Mind III

Human language and animal communication

Jason Merchant
4 April 2006

Goals of today's lecture

- To discuss some salient characteristics of human language

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- To present a subset of human language data to give you an appreciation of its nature

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- To present a subset of human language data to give you an appreciation of its nature
- To discuss animal communication systems and explore what analogs they show with human language

The big questions for today

- What constitutes knowledge of language?
  - What are the structures and entities involved?

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  - What are the structures and entities involved?
- What properties do animal communication systems share (and not) with human language?
- Can animals be *taught* to use a communicative system with the essential properties of a human language?

Some characteristics of human language

5 characteristics of language use and meaning

- semanticity (words can be about external things in the world;)
- arbitrariness (word meaning is arbitrary [symbolic], not iconic)
- prevarication (language can be used to lie)
- displacement (we can refer to objects and events distant in place and time from the speech event; “black scorpions”)
- reflexiveness (language can refer to itself and its properties)

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3 characteristics of language structure

- discreteness (the pieces are discrete, not continuous)
- duality of patterning (small number of sounds combine to make words, finite number of words make sentences)
- productivity (number of possible utterance types is infinite)

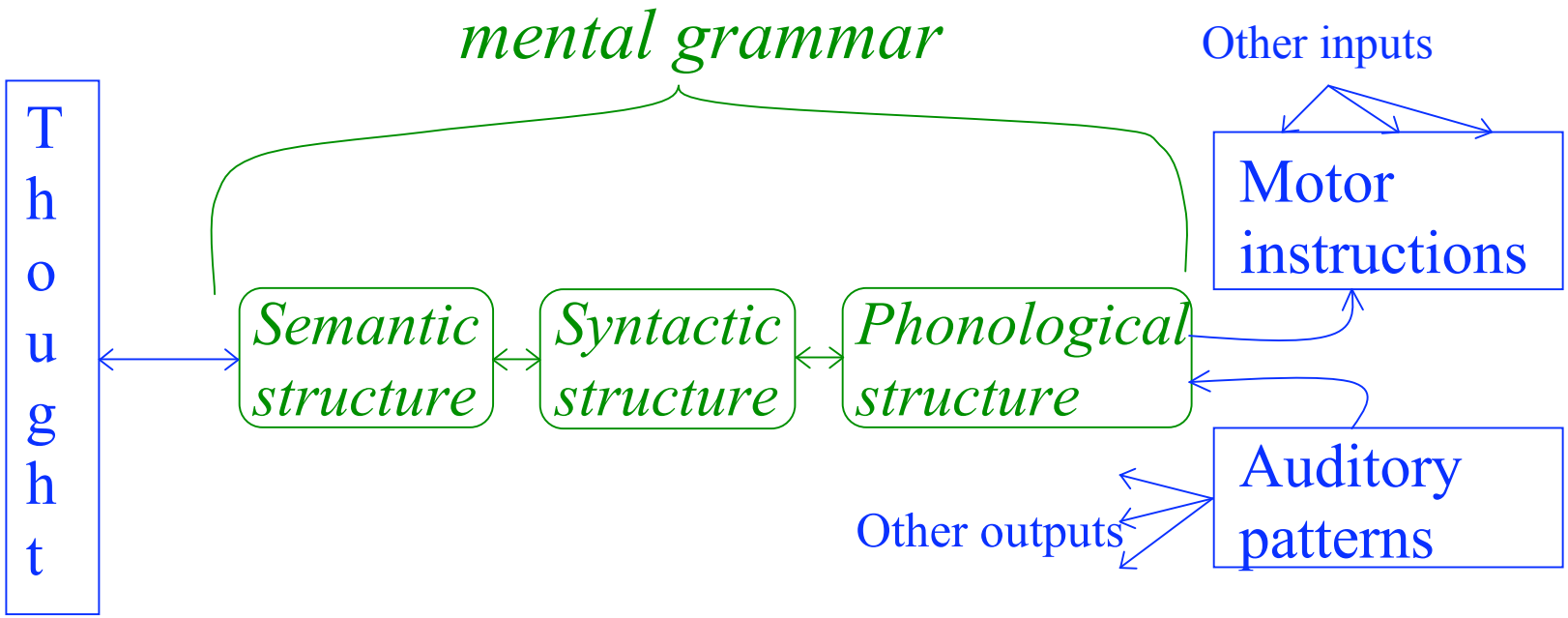
Some characteristics of human language

These characteristics come from the nature of the language system.

- What constitutes knowledge of language?
    - What are the structures and entities involved?

Knowledge of language is possession of a **mental grammar**

Some elements of **mental grammar**



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- the 'software' that runs on the 'hardware' of the neural circuitry of the brain

A **mental grammar** is

- a property of the mind/brain of an individual
- a set of linguistic elements (words, word parts, etc.) called a *lexicon*
- a finite set of *rules* for combining these elements
- the 'software' that runs on the 'hardware' of the neural circuitry of the brain
- 'unconscious' in the same way the systems of e.g. visual perception are, not in a Freudian sense—it is not accessible to introspection, under therapy or hypnosis or whatever

A **mental grammar** is not

- the kind of ‘grammar’ you were taught in school
  This sense of ‘grammar’ is typically a bunch of made-up rules of usage whose sole purpose is identifier of social stratum (also known as ‘prescriptive grammar’)

As in ‘grammarian’, ‘old drudge’, ‘William Safire’

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Examples:

1. don't split an 'infinitive' (*"Its mission: to boldly go where no-one has gone before"*)
2. don't end a sentence with a preposition (*"The lights are on."*)

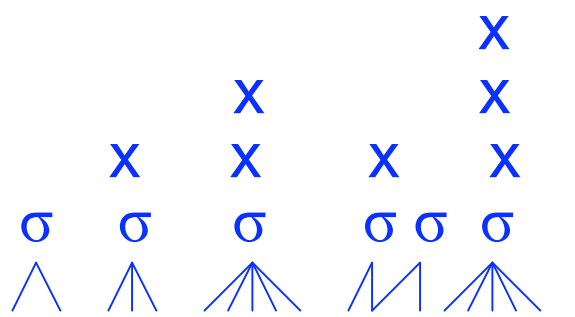
The structure of a simple sentence

(1)The big truck’s on a street.

The big truck's on a street.

Phonological structure:
(A representation of the sounds and their groupings)

(2)



Prosodic structure

Syllabic structure

Segmental structure

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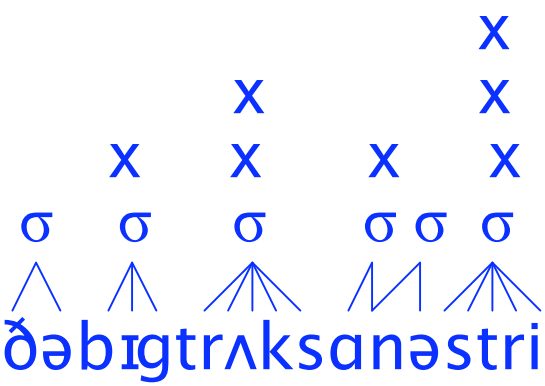


Prosodic structure

Syllabic structure

Segmental structure

- This is still a vast simplification
  The segments are themselves complex feature bundles:
  /s/ = [+consonantal, -vocalic, -sonorant, -nasal,
  +continuant, -voiced, +coronal, +anterior]

The big truck's on a street.

The elements from the lexicon (**lexical items**) involved in this sentence:

lexical item

the
big
truck
's
on
a
street

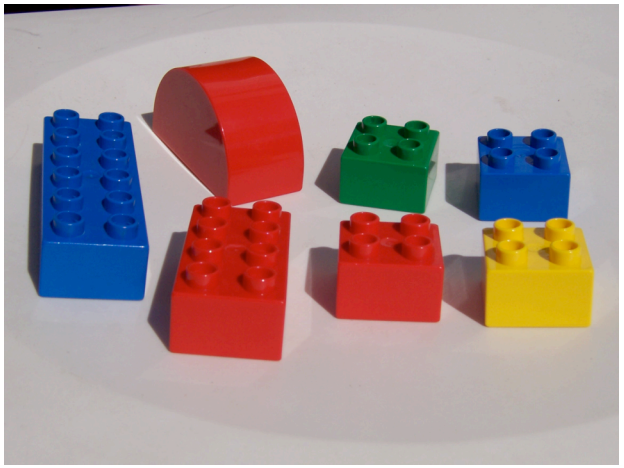
The big truck's on a street.

