Is language uniquely human?

Language myths and realities
Summer 2007
Καλημέρα. Σας καλωσορίζω στο νέο τρίμηνο και ελπίζω να είχατε όλοι διασκεδαστικές και ξεκουραστικές διακοπές. Το μάθημα αυτό λέγεται «μύθοι και πραγματικότητες για τη γλώσσα». Θα το αρχίσουμε το μάθημα τώρα.
What did she just say?

ekalimerasaskalosorizostoneotriminokeelpizonaixateolidhiaskedhastik
eskeksekurastesdhiakopestomathimaaftoleyeyetemithikepragmatikotite
syatighlosathatoarcisumetora.
What did she just say?

kalimera. sas kalosorizo sto neo trimino ke elpizo na ixate oli dhiaskedhastikes ke ksekurastes dhiakopes. to mathima afto leyete mithi ke pragmatikotites ya ti ghlosa. tha to arcisume tora.
What did she just say?

to mathima afto leyete mithi ke pragmatikotites ya ti ghlosa.  
the course this called.is myths and thing.qualities  for the language

tha to arcisume tora.
will it  start.we  now
kalimera. sas kalosorizo sto neo trimino ke
hello you.all I welcome to.the new quarter and

elpizo na ixate oli dhiaskedhastikes ke ksekurastes dhiakopes.
I.hope to you.had all entertaining and relaxing vacations
to mathima afto leyete mithi ke pragmatikotites ya ti ghlosa.
the course this is.called myths and realities of the language

tha to arcisume tora.
will it we.start now
What did she just say?

‘Hello. Welcome to the new quarter. I hope you all had a fun and relaxing break. This course is called ‘Language Myths and Realities’. We’ll get started now.'
What do you know when you know a language?

- The sounds and intonational patterns
- Words and parts of words
- How words are combined into phrases and sentences
- How such sentences are used
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 discuss some salient characteristics of human language

• 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?
The big questions for today

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

- What properties do animal communication systems share (and not) with human language?
The big questions for today

• What constitutes knowledge of language?
  o 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)
Some characteristics of human language

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- reflexiveness (language can refer to itself and its properties)

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 kinds of grammar

• prescriptive grammar
• descriptive grammar
• mental grammar
Some kinds of rules

- prescriptive ‘rules’
- descriptive ‘rules’
- mental ‘rules’
Some kinds of rules

• prescriptive ‘rules’

Chicago

Texas
Some kinds of rules

• descriptive ‘rules’

In the United States, the 85th percentile rule generally holds. Roughly, 85% of vehicles go at or below the speed limit, and 15% above it. The 85th percentile is slightly greater than a speed that is one standard deviation above the mean of a normal distribution.

\[ F = ma \]
Some kinds of **rules**

- mental (and physical) ‘rules’

The activity in the brain that triggers the series of nerve and motor impulses that travel from brain to foot to increase pressure on the accelerator
Prescriptive grammar
E.g., William Safire's Rules for Writers

1. Remember to never split an infinitive.
2. The passive voice should never be used.
3. Do not put statements in the negative form.
4. Verbs have to agree with their subjects.
5. Proofread carefully to see if you words out.
6. If you reread your work, you can find on rereading a great deal of repetition can be by rereading and editing.
7. A writer must not shift your point of view.
8. And don't start a sentence with a conjunction. (Remember, too, a preposition is a terrible word to end a sentence with.)
9. Don’t overuse exclamation marks!!
10. Place pronouns as close as possible, especially in long sentences, as of 10 or more words, to their antecedents.
11. Writing carefully, dangling participles must be avoided.
12. If any word is improper at the end of a sentence, a linking verb is.
13. Take the bull by the hand and avoid mixing metaphors.
14. Avoid trendy locutions that sound flaky.
15. Everyone should be careful to use a singular pronoun with singular nouns in their writing.
16. Always pick on the correct idiom.
17. The adverb always follows the verb.
Prescriptive grammar

• 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

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

Example:
  1. don’t end a sentence with a preposition (“The lights are on.”)
Descriptive grammar

In English, restrictive relative clauses are formed with a relative pronoun (*who*, *which*), an invariant complementizer (*that*), or with neither.

Examples:

This is the pen which I bought.
This is the pen that I bought.
This is the pen I bought.
Some elements of mental grammar

- Thought
  - Semantic structure
  - Syntactic structure
  - Phonological structure

Other inputs:
- Motor instructions
- Auditory patterns

Other outputs:
A mental grammar is

• a property of the mind/brain of an individual
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 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
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
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
(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
The big truck’s on a street.

