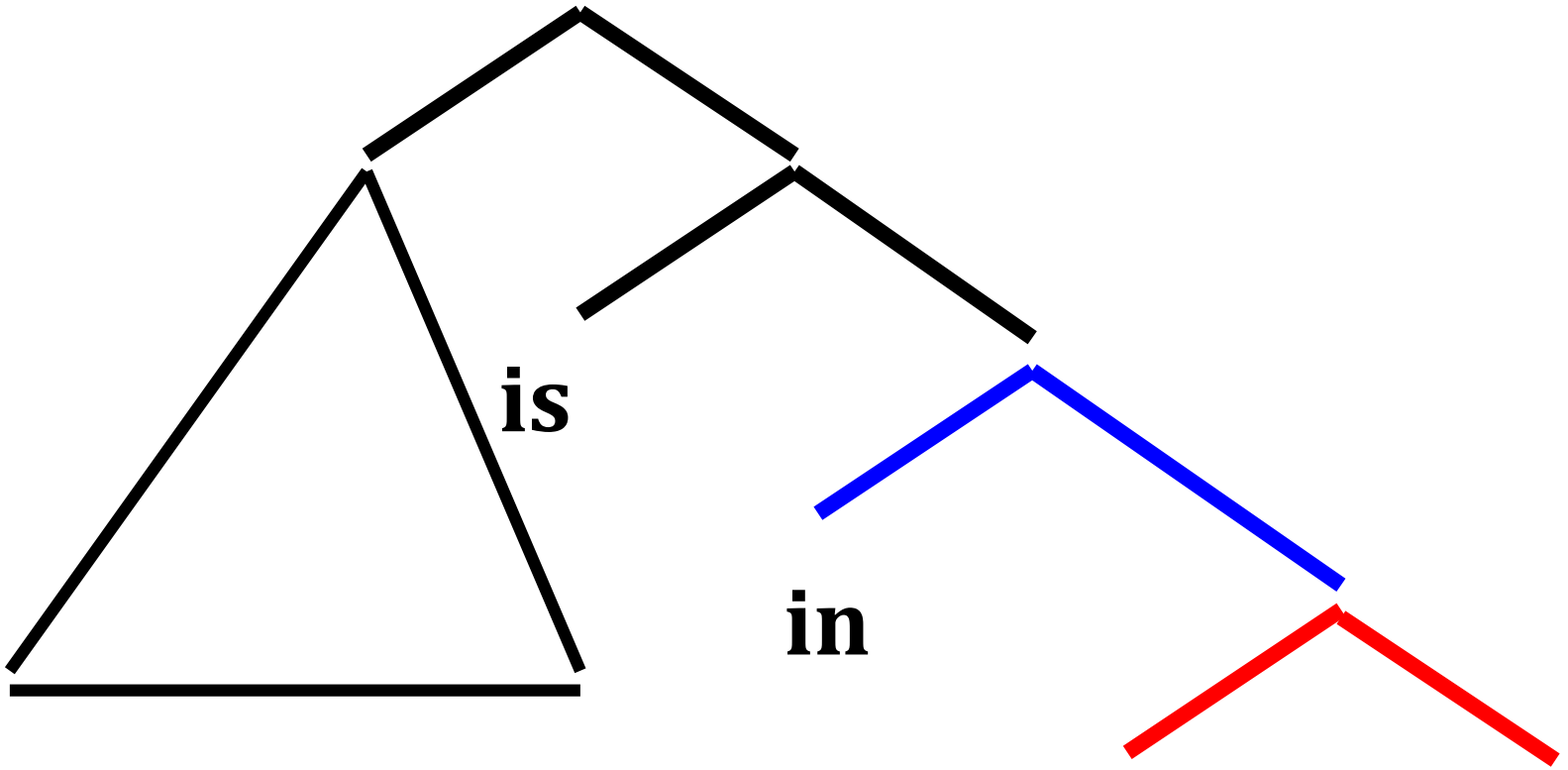
?

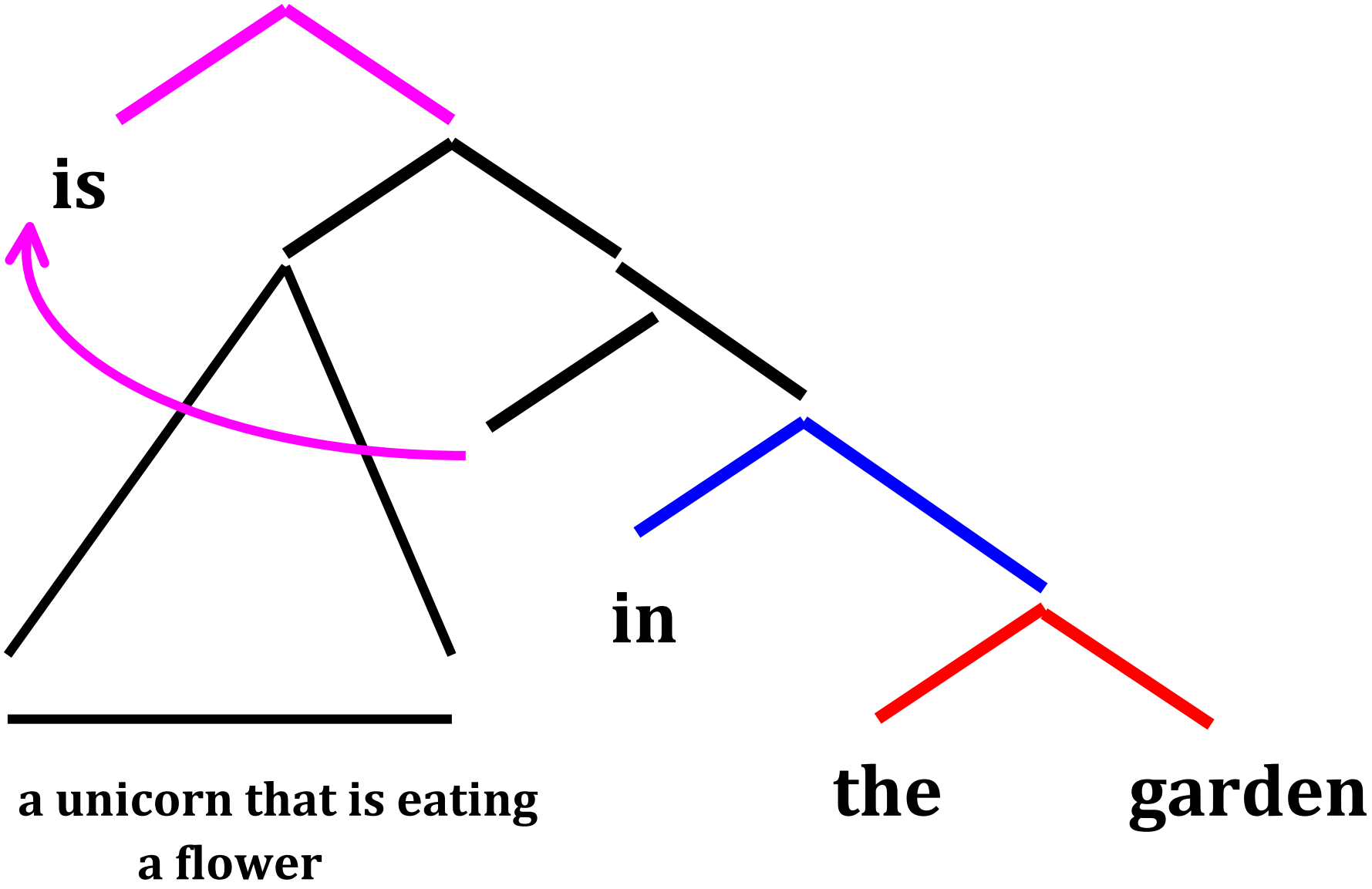
A unicorn that is eating a flower is in the garden →
Is a unicorn that is eating a flower __ in the garden ?

'First *is*' or 'second *is*' are not the right notions. Rules of grammar depend on **structure** NOT on linear order.


a unicorn
is
in
the
garden


is
a unicorn
in
the
garden


is
in
a unicorn that is eating
a flower
the
garden


is
in
a unicorn that is eating
a flower
the
garden

Question Formation

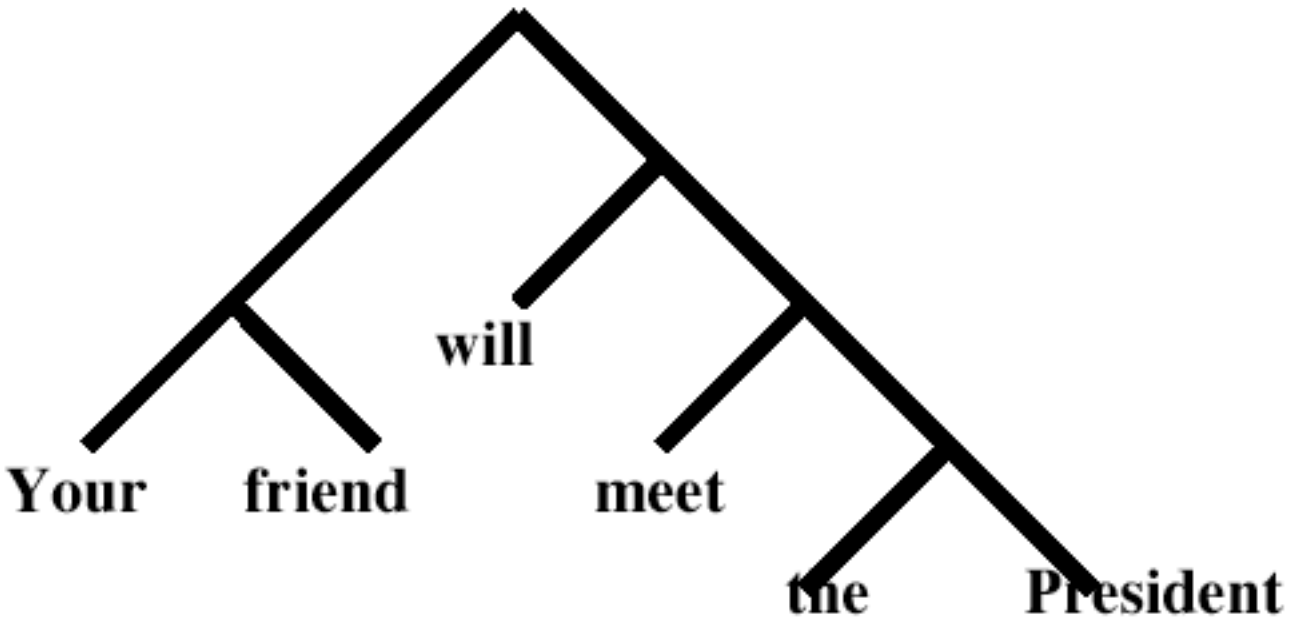
- a. A unicorn that is eating a flower is in the garden
  b. *Is a unicorn that __ eating a flower is in the garden?
  c. Is a unicorn that is eating a flower __ in the garden?

- **... move the last *is*?**

- a. John is in the garden next to someone who is asleep.
  b. Is John __ in the garden next to someone who is asleep?
- c. *Is John is in the garden right next to someone who __ asleep?
- **... move the first *is*?**

Where do Trees come from?