The elements from the lexicon (**lexical items**) involved in this sentence:

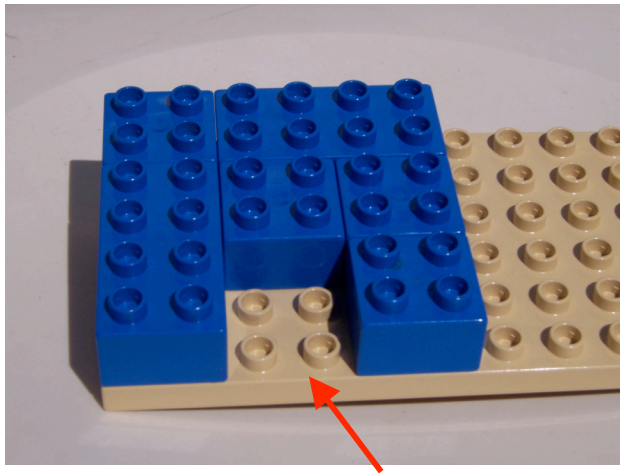
lexical item	lexical category ('part of speech')
the	Art(icle)
big	A(djective)
truck	N(oun)
's	V(erb)
on	P(reposition)
a	Art(icle)
street	N(oun)

What's a category?

An *equivalence class*: a set of items whose external distribution is the same



Which of these blocks...



...fit in this gap exactly?

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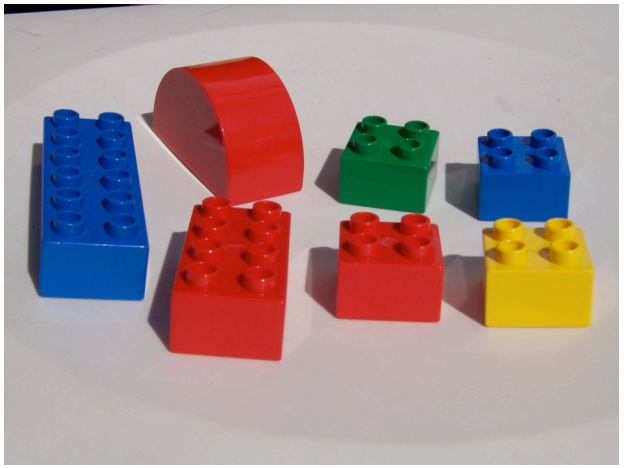

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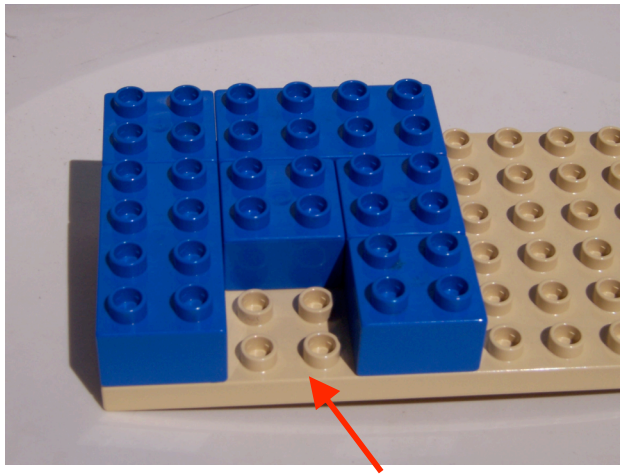

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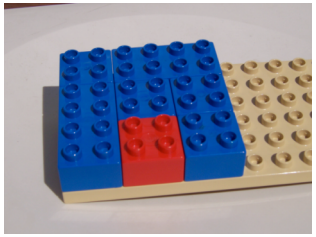

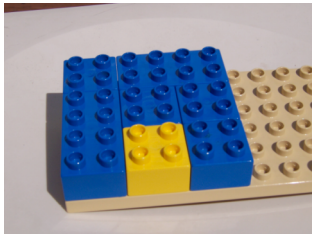

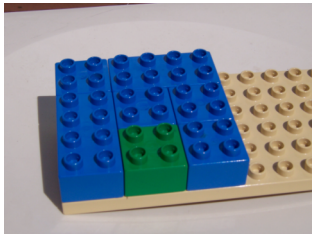

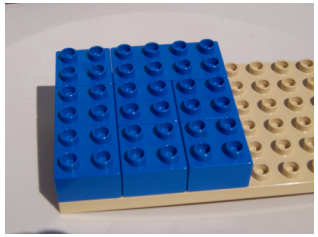

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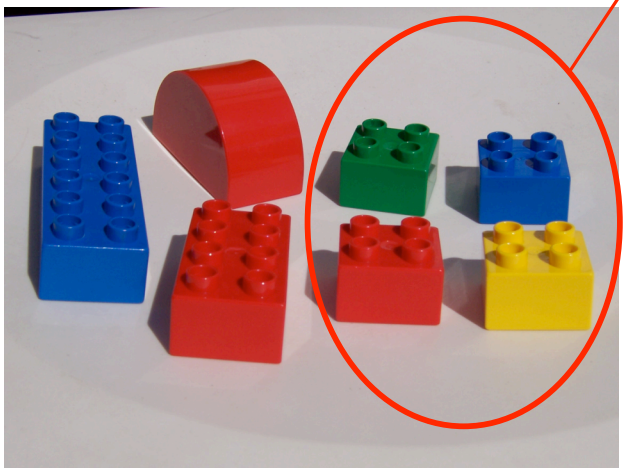

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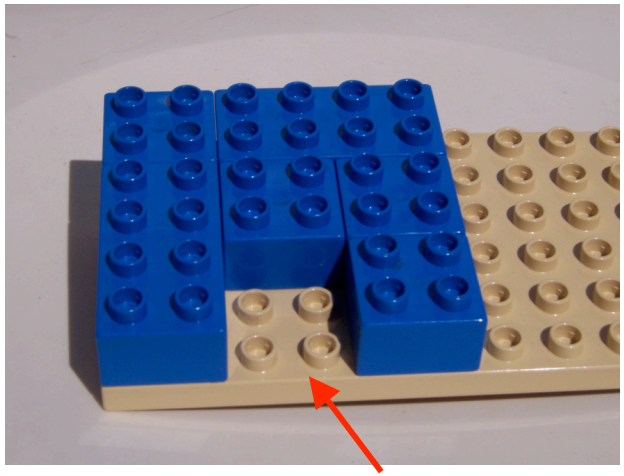

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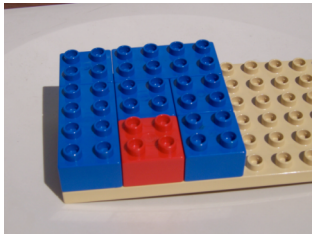
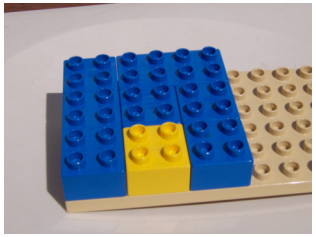
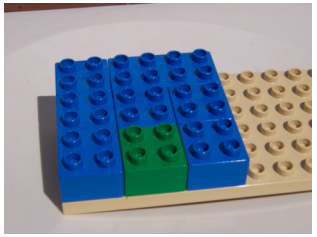
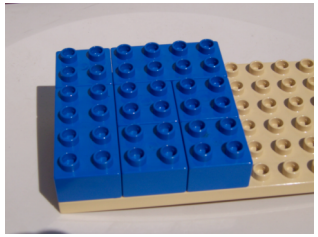

What's a lexical category?

- An equivalence class of words (or parts of words)

For example, a noun (N):

(3) The *X* was not remarkable.
The nun was not remarkable.
The school was not remarkable.
The grape was not remarkable.
...

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- Nouns (and all other lexical categories) are defined by their equivalence class behavior: an irreducible *syntactic* fact. They cannot be adequately defined in phonological or semantic terms.

So we have the entities (lexical categories): How do we put them together?

- There is a system of ‘rules’ (patterns, constraints, operations, combinatorics, laws), called the *syntax*

“Syntax is the study of the principles and processes by which sentences are constructed...”
Noam Chomsky, *Syntactic Structures* (1957), p. 11.

Two hypotheses about syntax

Hypothesis 1: Syntax (words in a phrase) as beads on a string

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The syntactic component of mental grammar consists of a set of successor functions (functions that determine what each word can be followed by).