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

(2)

\[ \text{x x x} \quad \text{Prosodic structure} \]
\[ \text{x x x} \quad \text{Syllabic structure} \]
\[ \text{σ σ σ σ σ σ σ} \quad \text{Segmental structure} \]

• This is still a vast simplification
  The segments are themselves complex feature bundles:
  \( /s/ = [+\text{consonantal}, -\text{vocalic}, -\text{sonorant}, -\text{nasal}, +\text{continuant}, -\text{voiced}, +\text{coronal}, +\text{anterior}] \)
The big truck’s on a street.

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

- 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:

<table>
<thead>
<tr>
<th>lexical item</th>
<th>lexical category (‘part of speech’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>Art(icle)</td>
</tr>
<tr>
<td>big</td>
<td>A(djective)</td>
</tr>
<tr>
<td>truck</td>
<td>N(oun)</td>
</tr>
<tr>
<td>’s</td>
<td>V(erb)</td>
</tr>
<tr>
<td>on</td>
<td>P(reposition)</td>
</tr>
<tr>
<td>a</td>
<td>Art(icle)</td>
</tr>
<tr>
<td>street</td>
<td>N(oun)</td>
</tr>
</tbody>
</table>
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?
What’s a category?

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

Experiment:

Which of these blocks... fit in this gap exactly?

Experiment:
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?

Experiment:
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.

...
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.
...

• 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.
What’s a lexical category?

- Phonology is insufficient:

  Homophones: ortho- lexical

  (4) a. The [bɛər] was in the woods. <bear> N(oun)
b. We couldn’t [bɛər] the thought. <bear> V(erb)
c. The room was [bɛər]. <bare> A(adjective)
d. The suitcase [bɛər]ly fit in the trunk. <bare> Adv(verb)
What’s a lexical category?

• **Phonology** is insufficient:

  *Homophones:*
  
  (4) a. The [bɛ̃r] was in the woods.  
  b. We couldn’t [bɛ̃r] the thought.  
  c. The room was [bɛ̃r].  
  d. The suitcase [bɛ̃r]ly fit in the trunk.

• **Semantics** (meaning) is insufficient:  
  A noun is not a “person, place, or thing”

  
  (5) *redness, destruction, independence*
What’s a lexical category?

- Likewise for other lexical categories:

Traditional definition of \textbf{V (Verb)}: “A verb describes an action”, e.g., \textit{breathe, enter, interpret, destroy}

But this is neither necessary: \textit{have, be, own, know, love}  
nor sufficient: \textit{destruction, breathing, earthquake}
What’s a lexical category?

• Likewise for other lexical categories:

Traditional definition of V (Verb): “A verb describes an action”, e.g., breathe, enter, interpret, destroy

But this is neither necessary: have, be, own, know, love
nor sufficient: destruction, breathing, earthquake

Traditional definition of A (Adjective): “An adjective describes a property”, e.g. red, hot, sick, insubstantial, quick

Neither necessary: subject (to), proud (of), former, alleged
nor sufficient: redness, warmth, insubstantiality, die, quickly
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...”
Two hypotheses about syntax

Hypothesis 1: Syntax (words in a phrase) as beads on a string
Two hypotheses about syntax

Hypothesis 1: Syntax as beads on a string

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).
Two hypotheses about syntax

Hypothesis 1: Syntax as beads on a string

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

This is equivalent to a kind of finite state automaton:
Two hypotheses about syntax

• Problems for ‘beads on a string’

Structural ambiguity

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

(7) the man in the chair with a broken leg [ambiguous!]
(8) a. The man’s leg is broken.
    b. The chair’s leg is broken.

Repeated elements

(9) 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: a prefixed * means ‘ungrammatical’
Two hypotheses about syntax

Hypothesis 2: Syntax involves abstract structures

Syntactic structure (Phrase structure):

(10)  

S  
  / \  
 NP  VP  
  /   \  
 Art A N V PP  
 \     / \   /  
 the big truck 's on Art N  
   \  /    /  
     on the street  

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 $P$

(11) $NP = \text{Art N}$

(12) $NP$ ((10) = (11))

Art  N

(13) 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

(14) the man in the chair with a broken leg [ambiguous!]
(15) 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

(14) the man in the chair with a broken leg [leg $\rightarrow$ man, chair?]