General Idea: Trees encode **the way in which sentences are built.** Two elements form a constituent if they have been introduced by the **same rule**.


will
Your
friend
meet
the
President

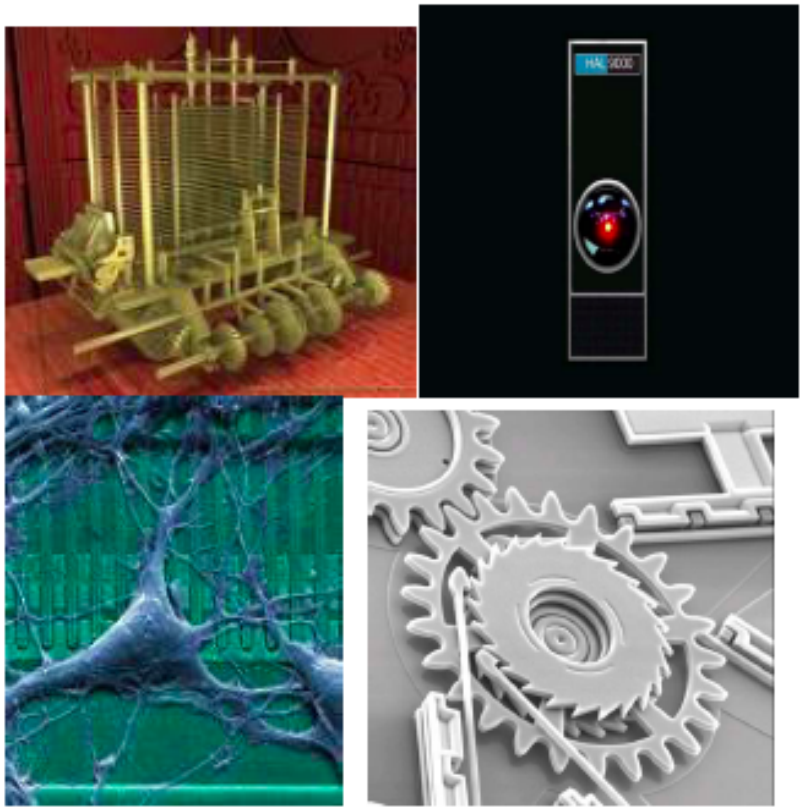
(From) Phrase structure rules

via X-bar theory
to

Bare Phrase structure
(Chomsky 1995, 2008)
(Merge two syntactic objects)
Label

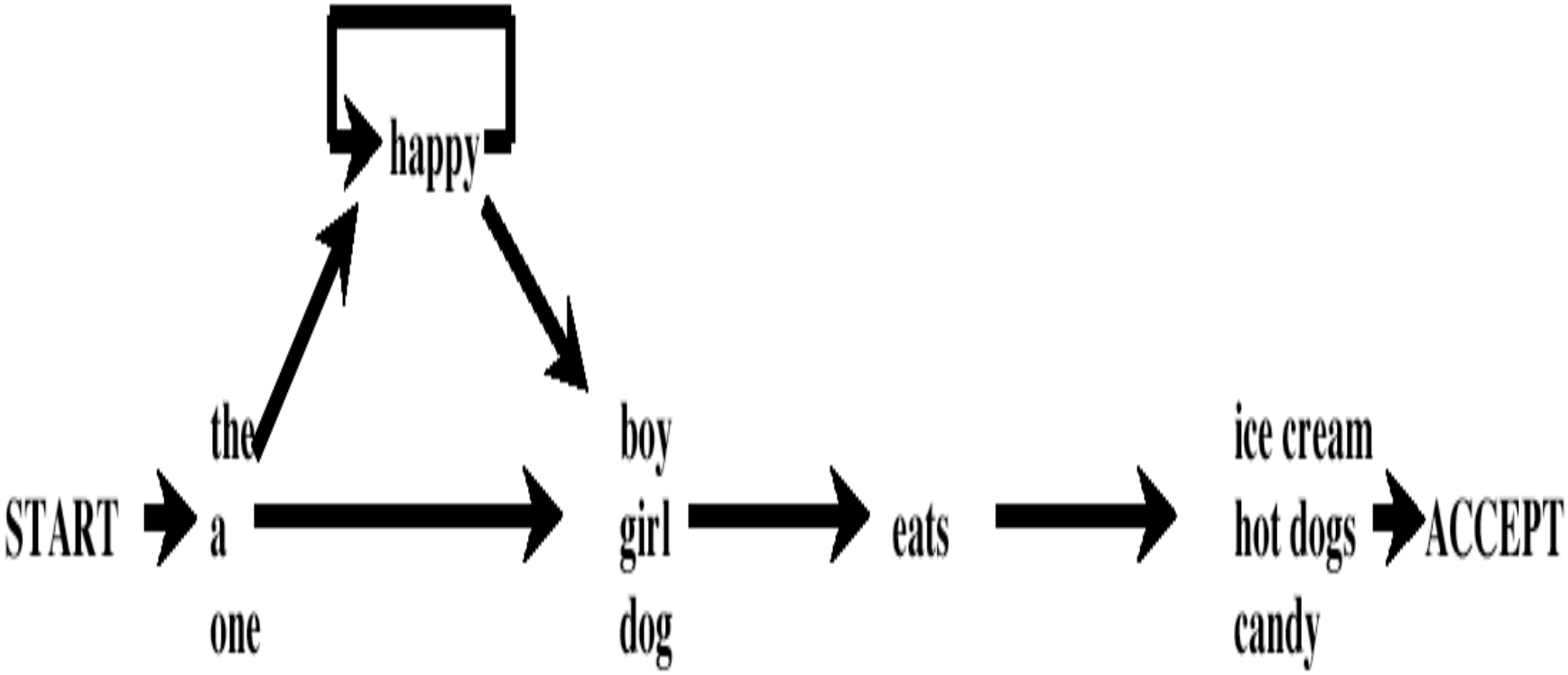
Computational Aspect of Language

What kind of rules? Which type(s) of computational system can generate natural language? How powerful does it need to be to accomplish these tasks?
Which languages can human brain recognize/learn?



Natural Language: Finite State Model?

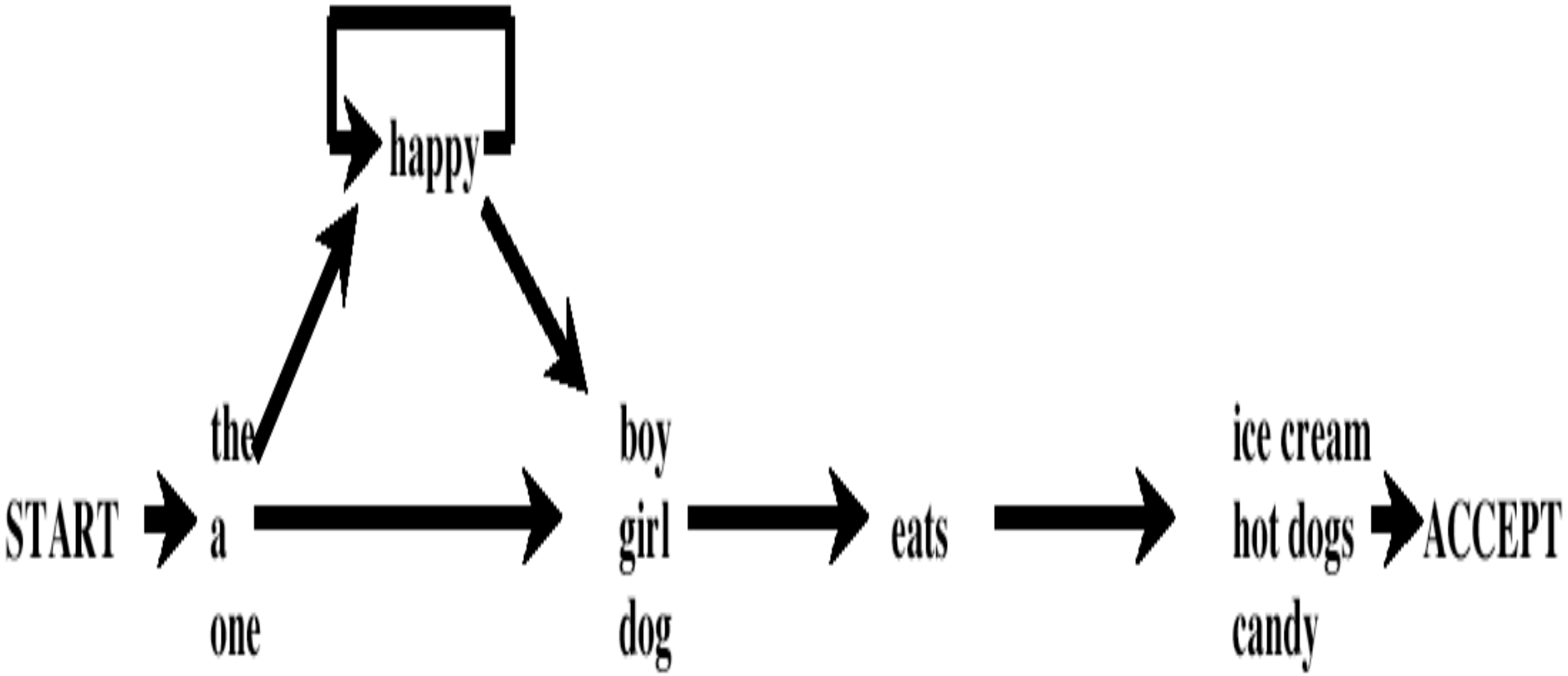
(= word chain device, Markov Model)



- **Grammatical sentences that are generated:**

  a. the boy eats ice cream
  b. the happy boy eats ice cream
  c. the happy happy boy eats hot dogs
  d. a happy happy girl eats candy

Natural Language: Finite State Model?



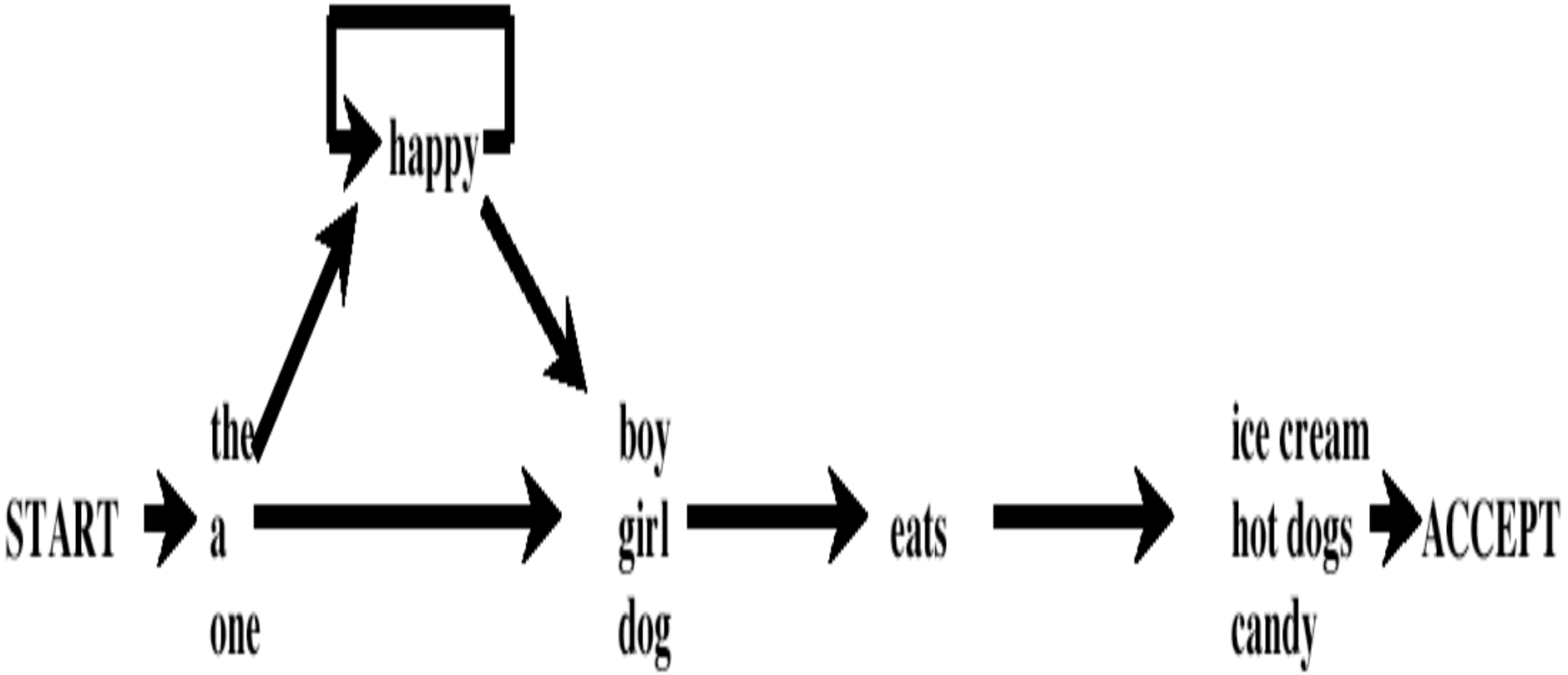
- **Ungrammatical sentences that are not generated:**

  a. *boy the eats ice cream

  b. *happy boy eats hot dogs

  c. *hot dogs eats the dog

Natural Language: Finite State Model?