> For each word *w*, the mental grammar associates with that word a function *S(w)* which yields a set of possible successor words (plus some mechanism for choosing an element from that set)

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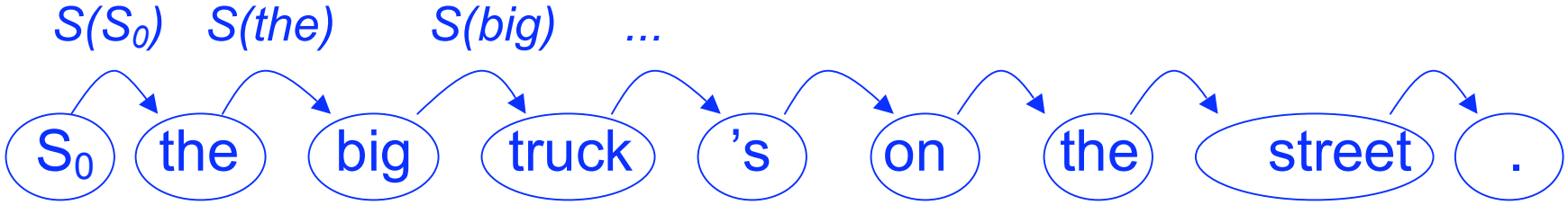
The syntactic component of mental grammar consists of a set of successor functions (functions that determine what each word can be followed by).

> For each word *w*, the mental grammar associates with that word a function *S(w)* which yields a set of possible successor words to *w* (plus some mechanism for selecting an element of that set)

Example: *S(big) = {truck, tree, nun, trouble, aardvark, lie, ...}*

This is equivalent to a kind of *finite state automaton*:



Two hypotheses about syntax

- Problems for ‘beads on a string’

Structural ambiguity

(4) the man in the chair with a broken leg [ambiguous!]

(5) a. The man’s leg is broken.

b. The chair’s leg is broken.

Two hypotheses about syntax

- Problems for 'beads on a string'

Structural ambiguity

(6) the man in the chair with a broken leg [ambiguous!]

(7) a. The man's leg is broken.
b. The chair's leg is broken.

Repeated elements

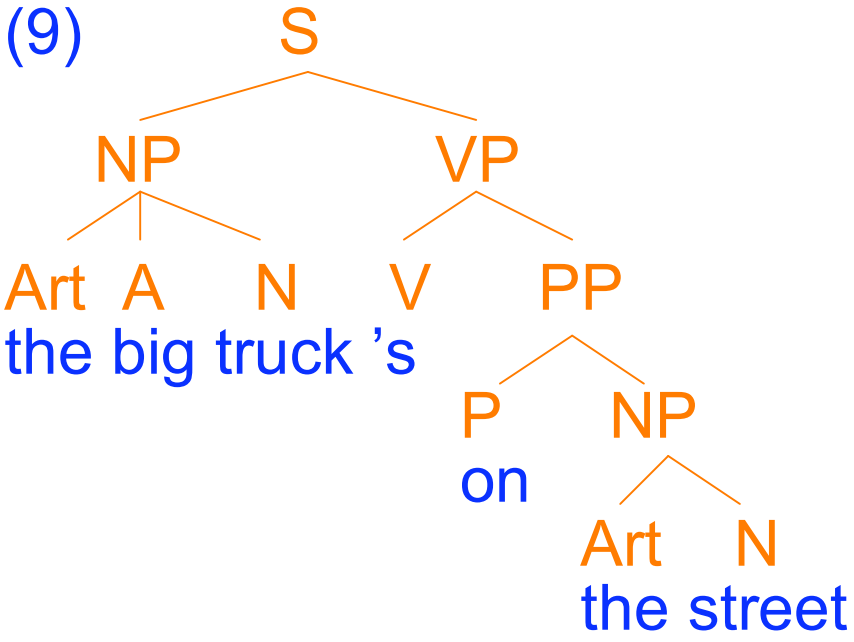
(8) a. The guy who said [he was great] wouldn't listen to Abby.
b. The guy who said [he was great] wouldn't listen to anyone who didn't think [he was great].
c. *The guy who said [he was great] wouldn't listen to anyone who didn't think [he was great] wouldn't listen to Abby. (NB: prefixed * means 'ungrammatical')

Two hypotheses about syntax

Hypothesis 2: Syntax involves abstract structures

Syntactic structure (Phrase structure):

(9)



S(entence)

N(oun)P(hrase), V(erb)P(hrase)

P(repositional)P(hrase)

These phrases (S, NP, VP, PP) are determined on the basis of equivalence class behavior

Two hypotheses about syntax

Hypothesis 2: Syntax involves abstract structures

The syntactic component of mental grammar consists of a finite set of phrase structure rules ('grouping laws') for combining words into phrases, and such phrases into larger phrases

> For each phrase *P*, the mental grammar has a phrase structure rule PS_P that determines what kind of categories or phrases occur in *P* and determines their relative position in *P*

(10) NP = Art N

(11)

((10) = (11))

(12) a. PP = P NP
b. VP = V PP
c. S = NP VP

Phrase structure ambiguity

- What phrase structure rules can do that successor functions can't

(13) the man in the chair with a broken leg [ambiguous!]

(14) a. The man's leg is broken.
b. The chair's leg is broken.

Phrase structure ambiguity

- What phrase structure rules can do that successor functions can't

(13) the man in the chair with a broken leg [leg → man, chair?]

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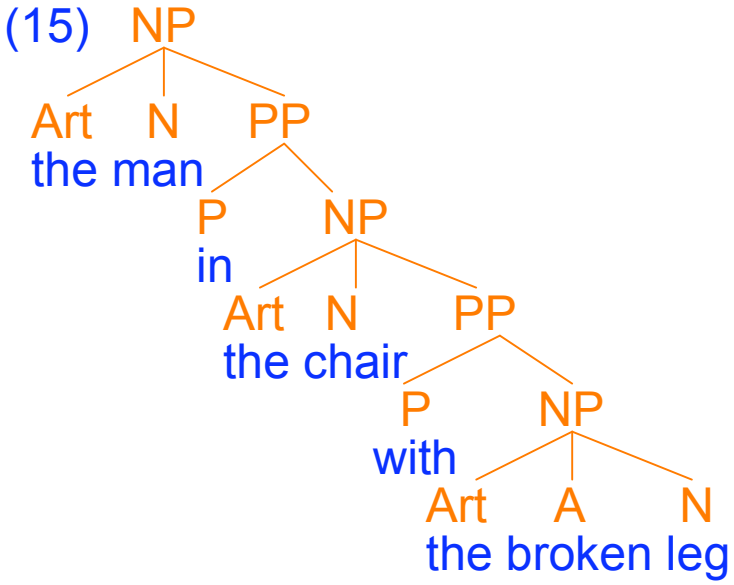
(15)



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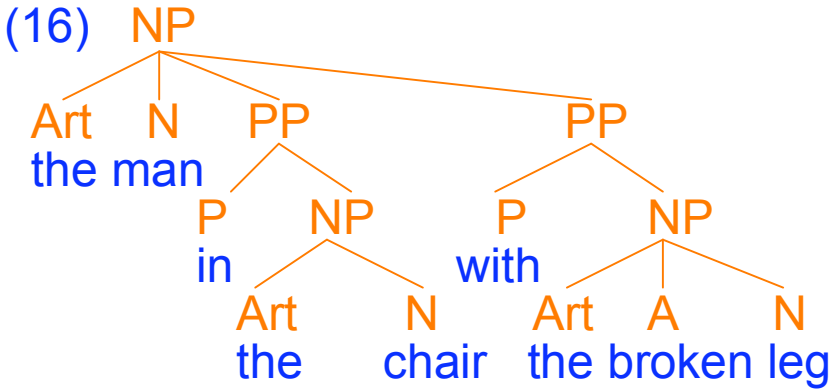

Phrase structure ambiguity

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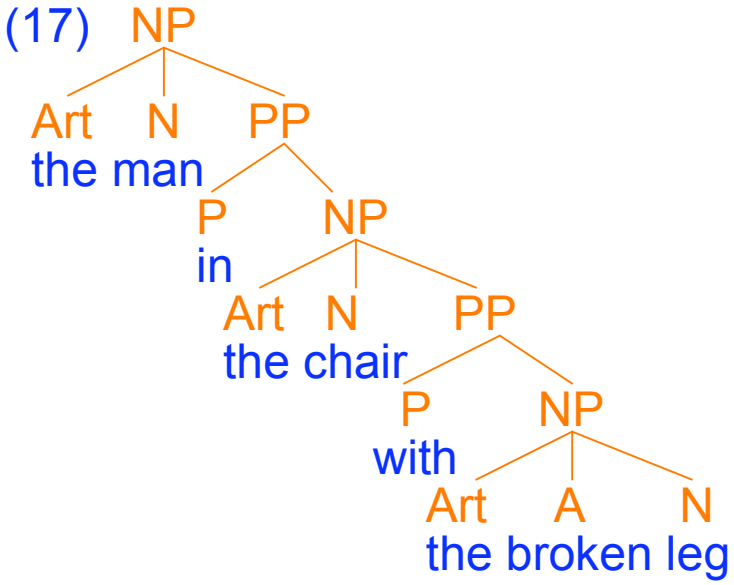