- **Grammatical sentences that are not generated (!!!):**
  a. some boy eats ice cream
  b. the dog that the dog eats eats ice cream
  c. either the boy eats ice cream or the girl eats candy

Arguments against the Finite State Model

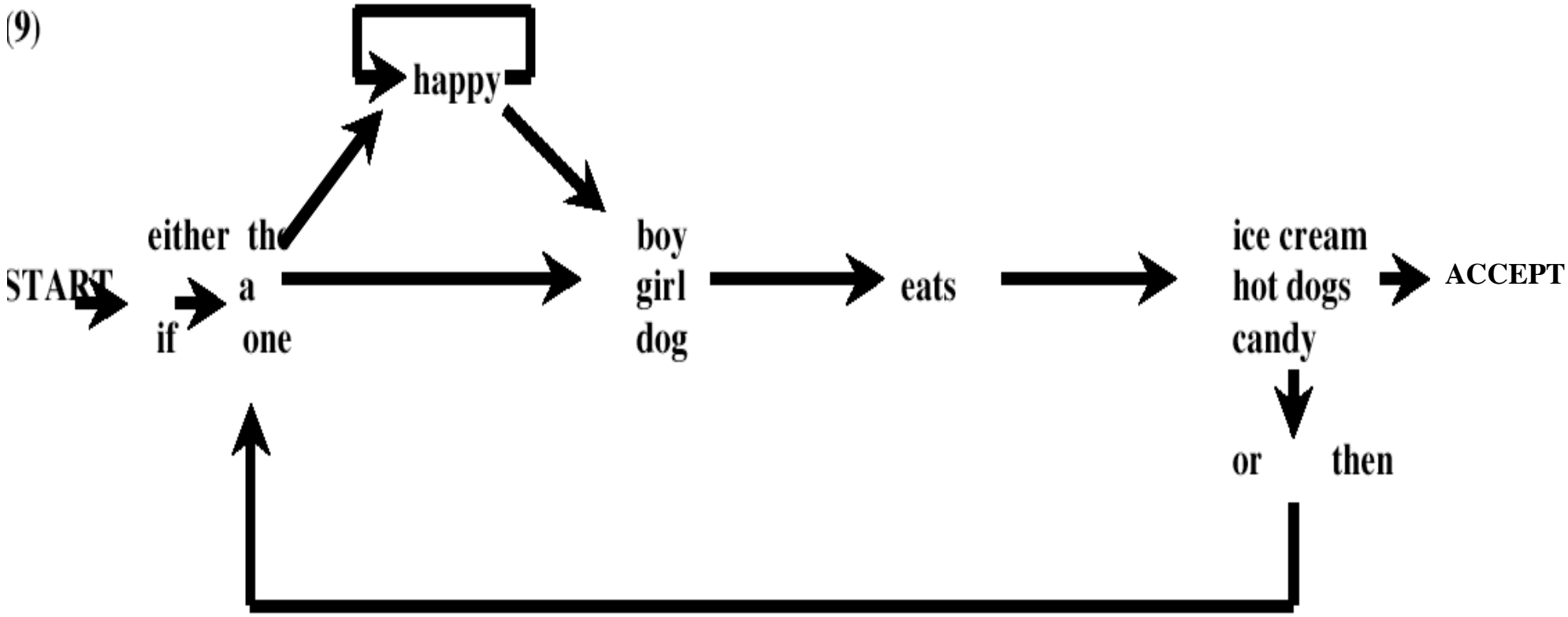
- **Argument 1:** it doesn't account for the **tree-like structure** of sentences

- **Argument 2:** It cannot properly account for **long distance dependencies**, i.e. constructions in which two elements that depend on each other are separated by an arbitrary number of words.

- Example of a long distance dependency: **either ... or...**

a. **Either** John is sick **or** he is depressed
b. Either John thinks that he is sick or he is depressed
c. **Either** Mary knows that Johns thinks that he is sick **or** she is depressed
d. Either the boy eats hot dog or the dog eats hot dog
e. Either the happy happy boy eats hot dog or the dog eats

Arguments against the Finite State Model

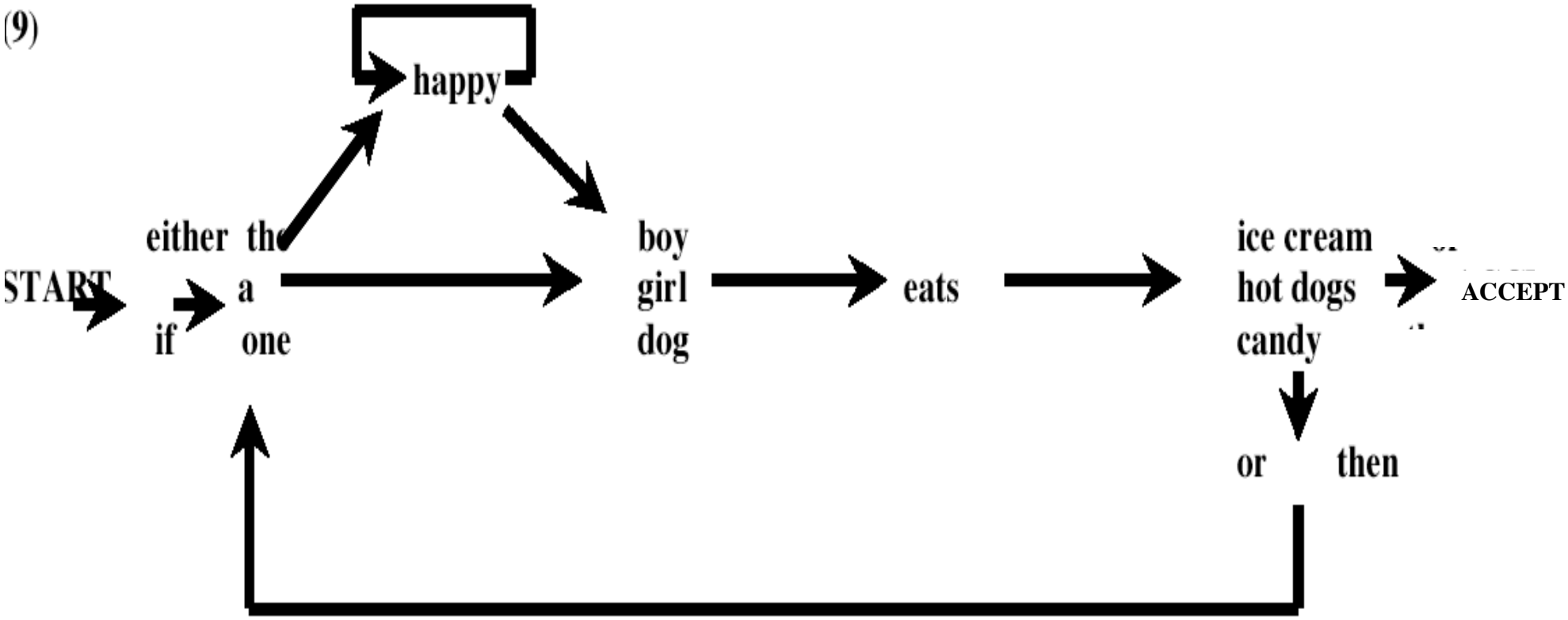


- **Some grammatical sentences generated by (9):**

  a. Either a girl eats candy or a boy eats hot dogs

  b. Either a happy girl eats candy or a boy eats hot dogs

Arguments against the Finite State Model



- **Some ungrammatical sentences generated by (9):**

  a. *Either a girl eats candy

  b. *Either a happy girl eats candy

A Better Model: Phrase Structure Grammars

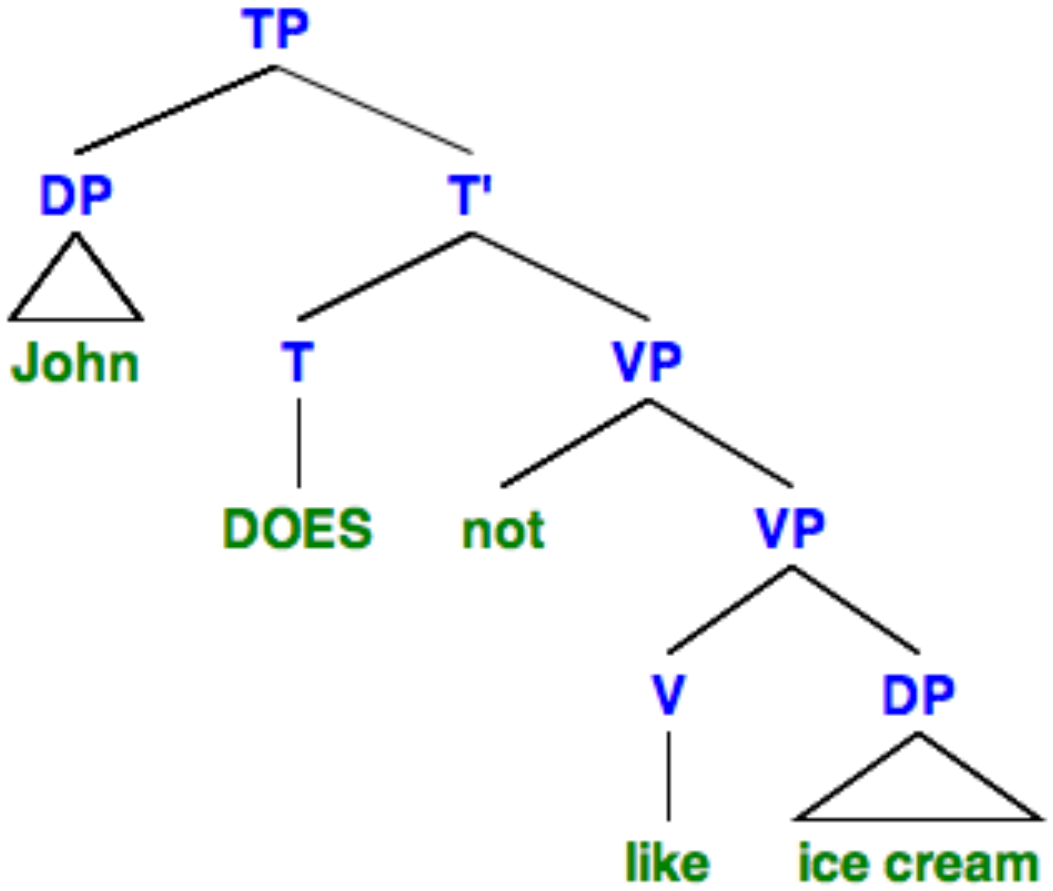
AND MOVEMENT

- **Requirement 1:**
  Account for the **tree-like structure** that sentences have

  Phrase Structure Grammars are based on the **constituency relation**.

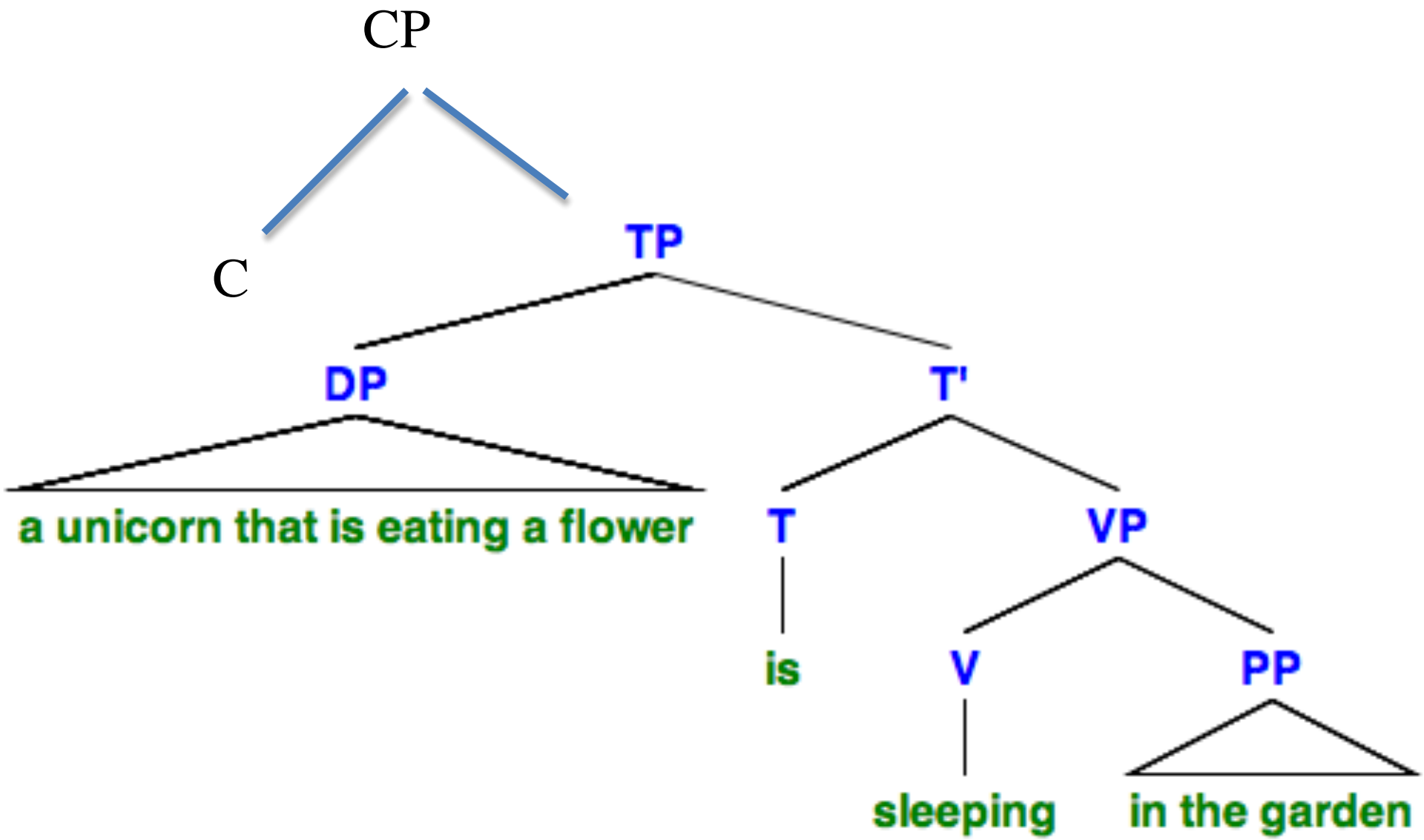
- **Requirement 2:**
  Provide an analysis of **long-distance dependencies**

Subject agreement



Agreement is between **T** and the **subject**

Question formation T moves to C



Question formation: movement?

a. Your friend will meet him
b. Will your friend meet him?

Q formation: moves T constituent (where to?)

c. I wonder [if [your friend will meet him]]
d. I wonder [*if will/ will if] your friend meet him

Language design:
Clause type properties are located at the C level.
Will moves to C, and thus expresses two properties: 1. Of being a (future) T and 2. that of expressing a yes/no question

- **Long distance dependencies**, i.e. constructions in which two elements that depend on each other are separated by an arbitrary number of words.

Example of a long distance dependency: **either ... or...**

a. **Either** John is sick **or** he is depressed
b. Either John thinks that he is sick or he is depressed
c. **Either** Mary knows that Johns thinks that he is sick **or** she is depressed
d. Either the boy eats hot dog or the dog eats hot dog
e. Either the happy happy boy eats hot dog or the dog eats

Phrase Structure Grammar 1: TP

TP → DP T'

A sentence consists of a Determiner Phrase and a T bar

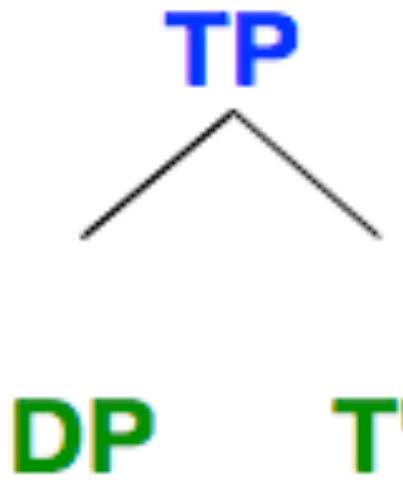
T' → T VP

= a T bar consists of a Tense (=Auxiliary) and Verb Phrase.

T → will, might, can, should, does, did

- a. [John] [will sleep]
  b. [The director] [will sleep]
  c. [Mary] [will [hit John]]
  d. [The director] [will [criticize John]]

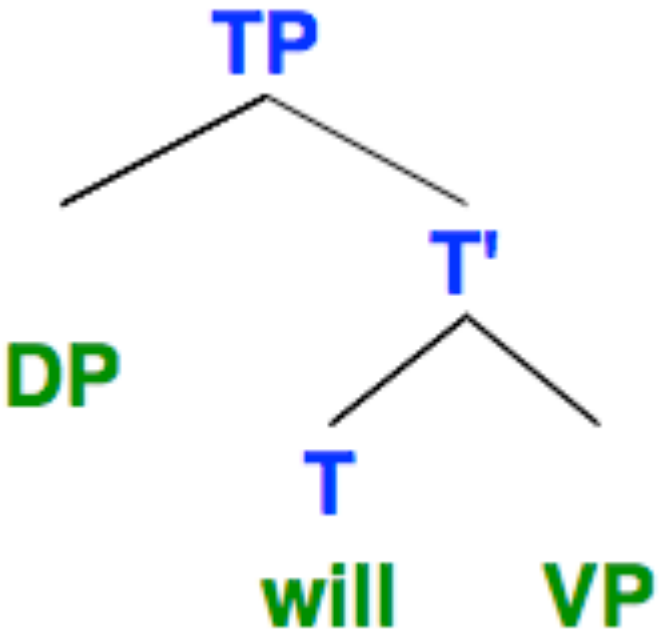
Phrase Structure Grammar 1: TP



TP → DP T'

- a. [John] [will [sleep]]
  b. [The director] [will sleep]
  c. [Mary] [will [hit John]]
  d. [The director] [will [criticize John]]

Phrase Structure Grammar 1: TP



T' → T VP

- a. [John] [will [sleep]]
  b. [The director] [will [sleep]]
  c. [Mary] [will [hit John]]
  d. [The director] [will [criticize John]]

Phrase Structure Grammar 2: **DP**

DP → PN, D N , ..

= a Noun Phrase comprises either

(i) a Proper Name/Pronoun alone, or
(ii) a Determiner and a Noun

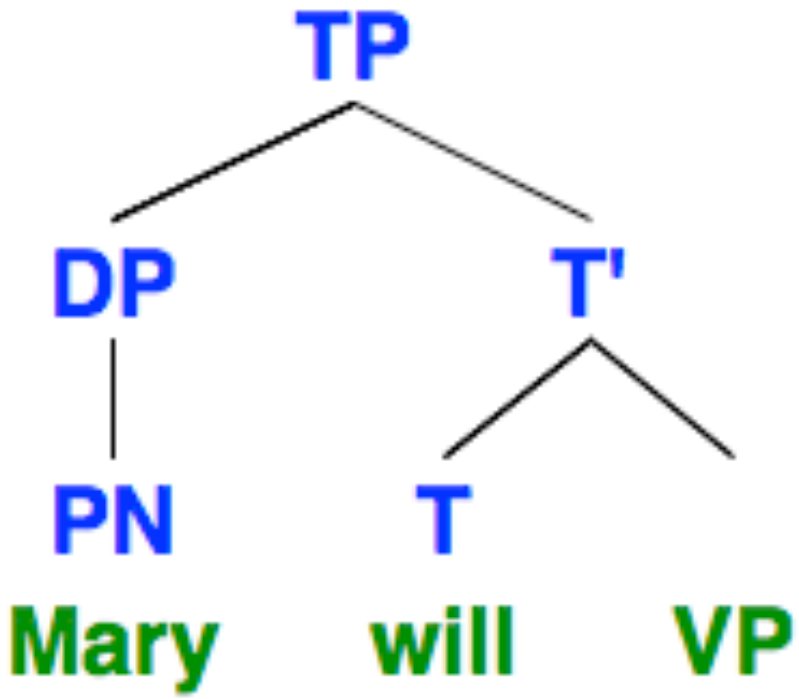
PN → John, Bill, Mary, Sam, he, she...

N → President, director, boy, girl, Dean, friend, mother...

D → the, some, a, every, my, his, her...

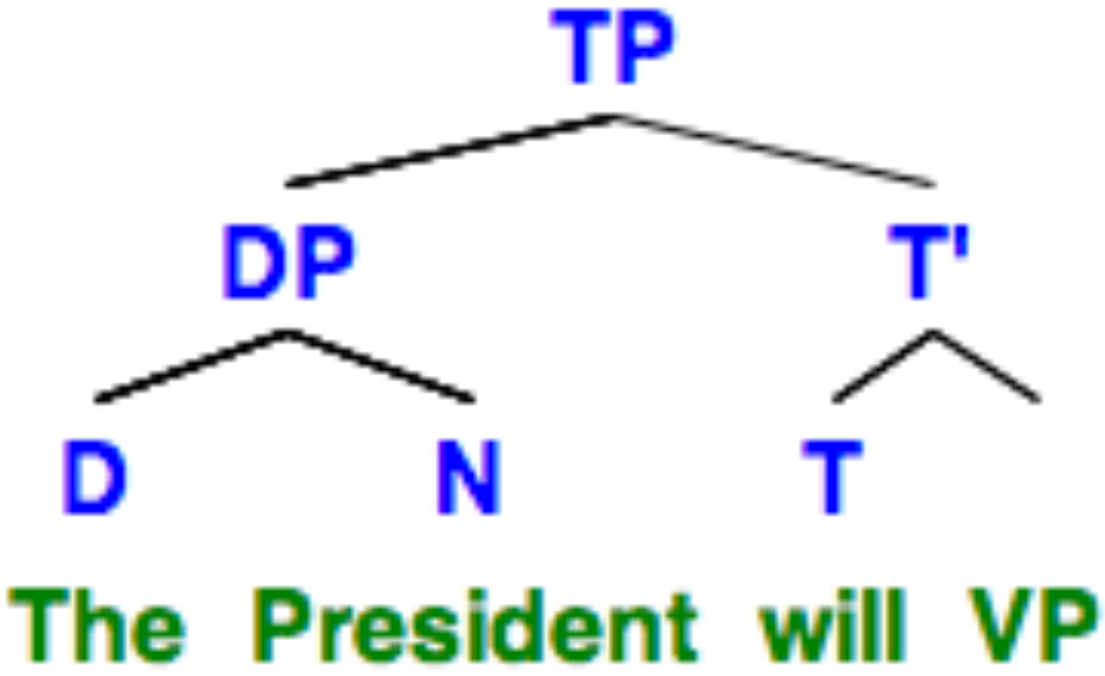
Phrase Structure Grammar 2: DP

DP → PN, D N



Phrase Structure Grammar 2: DP

DP → PN, D N



Phrase Structure Grammar 3: **VP**

$VP \rightarrow V_i, V_t\ DP, V_s\ CP$

= a Verb Phrase comprises either

(i) an intransitive verb alone, or
(ii) a transitive verb followed by a Noun Phrase, or
(iii) a verb of speech/thought followed by Complementizer Phrase

$V_i \rightarrow$ sleep, run, snore, fall...
$V_t \rightarrow$ meet, date, hit, kill, criticize...
$V_s \rightarrow$ think, say, believe, claim...