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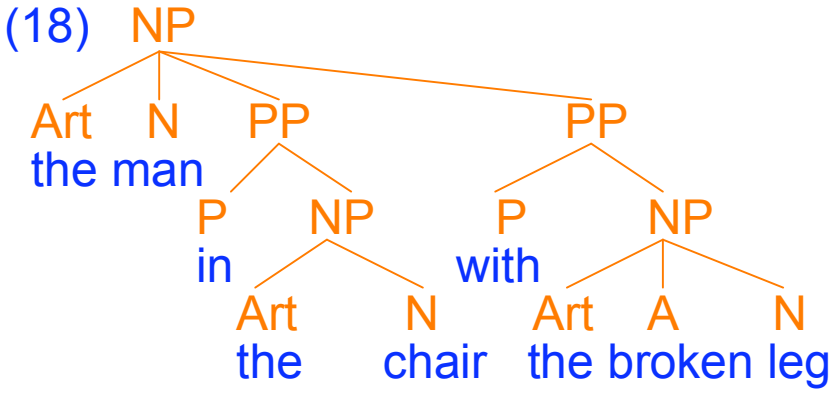

(19) the man with a broken leg in the chair [leg → man]

More phrase structure ambiguity

(20) competent women and men

(21) a. [competent women] and [men] [Adj N] and [N]

b. competent [women and men] Adj [N and N]

More phrase structure ambiguity

(16) competent women and men

(17) a. [competent women] and [men] [Adj N] and [N]

b. competent [women and men] Adj [N and N]

(22) "this crime covers anyone who intentionally accesses a federal computer without authorization, and by means of one or more instances of such conduct alters, damages, or destroys information" 18 U.S.C. §1030(a)(5)(A) debated in *United States v. Morrison* (1991).

(23) a. Adverb [VP and VP] or b. [Adverb VP] and [VP] ?

defendant plaintiff

Syntactic recursion

- The set of possible sentences in any human language is infinite, in principle

Embedding:

(24) a. Mr. Burns bribed Mayor Quimby.

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Embedding:

(19) a. Mr. Burns bribed Mayor Quimby.
b. Bart claims that Mr. Burns bribed Mayor Quimby.

Syntactic recursion

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Embedding:

(19) a. Mr. Burns bribed Mayor Quimby.
b. Bart claims that Mr. Burns bribed Mayor Quimby.
c. Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.

Syntactic recursion

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Embedding:

(19) a. Mr. Burns bribed Mayor Quimby.
b. Bart claims that Mr. Burns bribed Mayor Quimby.
c. Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.
d. Marge's been saying that Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.

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Embedding:

(19) a. Mr. Burns bribed Mayor Quimby.
b. Bart claims that Mr. Burns bribed Mayor Quimby.
c. Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.
d. Marge's been saying that Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.
e. Homer thinks that Marge's been saying that Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.

Syntactic recursion

- The set of phrase structure rules is finite, but *recursive*

(19) Lisa insists that Bart claims that Mr. Burns bribed Quimby.

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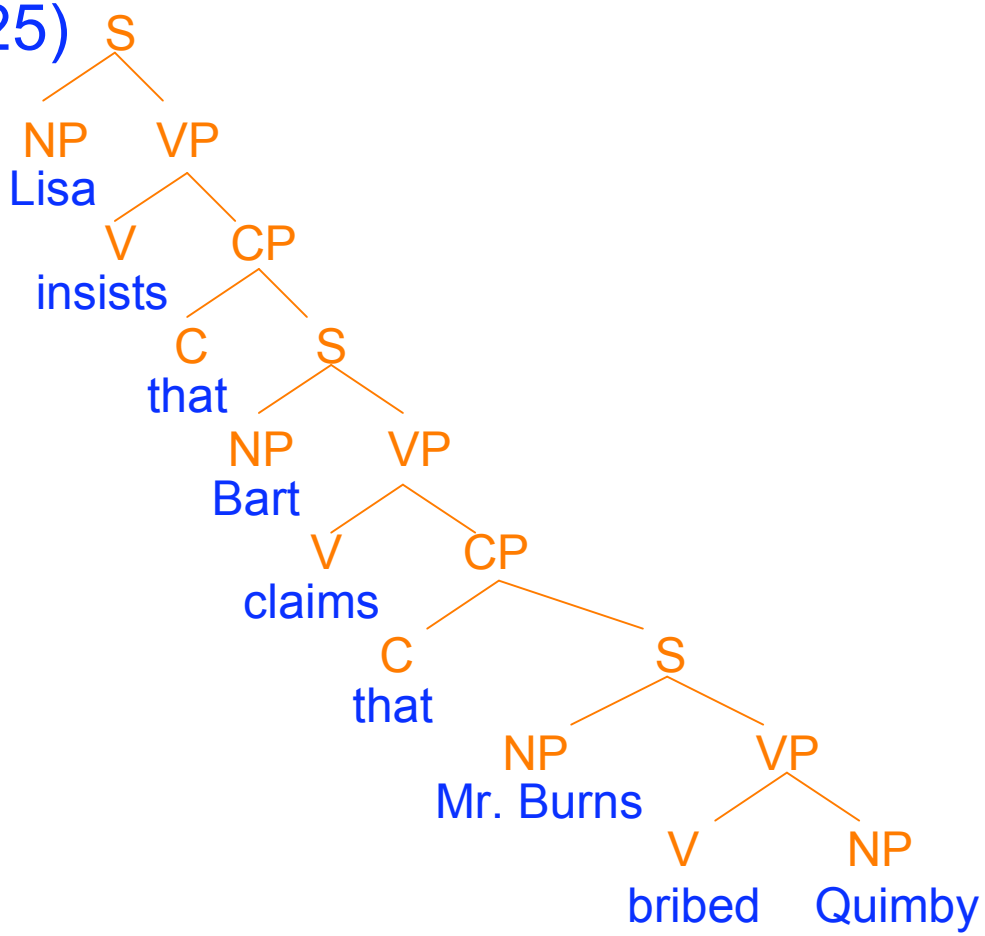

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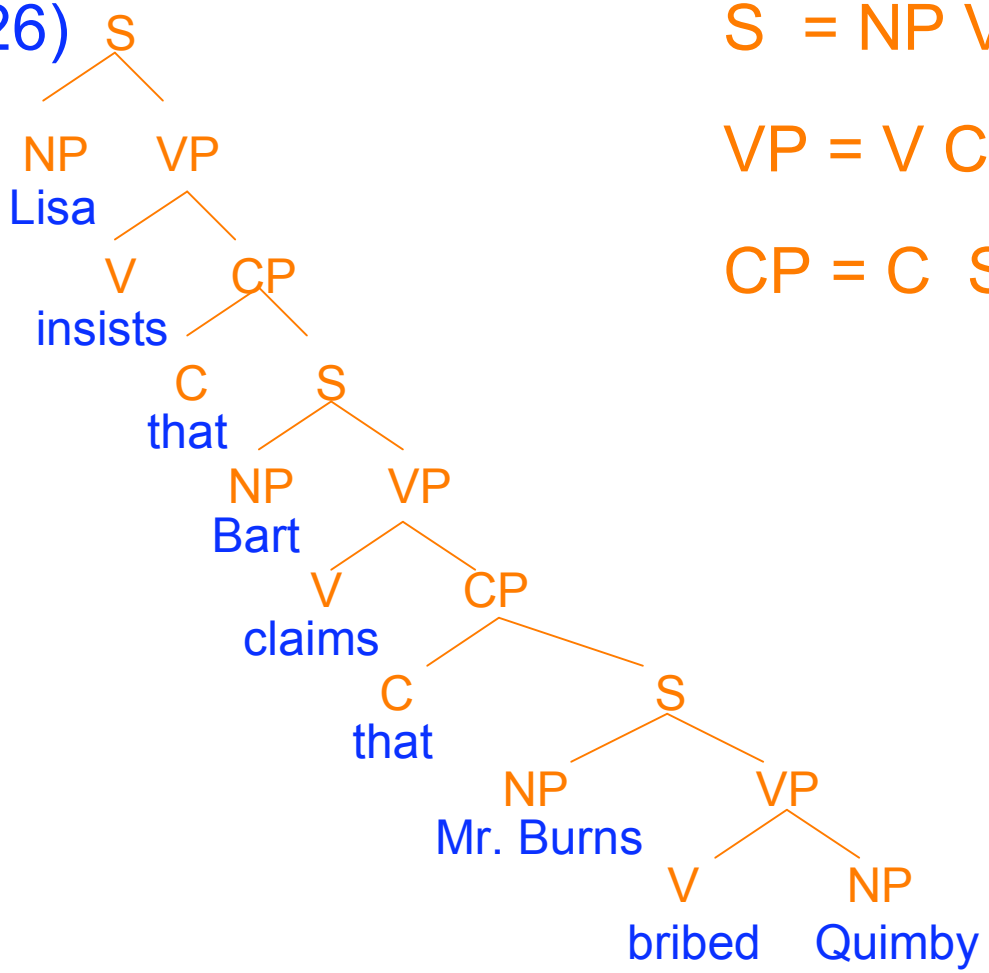