Phrase Structure Grammar 3: **VP**

$VP \rightarrow V_i$

(i) an intransitive verb alone, or

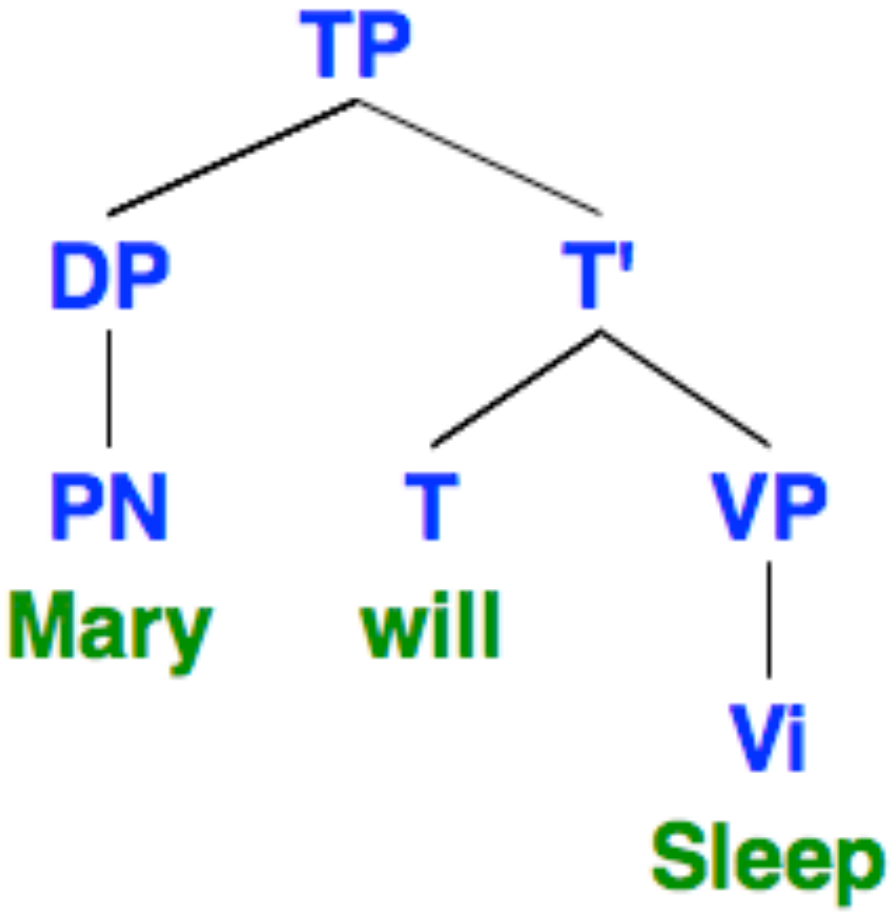
$VP \rightarrow V_t\ DP$

(ii) a transitive verb followed by a Noun Phrase, or

$VP \rightarrow V_s\ CP$

(iii) a verb of speech/thought followed by Complementizer Phrase

Phrase Structure Grammar 3: **VP**

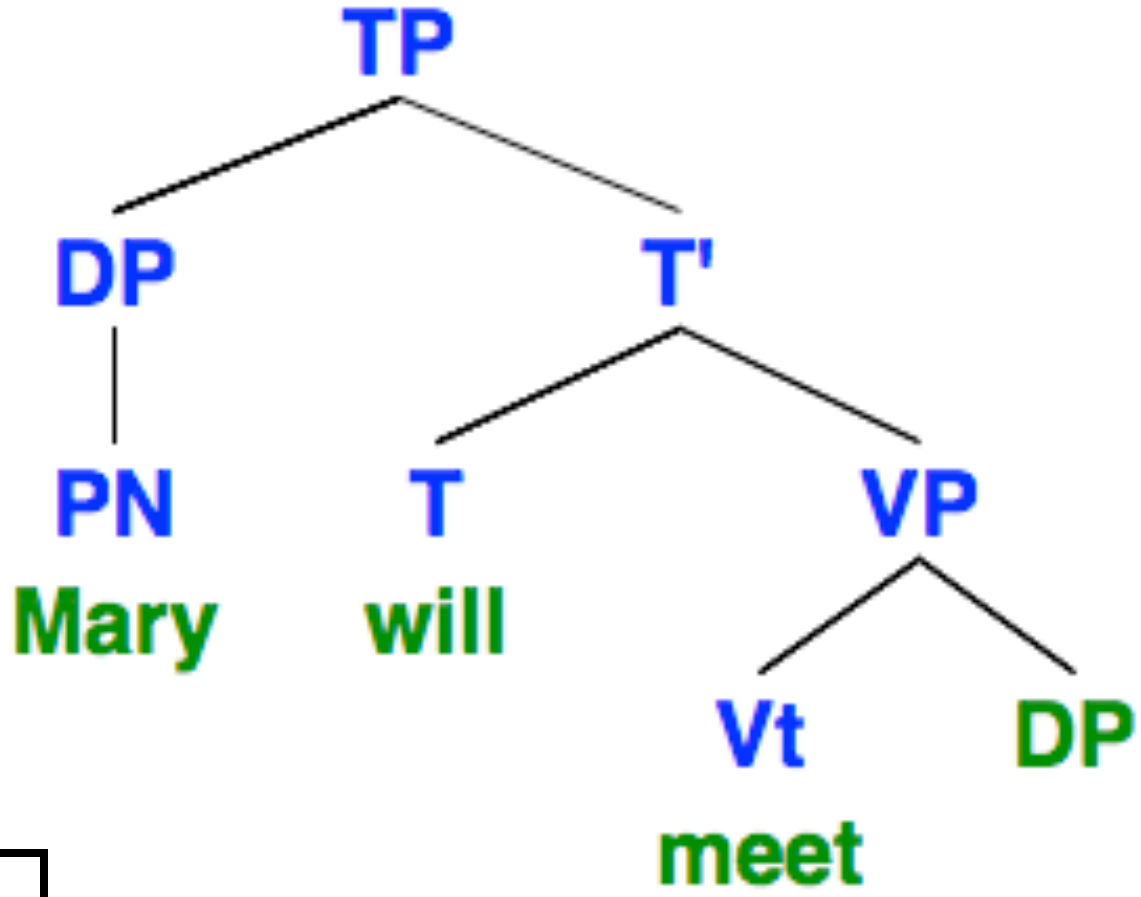


$VP \rightarrow V_i$

$VP \rightarrow V_t\ DP$

$VP \rightarrow V_s\ CP$

Phrase Structure Grammar 3: **VP**

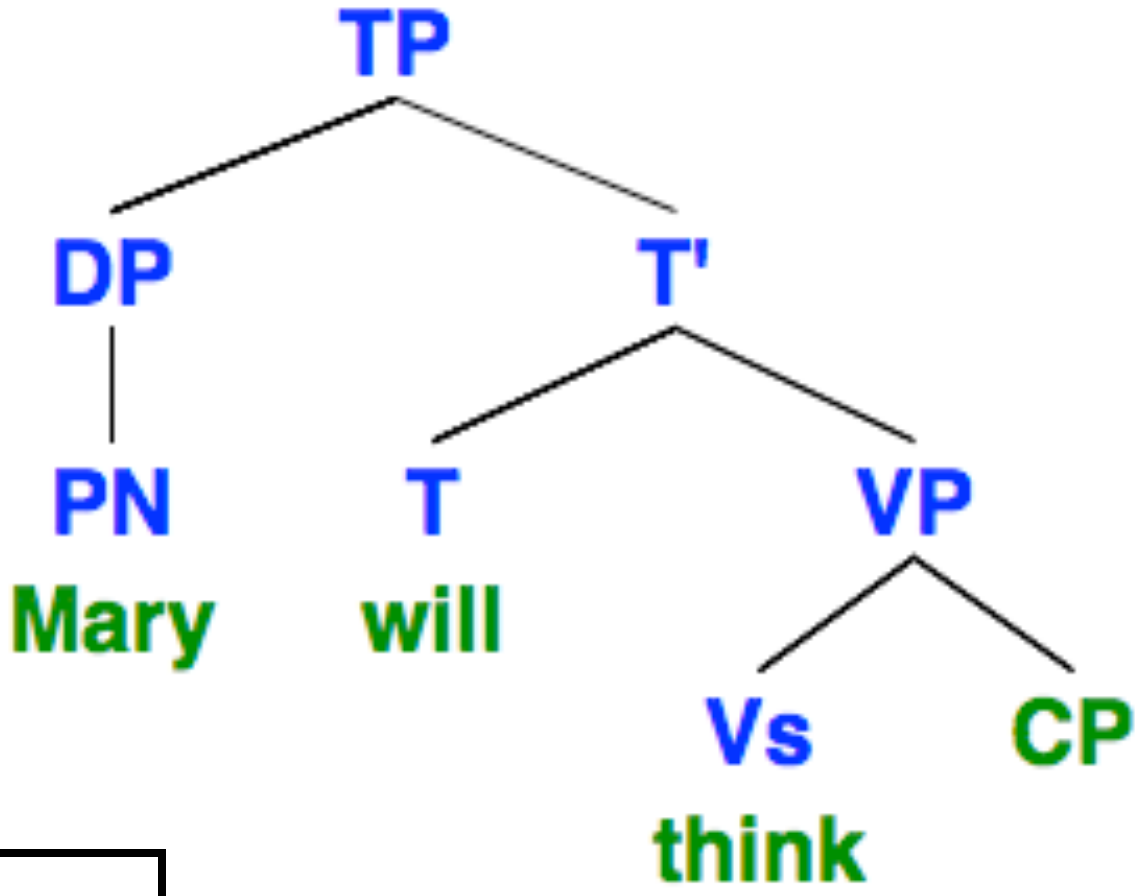


$VP \rightarrow V_i$

$VP \rightarrow V_t\ DP$

$VP \rightarrow V_s\ CP$

Phrase Structure Grammar 3: VP



$VP \rightarrow V_i$

$VP \rightarrow V_t\ DP$

$VP \rightarrow V_s\ CP$

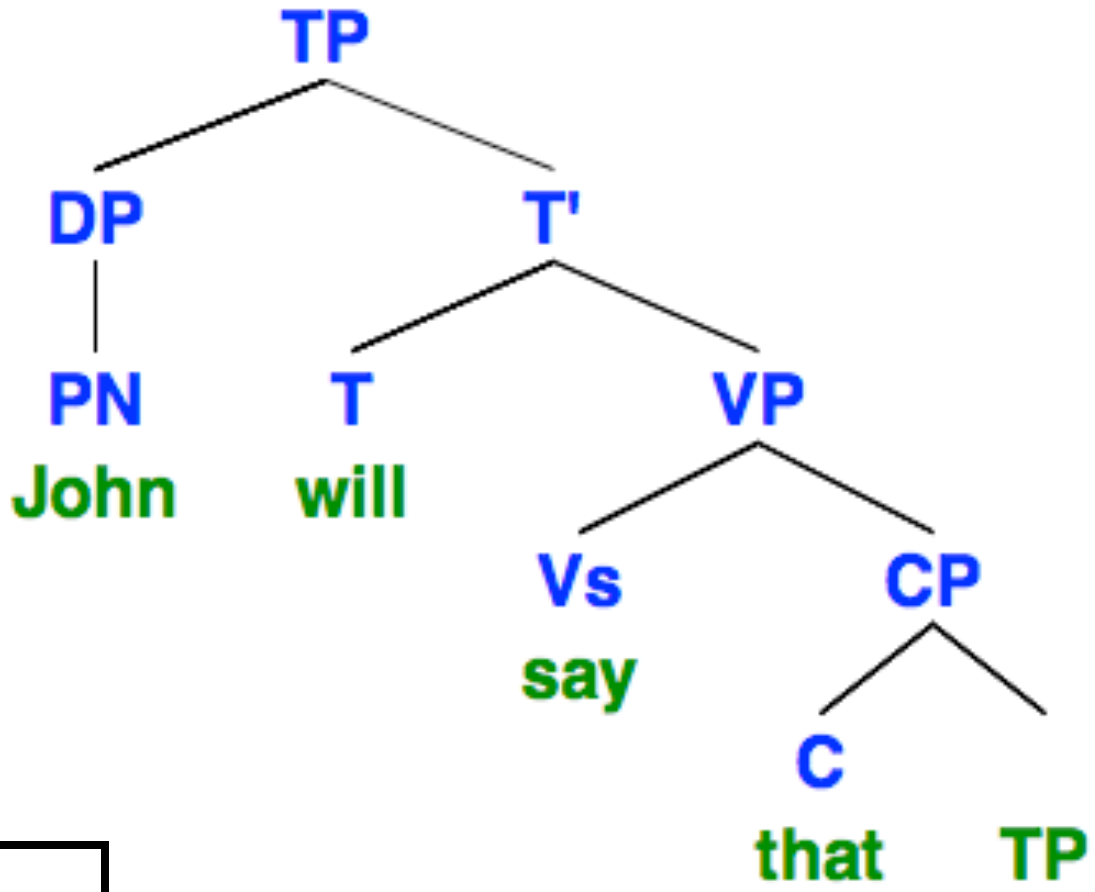
Phrase Structure Grammar 4: **CP**

CP → C TP

= a Complementizer Phrase comprises a Complementizer followed by a Tense Phrase

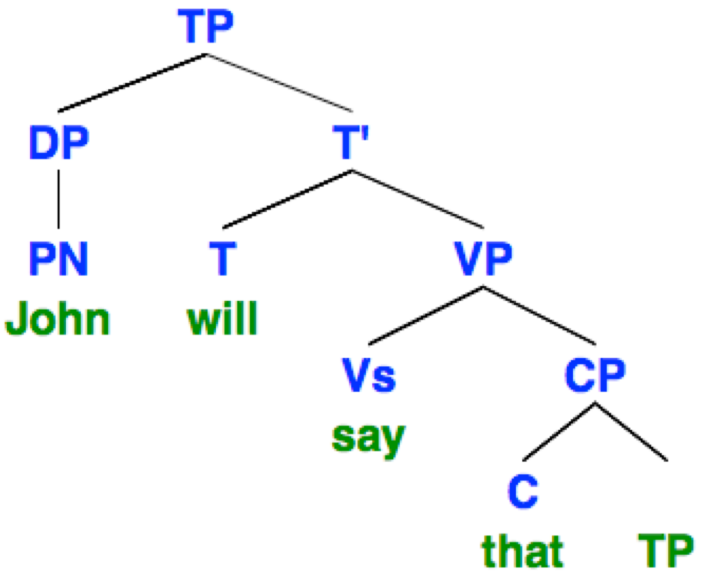
C → that

Phrase Structure Grammar 4: CP

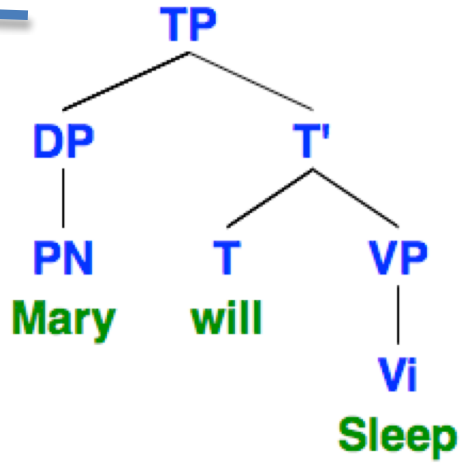


CP → C TP

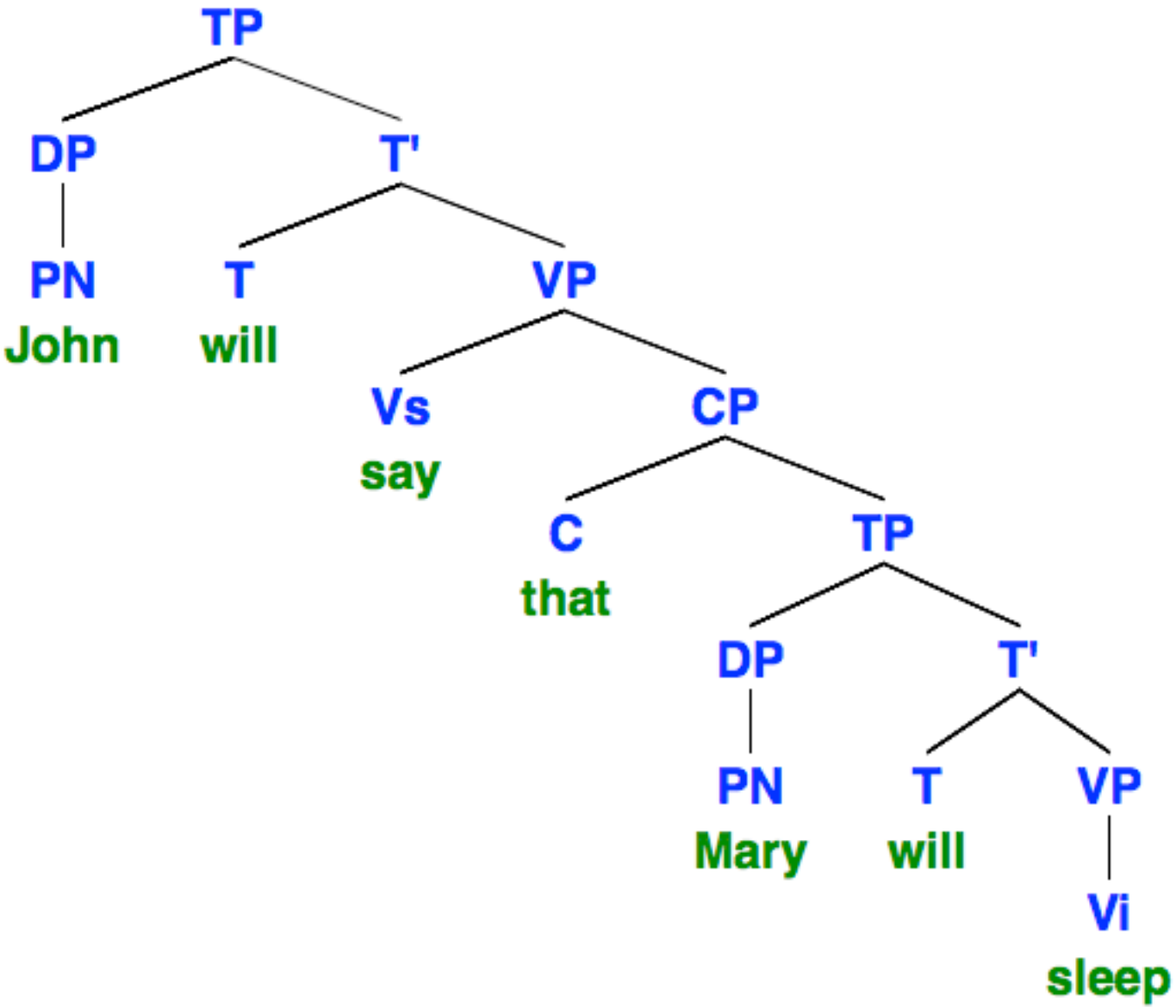
Recursion



RECURSIVE STEP



Recursion


TP
DP
T'
PN
John
T
will
VP
Vs
say
CP
C
that
TP
DP
T'
PN
Mary
T
will
VP
Vi
sleep

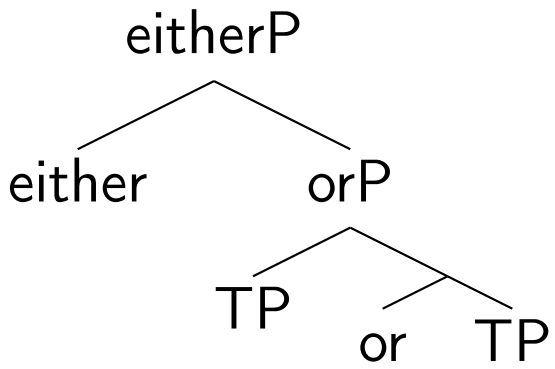
Long-distance Dependencies
(= Requirement 2)

How to match the EITHERs
With the ORs

eitherP $-->$ either orP

orP $-->$ TP or'

or' $-->$ or TP



Monkeys fail to Acquire Phrase Structure Grammars!