S = NP VP

VP = V C(omplementizer)P

CP = C S

Syntactic recursion

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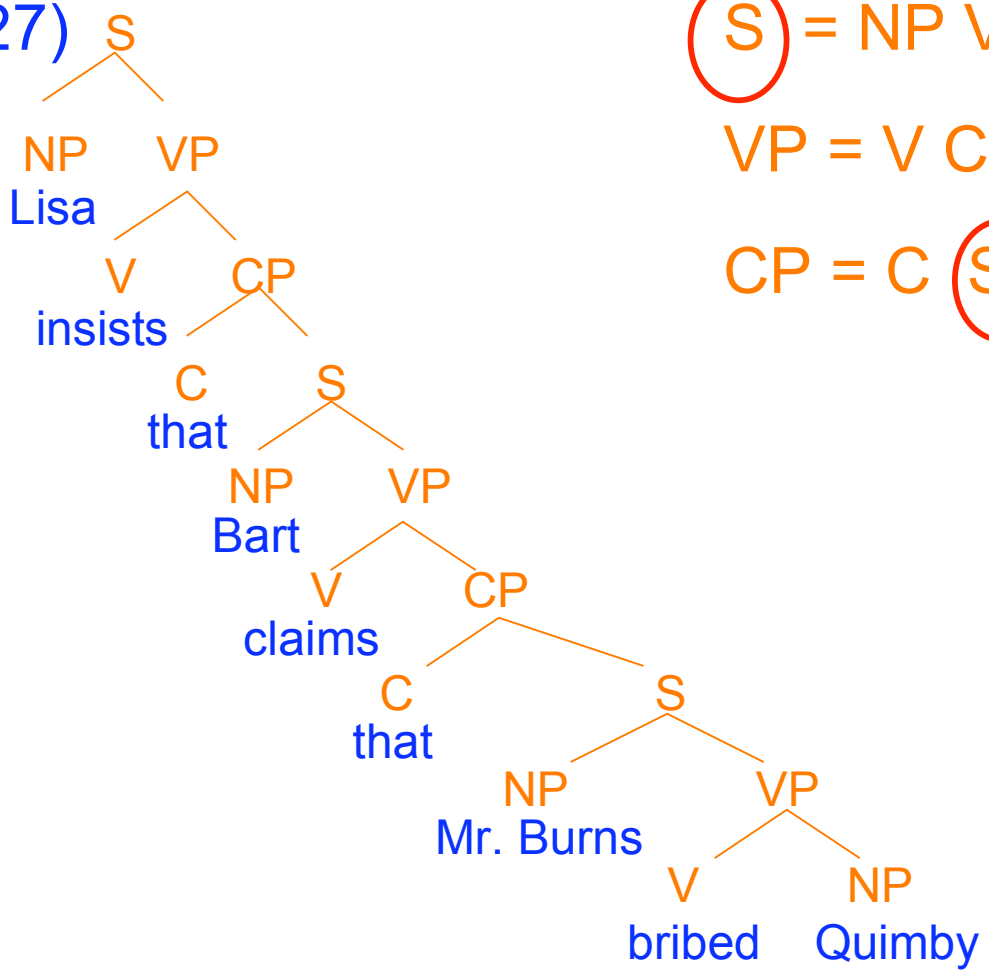

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Nonlocal dependencies

- *wh*-'movement' in questions

(28) Who did Mr. Burns bribe?

- 'Preposing' in contrastive phrase fronting

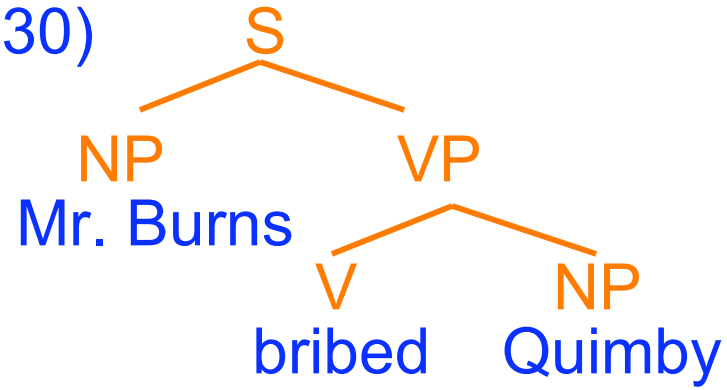
(29) Mayor Quimby, Mr. Burns would never bribe!

  - For purposes of semantic role assignment, syntactic case, etc., the *wh*-word *who* in (28) and *Mayor Quimby* in (29) behave like ordinary objects of the verb *bribe*
  - For purposes of pronunciation, *who/Mayor Quimby* is at the front of the clause: pronounced *before* the verb

Nonlocal dependencies

- Chomsky's solution: Posit two structures and a system of relations between them

(30)



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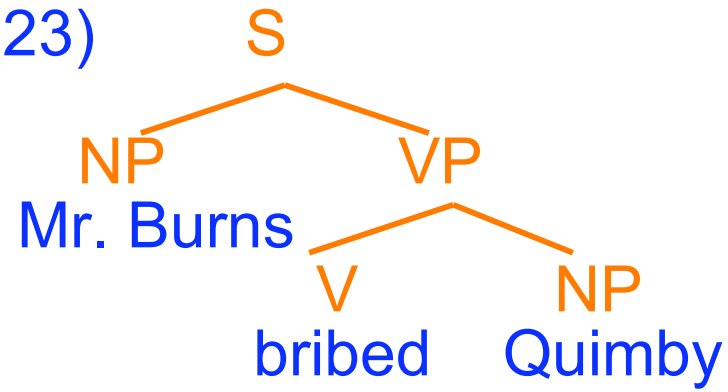

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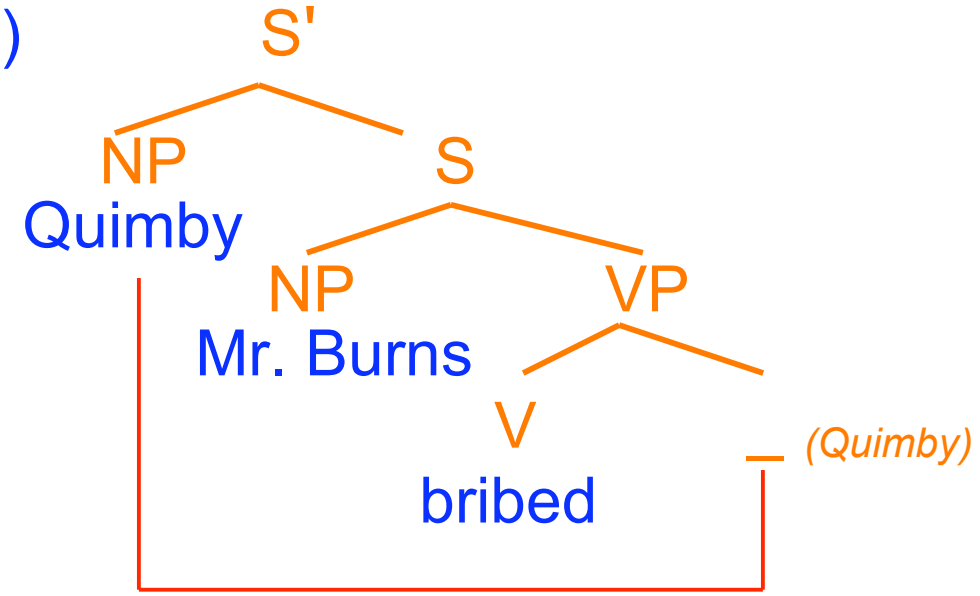

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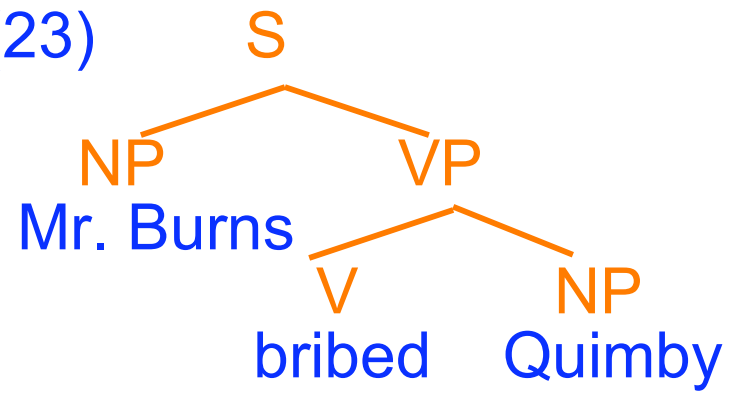

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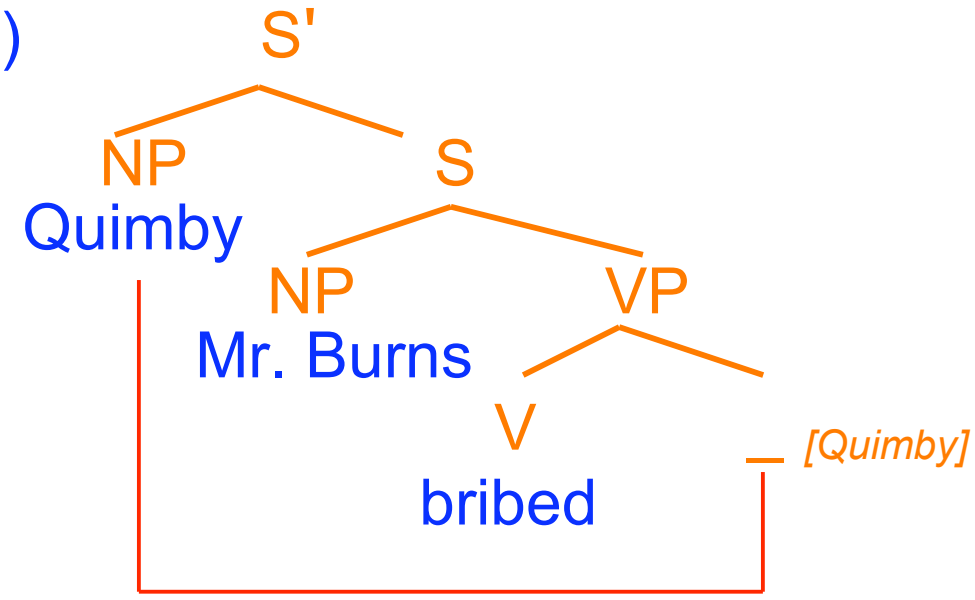


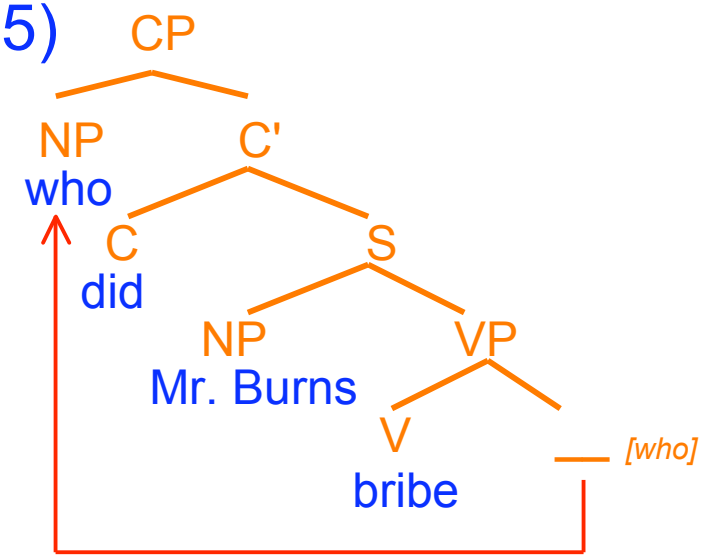
(33)<[Mr. Burns bribed Quimby], [Quimby, Mr. Burns bribed _]>

Nonlocal dependencies

- A constrastive phrase or a question word can be a long distance from its gap (trace):

(34) a. Who did Mr. Burns bribe?

(35)

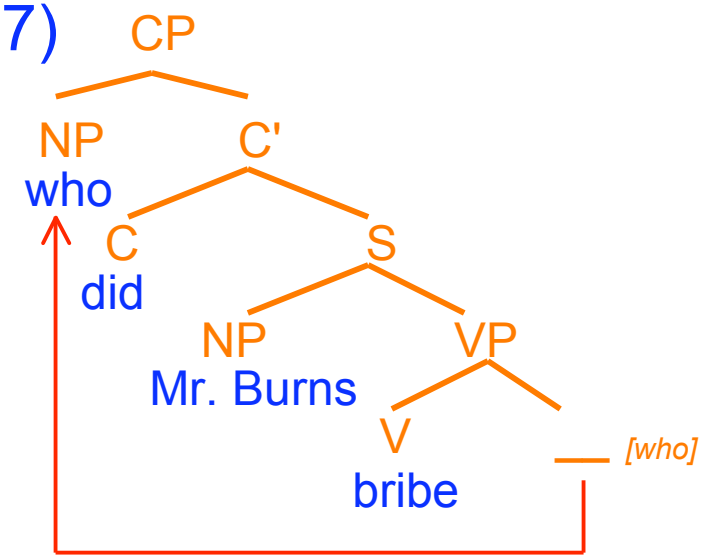


Nonlocal dependencies

- A constrastive phrase or a question word can be a long distance from its gap (trace):

(36) a. Who did Mr. Burns bribe?

(37)



b. Who does Bart claim that Mr. Burns bribed?

c. Who does Lisa insist that Bart claims that Mr. Burns bribed?

Nonlocal dependencies

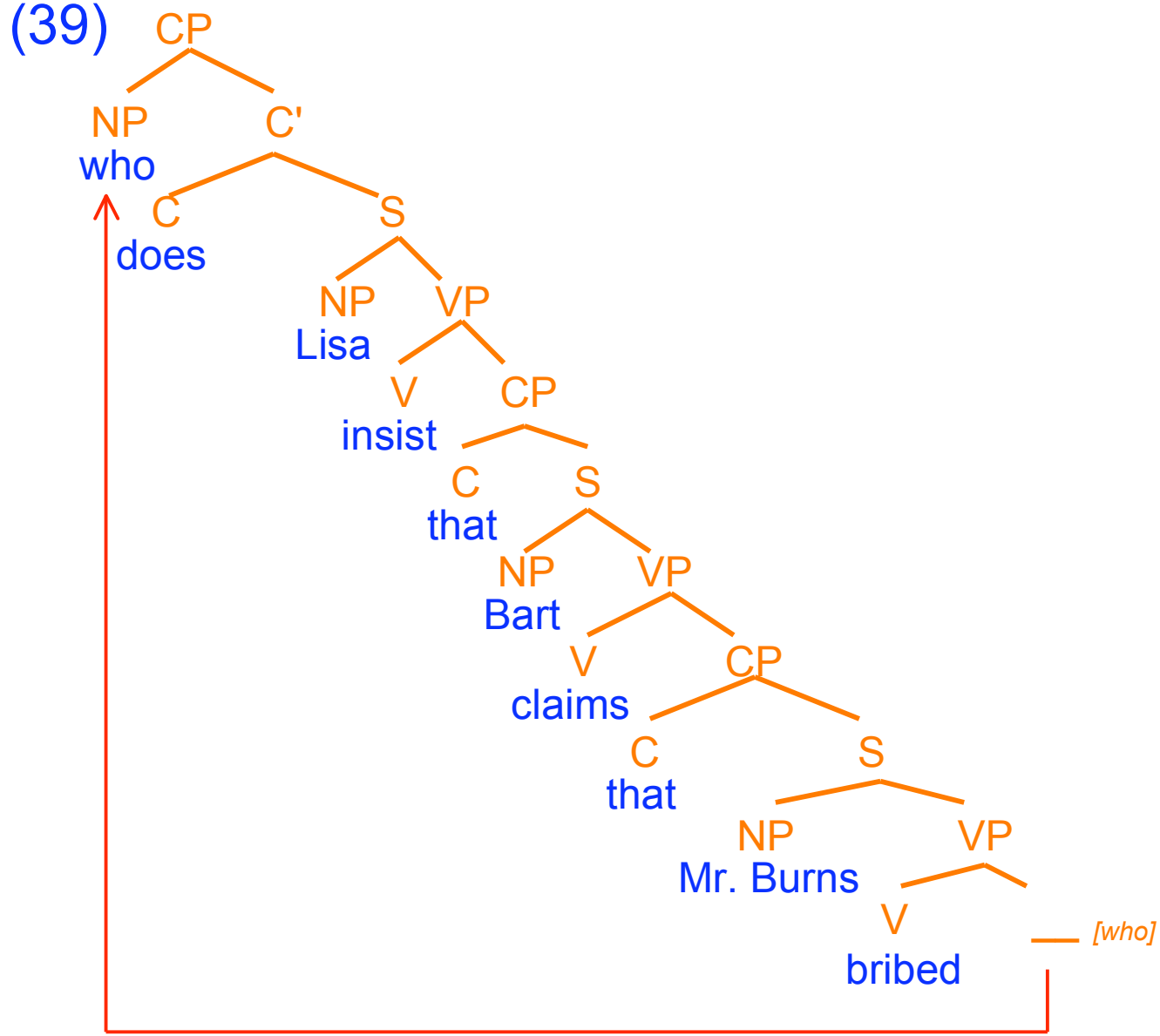
- A constrastive phrase or a question word can be a long distance from its gap (trace):