A

Finite State Grammar $(AB)^n$

AB AB — **no li ba** pa
AB AB AB — **la** pa **wu** mo **no** li

Phrase Structure Grammar: A^nB^n

AA BB — **yo la** pa do
AAA BBB — **ba la tu** li pa ka

B

Look

No Look

Conclusion

- **Finite State Grammars** are **inadequate**:
  1. They do not account for the tree-like structure of sentences
  2. They cannot account for long-distance dependencies

- **Phrase Structure Grammars** are (more) **adequate**:
  1. They do account for the tree-like structure of sentences (... and they yield the right constituency!)
  2. They do account for long-distance dependencies

- **Phrase Structure Grammar Rules**

  TP → DP T'

  T' → T VP

  DP → PN, D N

  VP → V_i, V_t DP, V_s CP

  CP → C TP

Headedness

- Head: element of a constituent that gives it its crucial properties (e.g. category, distribution)

- T is the head of TP/T

  D is the Head of DP
  V is the Head of VP
  C is the Head of CP

TP → DP T'
T' → **T** VP
DP → **D** N
VP → **V_t** DP, **V_s** CP
CP → **C** TP

The Head Parameter

- English (head-initial):

TP → T' DP
T' → T VP
DP → PN
VP → V_i, V_t DP, V_s CP
CP → C TP

The head always comes before its complement

- Japanese (head-final):

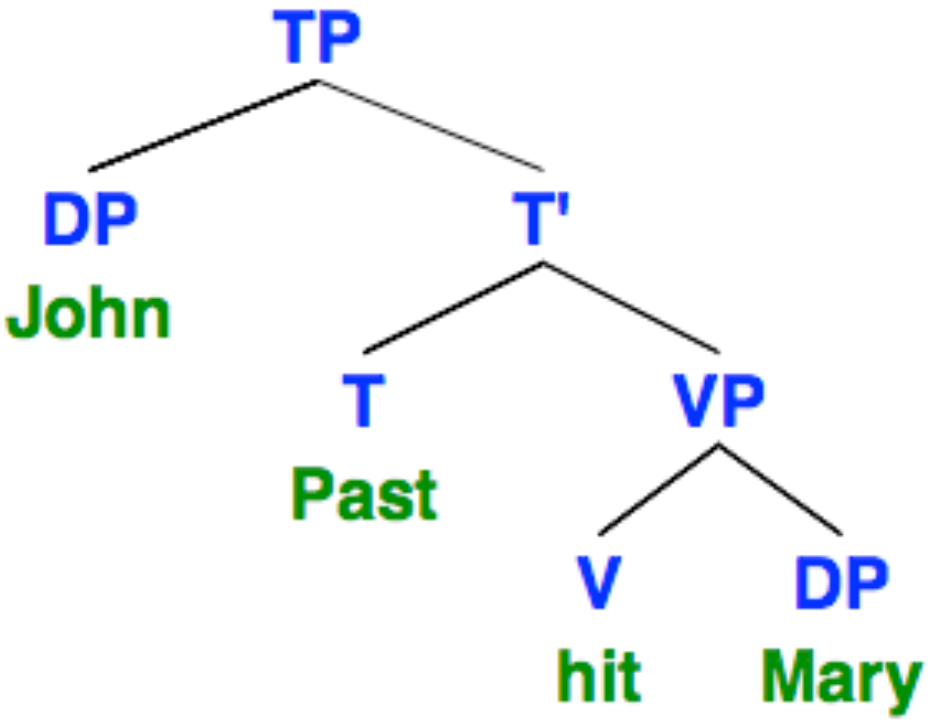
TP → DP T'
T' → VP T
DP → PN
VP → V_i, DP V_t, CP V_s
CP → TP C

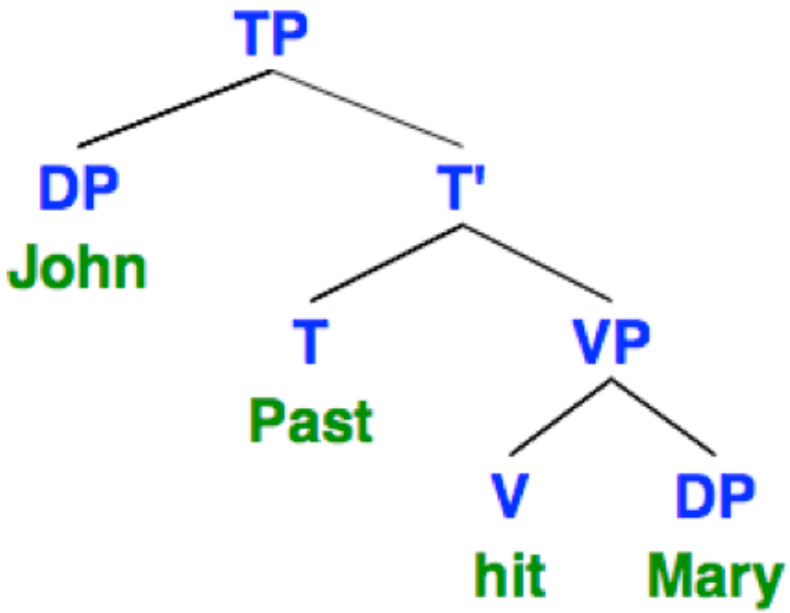
The head always comes after its complement

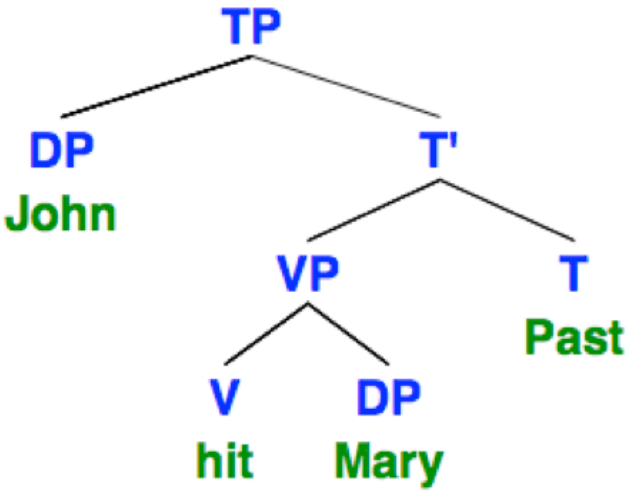
- Example:

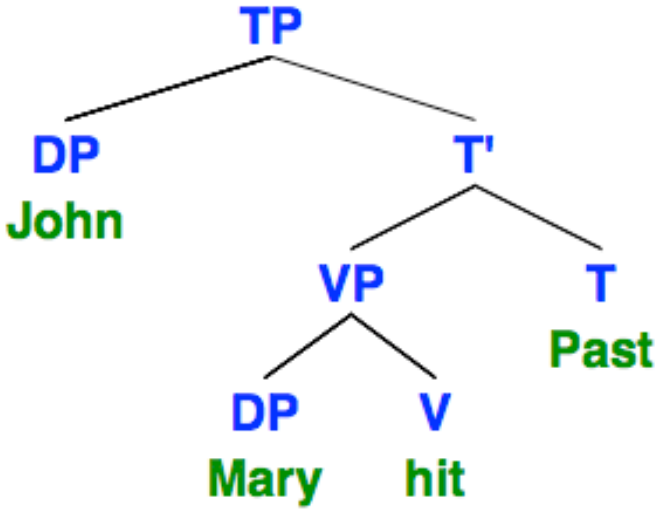
John-ga Mary-o but-ta
John-particle *Mary-particle* *hit-PAST*
'John hit Mary'

(Abbreviated Tree: no PN node)

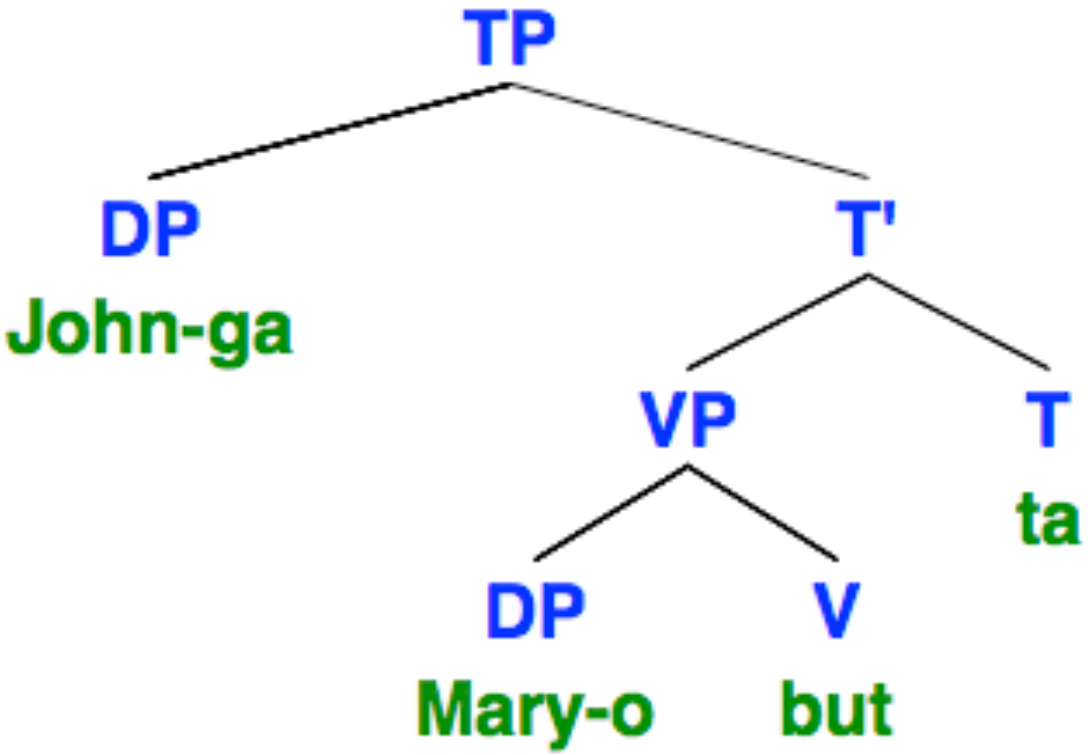



TP
DP
John
T'
T
Past
VP
V
hit
DP
Mary


TP
DP
John
T'
VP
T
Past
V
hit
DP
Mary


TP
DP
John
T'
VP
T
Past
DP
Mary
V
hit

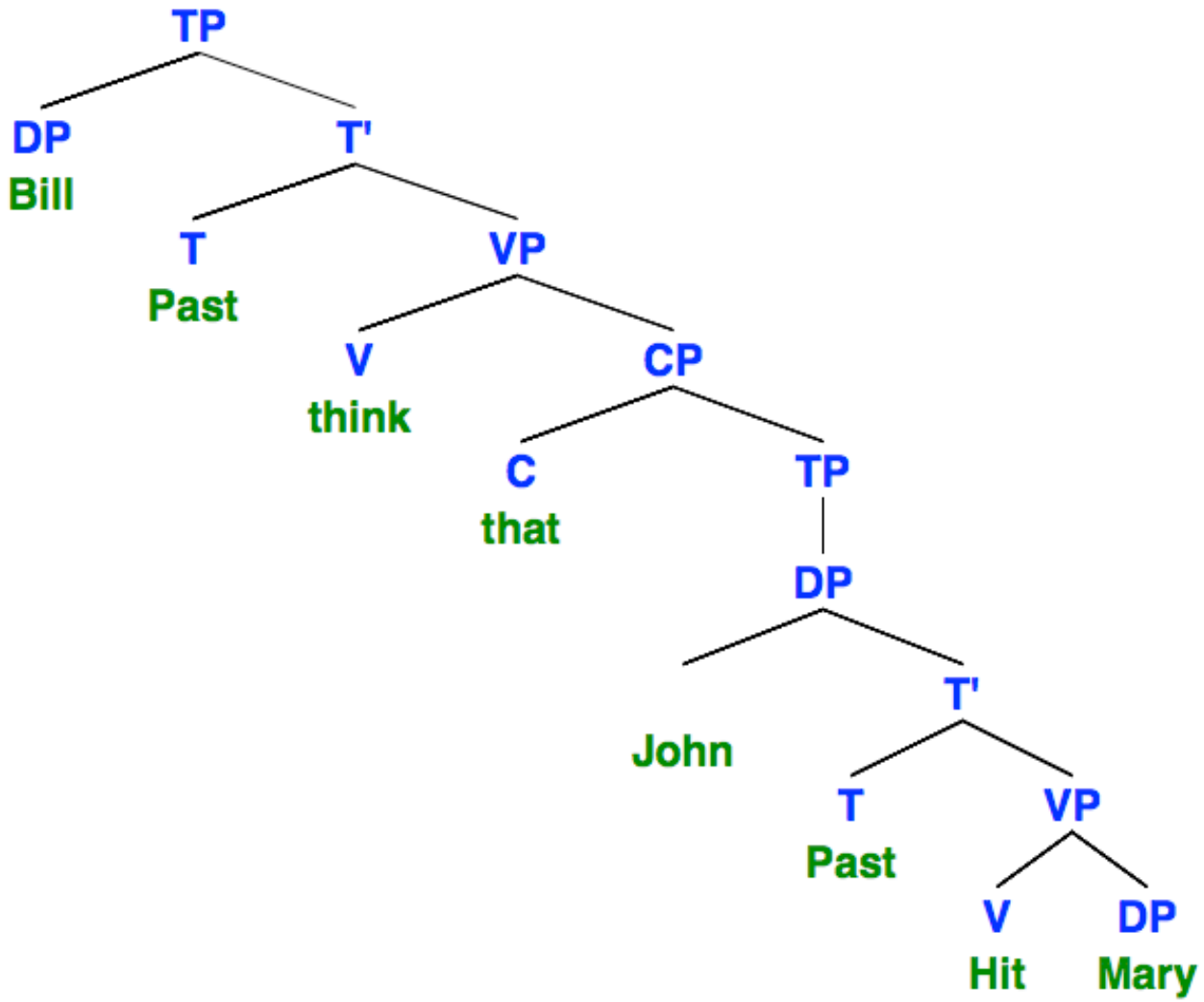
- John-ga Mary-o but-ta
  John-particle *Mary-particle* *hit-PAST*
  'John hit Mary'

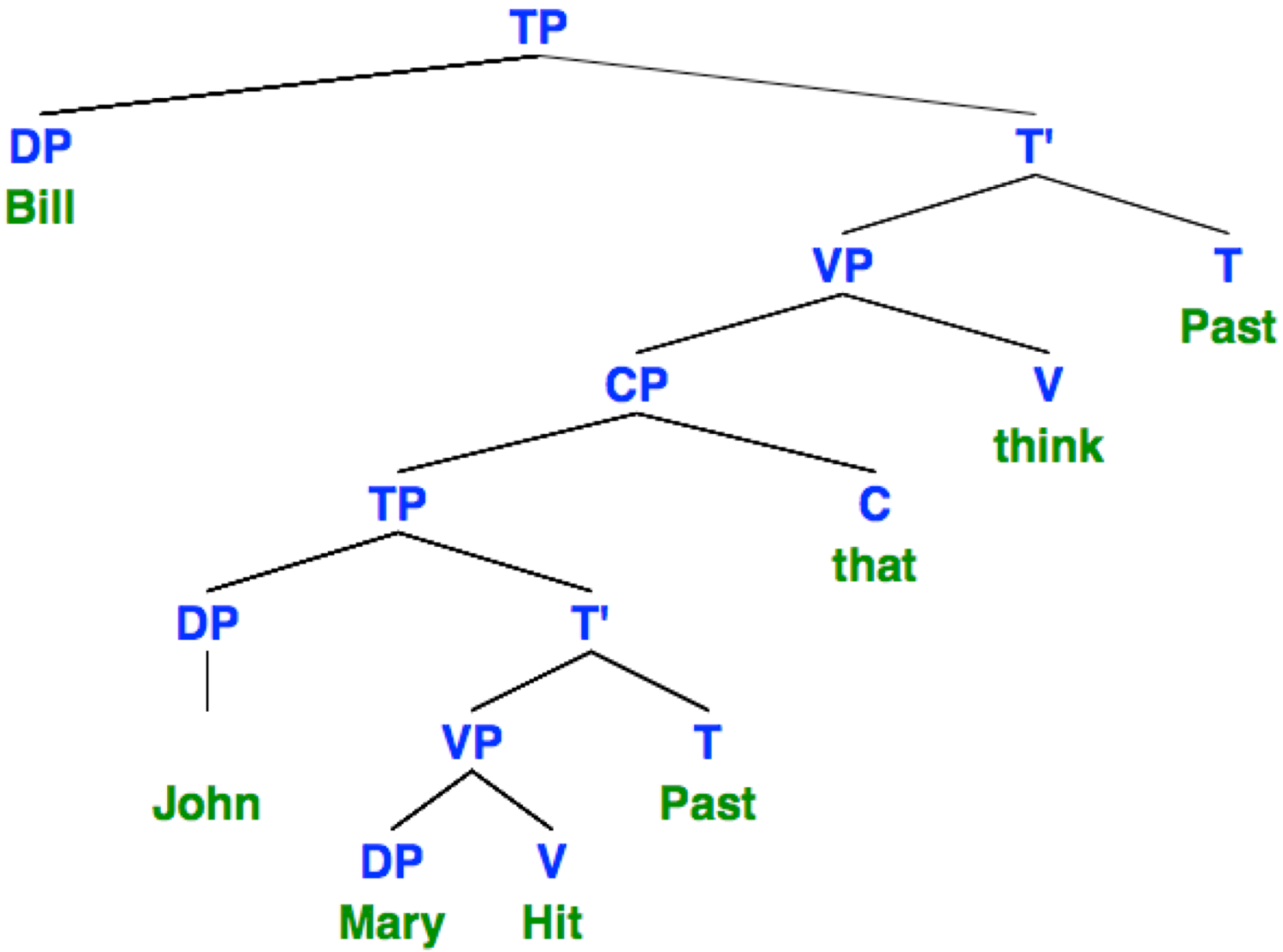


- Bill-wa John-ga Mary-o but-ta to omot-ta

  Bill-part John-part Mary-part hit-PAST that think-PAST

  'Bill thought that John hit Mary'