(38) a. Who did Mr. Burns bribe?
b. Who does Bart claim that Mr. Burns bribed?
c. Who does Lisa insist that Bart claims that Mr. Burns bribed?
d. Who has Marge been saying that Lisa insists that Bart claims that Mr. Burns bribed?
e. Who does$_1$ Homer$_2$ think$_3$ that$_4$ Marge$_5$'s$_6$ been$_7$ saying$_8$ that$_9$ Lisa$_{10}$ insists$_{11}$ that$_{12}$ Bart$_{13}$ claims$_{14}$ that$_{15}$ Mr.$_{16}$ Burns$_{17}$ bribed$_{18}$?

- An apparently *unbounded* distance, in fact: subject to memory and fatigue (performance) limits, but not to a *grammatical* (competence) limit

Nonloal dependencies

(39)



Constraints on nonlocal dependencies

(40) The Empire State Building was completed in the year in which Nora Ivers married a future Prime Minister.

(41) The Empire State Building was completed in the year in which *what actress* married a future Prime Minister?

Constraints on nonlocal dependencies

(40) The Empire State Building was completed in the year in which Nora Ivers married a future Prime Minister.

(41) The Empire State Building was completed in the year in which *what actress* married a future Prime Minister?

(42) *What actress was$_1$ the$_2$ Empire$_3$ State$_4$ Building$_5$ completed$_6$ in$_7$ the$_8$ year$_9$ in$_{10}$ which$_{11}$ __ married a future Prime Minister?

Some characteristics of the syntax of human languages

- Phrase structure and recursion (the heart of productivity in human languages)

(43) The men and the women (and the children (and the birds…)) NP → NP and NP

(44) The (misleading, (devious, (bad-smelling, (nervous, (suspicious, (unfriendly, …)))))) landlord NP → Adj NP

(45) The guy who said that [he was great] wouldn't listen to anyone who didn't think [he was great].

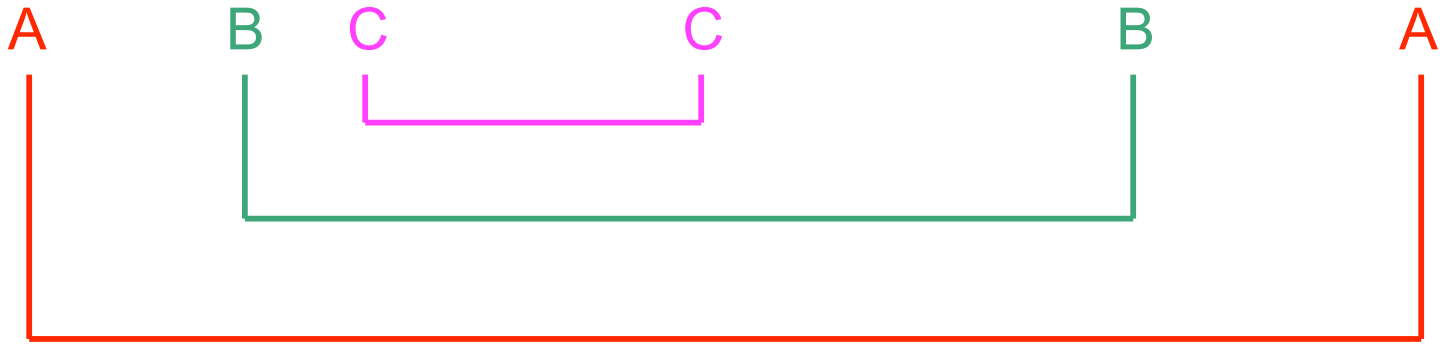
- Nonlocal dependencies
- Constraints on these

Nonlocal dependencies

- Nonlocal dependencies can involve other aspects of form and meaning

(46) In 1993, Enders finally admitted to a reporter, “I now know that the materials that we and the embassy passed on to Congress were wrong.”
(Eric Alterman, *When Presidents Lie*, [2004, Penguin: New York], p. 259)

[the materials [that [[we] and [the embassy]] passed on …] were wrong]



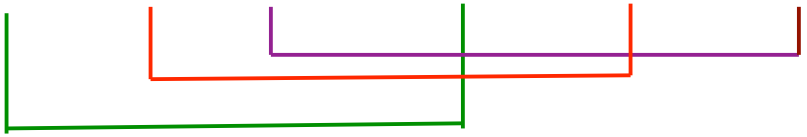
Nonlocal dependencies

Nested dependencies

(47)Who didn't you say that anyone was going to invite?

Cross-serial dependencies (first example from Greek)

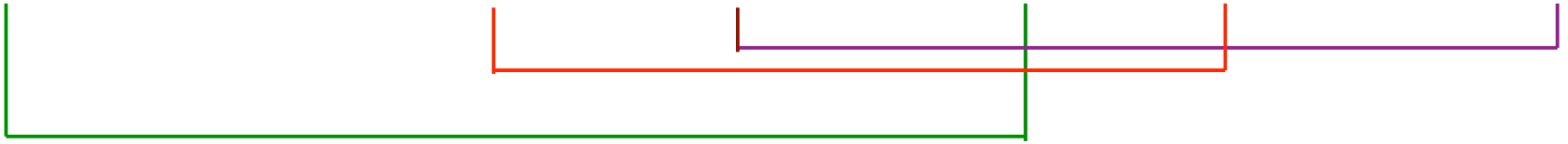
(48)Ego dhen tin idh-a katholou tin tenia.



I not it saw-1s at.all the movie 'I didn't see the movie at all.'

(49)

Any employee's next-of-kin whom a company gave his salary to would thank it.



Recursion and nonlocal dependencies

(50) [Because, more than a decade after the fact, journalist Mark Danner decided to devote himself to discovering the truth of what happened in El Mozote, [today [we have a [far clearer picture [of$_1$ [what$_2$ [administration members$_3$ [who$_4$ tried$_4$ to discredit [journalistic [reports of the massacre]]] knew$_3$ _$_2$ at the time]]] and [of$_1$ what actually took place there]]]]]

(slightly modified from Eric Alterman, *When Presidents Lie*, [2004, Penguin: New York], pp. 258-259)

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Animal communication

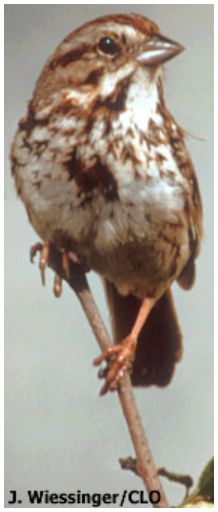
- In the wild
- In controlled settings (in the lab)

Birds

Calls (geese, roosters) vs. song

- **Cuckoo**: sing cuckoo song regardless of environment
- **Bullfinch**: song is entirely learned from its environment
- **Song Sparrow**: some properties of song develop the same no matter what; others depend on environment

Song sparrow

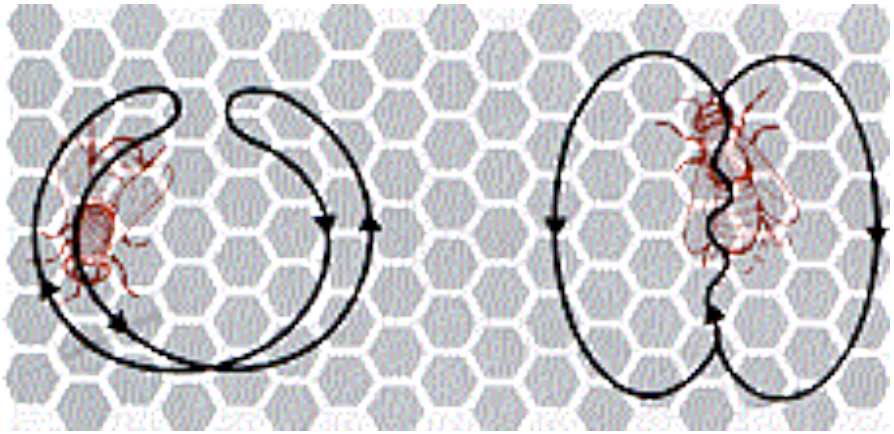


- Song is by males used to mark territory, attract and maintain females
- Song is structured, it consists of motifs arranged into groups.
- Some properties are constant, but there are ‘regional dialects’.
- Babies learn their regional dialect from the adult males.
- Isolated babies get song basics without fine-grained details.
- If the environment has other species, they may develop songs with ‘foreign’ note-groups, but in Song Sparrow patterns.
- To learn their song, they must hear it in the first 50 days or so.
- Specific brain structures control song learning and production

Honeybee dance

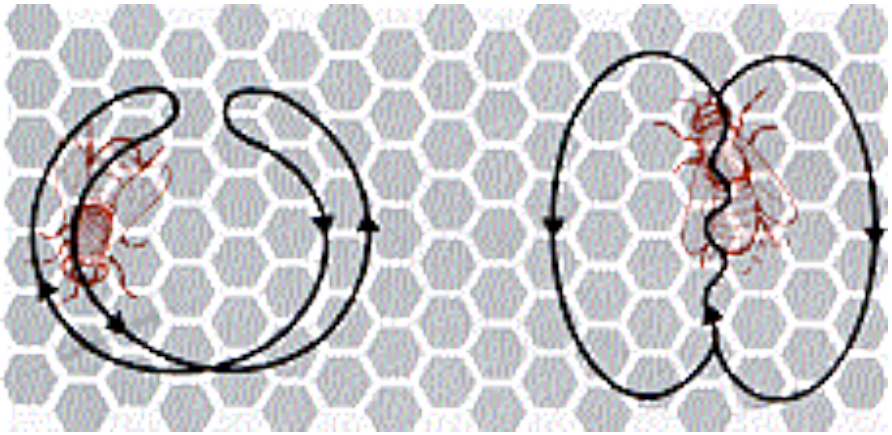
Bee dance indicates distance and direction of food sources (nectar and pollen)

- When food is within 50–75 meters of the hive, the foragers dance the "round dance" on the surface of the comb.
- But when the food is farther than 75 meters from the hive, the foragers dance the "waggle dance"



Honeybee dance

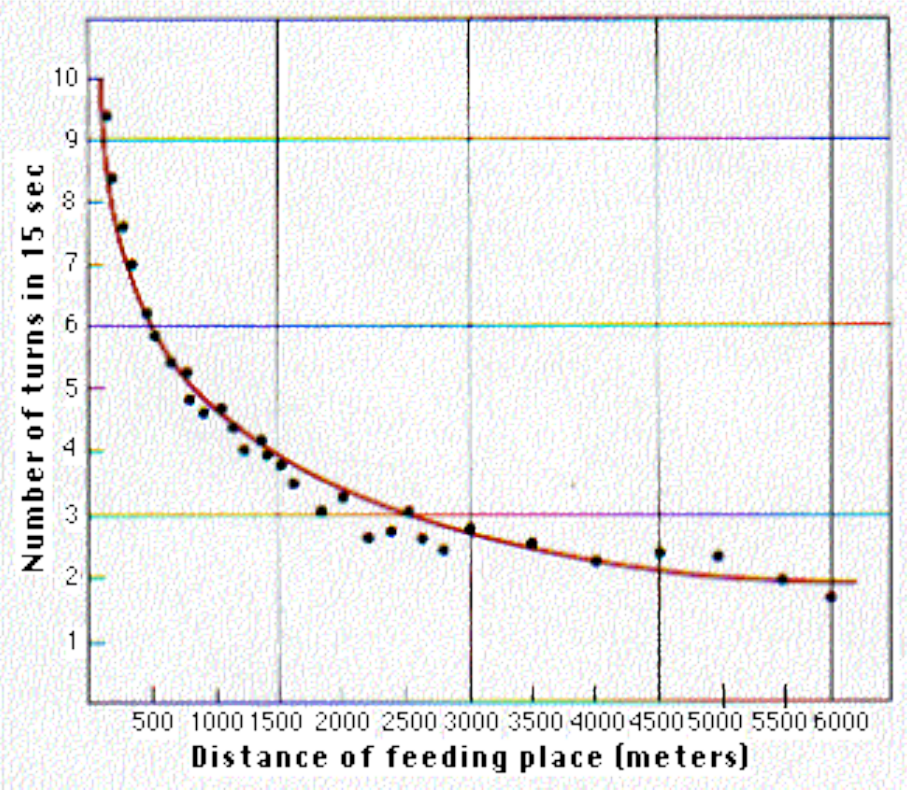
The waggle dance has two components:



Waggle dance components:

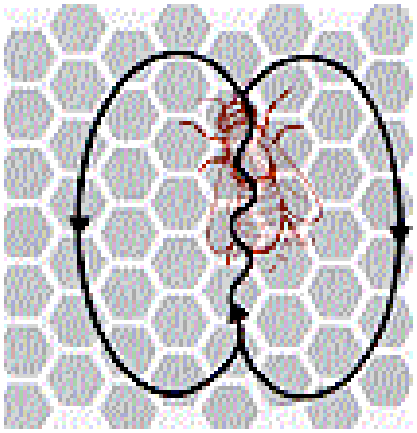
- a waggling run — the direction of which conveys information about the direction of the food
- the speed at which the dance is repeated indicates how far away the food is

Honeybee dance



Speed of the dance is inversely proportional to the bee's perceived distance to the food

Honeybee dance



Waggle dance

- is communication: other worker bees can use the information from the dance to find the food source
- is innate (bees raised in isolation can do the dance)
- is iconic (not symbolic)
- is continuous (not discrete)
- shows ‘displacement’? (only if what is communicated is propositional, and the dance is not instrumental—i.e., not merely an instruction to other bees to ‘fly this way for this far’)

Primates

Vervet monkey calls

Three distinct calls for different predators:

leopard [get up!]
eagle [get down!]
snake [look around]

Are these calls referential? ‘names’? or do they merely express internal states of the monkey (like laughter)?

Primates

Chimpanzees in the wild

1. alarm (wraa)
2. food (aaa)
3. ‘I’m here’ (pant-hoot)
4. greeting, subordinate to dominant (pant-grunt)
5. greeting, dominate to subordinate (soft bark)
6. attacked (scream 1)
7. upset (scream 2)
8. copulating (scream 3)

Animal communication in controlled settings

Wahoe, Nim, Koko

Koko: YOU KOKO LOVE DO KNEE YOU
Experimenter: KOKO LOVE WHAT?
Koko: LOVE THERE CHASE KNEE DO
Observer: The tree, she wants to play in it!
Experimenter: No, the girl behind the tree!

Animal communication in controlled settings

Kanzi (pygmy chimpanzee)

Lexigram keyboard/plastic board

Acquired symbolic (noniconic), noninstrumental, displaced uses

Combinations (6% of total utterances in the study):

CHASE TICKLE
CHASE PERSON(g) (g = gesture)
PERSON(g) CHASE KANZI

The big language question for today, revisited

- What constitutes knowledge of language?
  - What are the structures and entities involved?

Answer: Knowing a language *X* means having a **mental grammar** of *X*

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The big language question for today, revisited

- What constitutes knowledge of language?
  - What are the structures and entities involved?

Answer: Knowing a language *X* means having a **mental grammar** of *X*

But what's the status of the mental grammar in the mind/brain?

- The lexical categories, phrase structure rules, etc. model cognitive structures in the mind of a speaker
- The organizational principles are **abstract** and inaccessible to introspection

If you want to learn more, you can come hear me talk on "Voice heads, multiple case, and the abstractness of syntax" at the annual meeting of the Chicago Linguistics Society, this Friday, April 7, 11:30–12:15, at the International House

Language (mental grammar) is complex

- Human language complexity comes from a finite set of recursive combinatoric operations stated over a finite set of discrete combinators, together with constraints on them

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- Human language complexity comes from a finite set of recursive combinatoric operations stated over a finite set of discrete combinators, together with constraints on them

"Even the simplest sentences contain at least this rich a structure. ... If one wishes to join the conversation about the nature of language, one must recognize and acknowledge this complexity."

Ray Jackendoff, *Foundations of Language: Brain, meaning, grammar, evolution* (2004), p. 18.

- No animal communication system has this kind of complexity