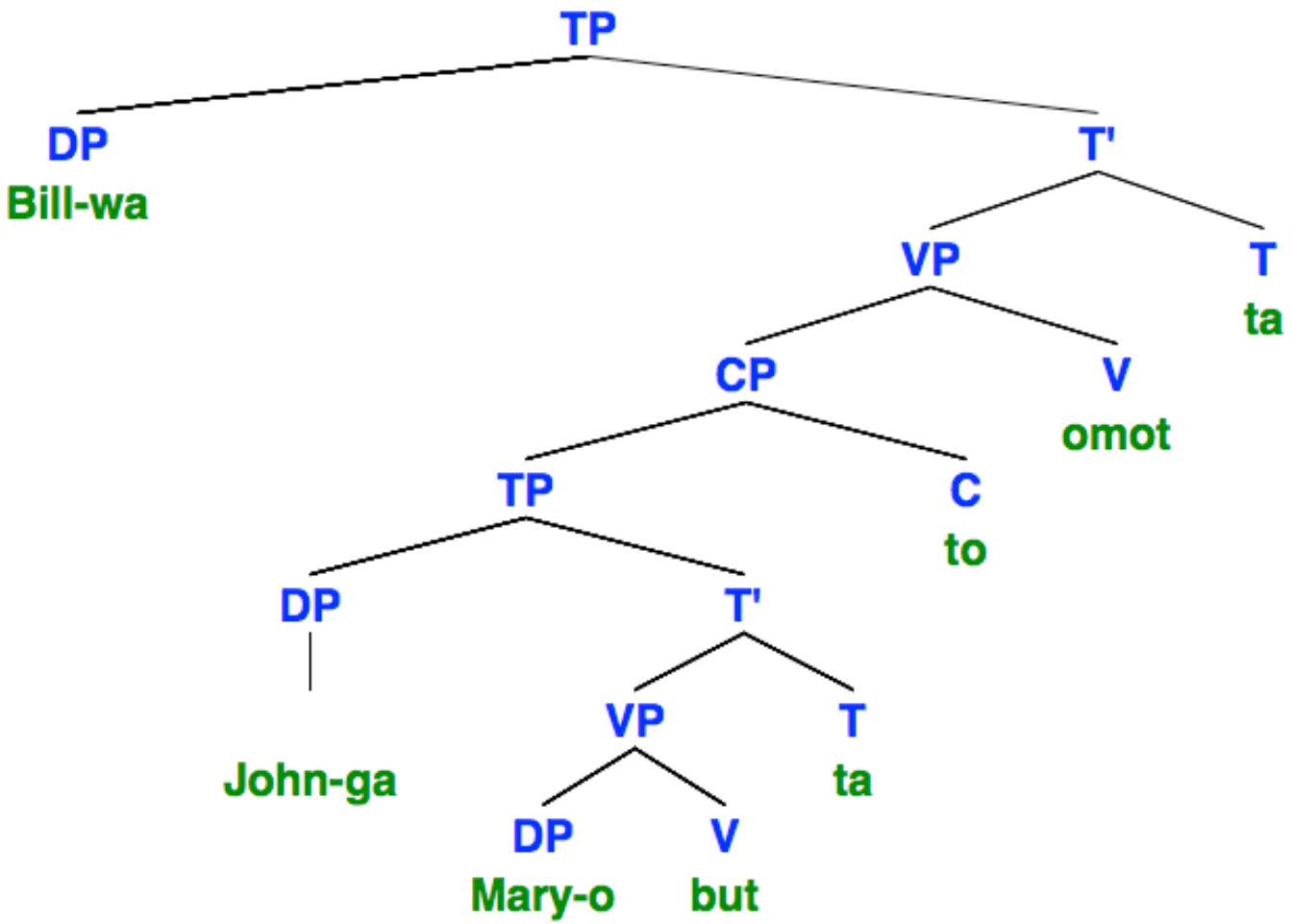



TP
DP
Bill
T'
VP
T
Past
CP
V
think
TP
C
that
DP
T'
John
VP
T
Past
DP
V
Mary
Hit

- Bill-wa John-ga Mary-o but-ta to omot-ta

  Bill-part John-part Mary-part hit-PAST that think-PAST

  'Bill thought that John hit Mary'



PPs

(1) PP $\rightarrow$ **P** DP

a. with the book, by car, to LA, on the table, for the baby, ...

(2) PP $\rightarrow$ DP **P**

a. John-ga Mary to kuruma da Kobe ni itta
John-nom Mary with car by Kobe to go-Past
Japanese

Important Note

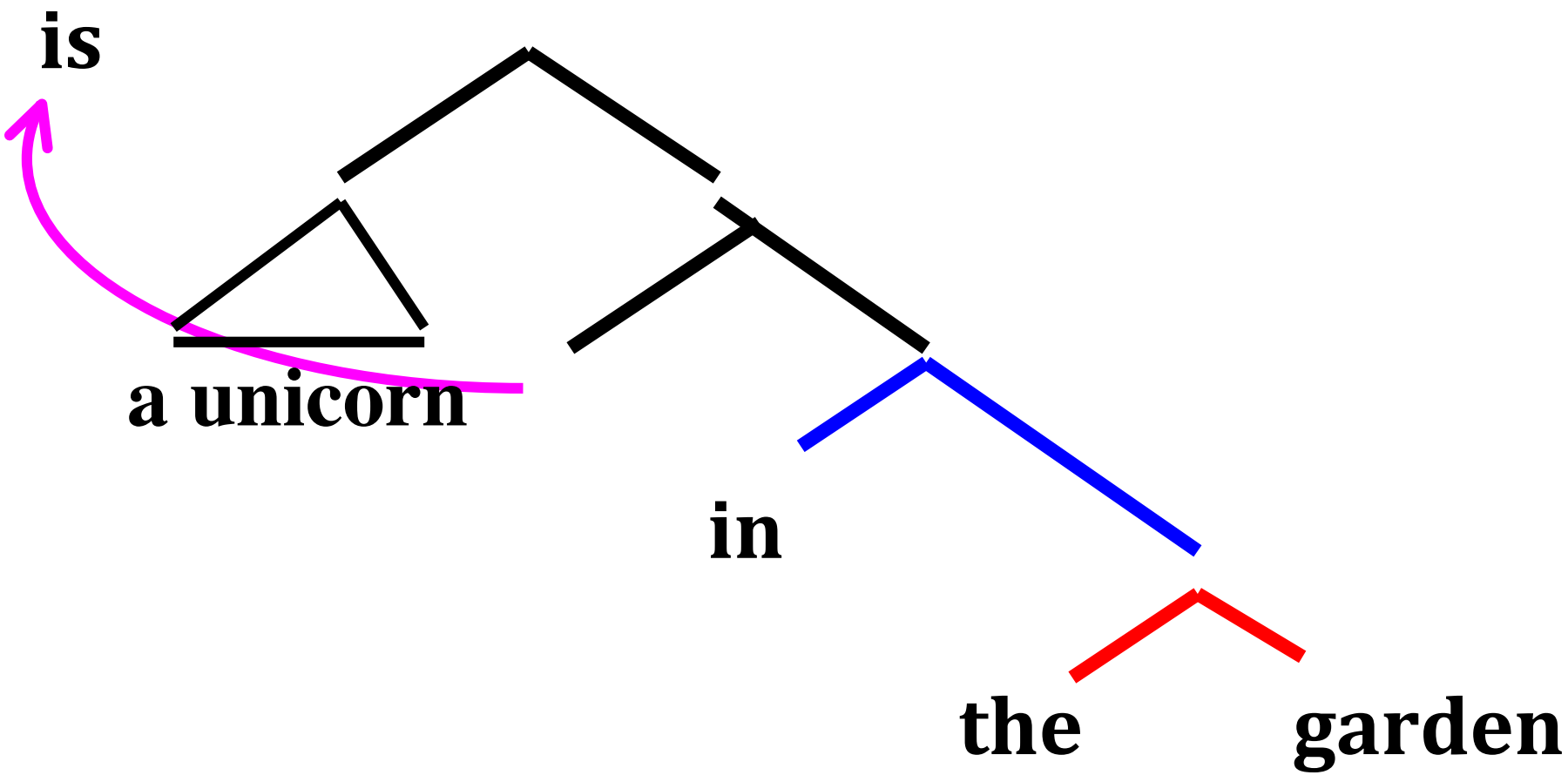
The Head Parameter
can be set independently
for different categories.

i.e. a language can be head-final for VP,
head-initial for CP, etc.

Go to Terraling for:
mixed headedness..

Phrase structure + movement:

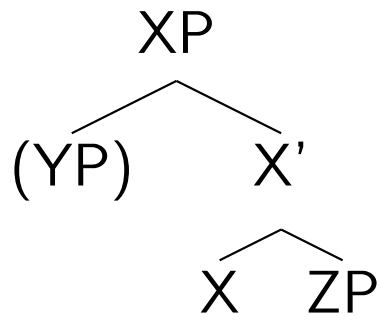
= surface structure.



From Phrase structure to X-bar theory

Constituency tests:
many phrases: similar forms!
What is the abstract design? X-bar theory

(1) X-bar schema:



X=head (C, T, V, P, A, N,...)
Heads combine with complements first;
and combine with *subjects* next (if they take subjects).

Language variation

Linear orders:

(2) Head Parameter:
Head initial : Head Complement
Head final: Complement Head
Subject first, subject last

(3) Expectations: All heads are fixed once and for all. Not true?

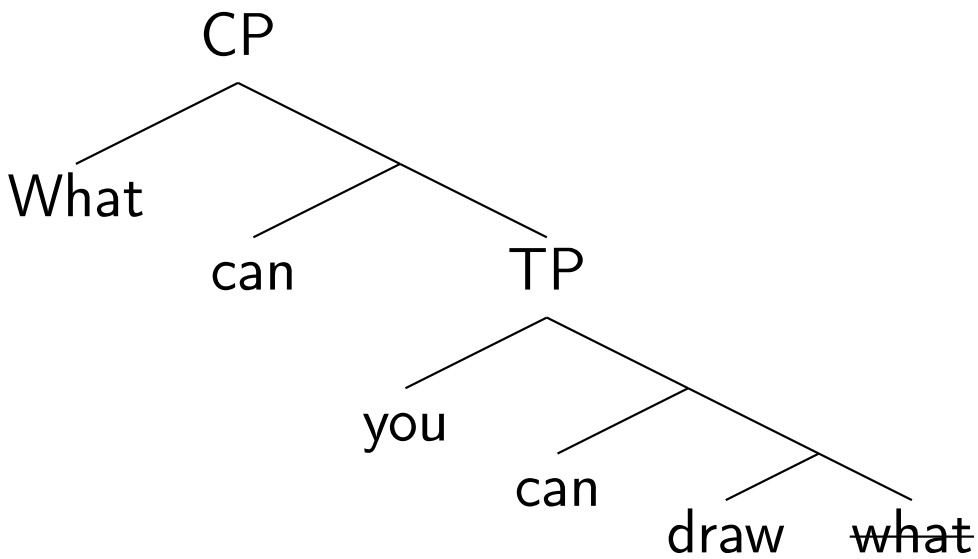
(4) Linear order results from Structure and movement.
To find out basic headedness you must undo movement.
question formation:

(5) a. John is sick.
b. is John sick?

Move T to a question C.

More Movement: question formation

(6) a. I can draw something
b. I can draw what
c. What can you draw ? O V S



Parameters:
English: move T to C of roots clauses (except for subjects) Move T to C [yes], no
Move wh-phrase to subject of C(Q). (Move wh phrase: [yes], no)