(15) a. The man’s leg is broken.
    b. The chair’s leg is broken.

(16) NP
    Art   N   PP
    the man
    P
    in
    Art   N   PP
    the chair
    P
    with
    Art   A   N
    the broken leg

(17) NP
    Art   N   PP
    the man
    P
    in
    Art   N   PP
    the chair
    P
    with
    Art   A   N
    the broken leg
Phrase structure ambiguity

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

(14) the man in the chair with a broken leg [leg $\rightarrow$ man, chair?]

(15) a. The man’s leg is broken.
    b. The chair’s leg is broken.

(18) NP
    Art    N     PP
    the man    in
    Art    N     PP
    the chair

(19) NP
    Art    N     PP
    the man
    P        NP
    in
    Art    N     PP
    the chair
    with
    Art    A       N
    the broken leg

(20) the man with a broken leg in the chair [leg $\rightarrow$ man]
More phrase structure ambiguity

(21) competent women and men

(22) 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]

(23) “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).

(24) a. Adverb [VP and VP] or b. [Adverb VP] and [VP] defendant plaintiff
All human languages use phrase structure rules

(16) In the beginning was the Word

Unattested
(17) Alphabetical:
and beginning In the was Word

(18) By length:
in {and, the, was} Word beginning

(19) Consonant-initial > vowel-initial:
was Word beginning the in and
Syntactic recursion

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

Embedding:
(25)  a. Mr. Burns bribed Mayor Quimby.
Syntactic recursion

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

*Embedding:*

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

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

*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

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

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.
Syntactic recursion

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

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.

(26)

```
( S
  ( NP Lisa)
  ( V insists)
  ( CP ( C that)
    ( S
      ( NP Bart)
      ( V claims)
      ( CP ( C that)
        ( S
          ( NP Mr. Burns)
          ( V bribed)
          ( NP Quimby))))))
```
Syntactic recursion

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

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

(27) $S = NP \ VP$

$VP = V \ C(omplementizer)P$

$CP = C \ S$

Tree diagram:

- $S$ is the root node.
- $NP$ represents a noun phrase.
- $VP$ represents a verb phrase.
- $CP$ represents a clause phrase.
- $C$ represents a complementizer.
- $V$ represents a verb.

The diagram shows the syntactic structure of the sentence, with nodes representing the constituents and edges representing the relationships between them.
Syntactic recursion

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

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

(28) \[
\begin{align*}
S &= NP \ VP \\
VP &= V \ C(omplementizer)P \\
CP &= C \ S \\
NP &= Lisa \\
V &= \text{insists} \\
S &= \text{that} \\
NP &= \text{Bart} \\
V &= \text{claims} \\
S &= \text{that} \\
NP &= \text{Mr. Burns} \\
V &= \text{bribed} \\
NP &= \text{Quimby}
\end{align*}
\]
Nonlocal dependencies

- *wh*—‘movement’ in questions

(29) Who did Mr. Burns bribe?

- ‘Preposing’ in contrastive phrase fronting

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

- For purposes of semantic role assignment, syntactic case, etc., the *wh*-word *who* in (29) and *Mayor Quimby* in (30) 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

(31)

```
S
  NP  VP
  Mr. Burns  V  NP
      bribed  Quimby
```
Nonlocal dependencies

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

(23) \[ S \]
\[ \text{NP} \quad \text{VP} \]
\[ \text{Mr. Burns} \quad \text{Quimby} \]
\[ \text{bribed} \quad \text{Quimby} \]

(32) \[ S' \]
\[ \text{NP} \quad S \]
\[ \text{NP} \quad \text{VP} \]
\[ \text{Quimby} \quad \text{Mr. Burns} \quad \text{bribed} \]
\[ (\text{Quimby}) \]
Nonlocal dependencies

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

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

(34)
Nonlocal dependencies

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

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

(36)  b. Who does Bart claim that Mr. Burns bribed?

(36)  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):

(37) 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 Homer think that Marge’s been saying that Lisa insists that Bart claims that Mr. Burns bribed?

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

(38) who
  
  does
  
  Lisa
  
  insist
  
  that
  
  Bart
  
  claims
  
  that
  
  Mr. Burns
  
  bribed

[who]
Constraints on nonlocal dependencies

(39) The Empire State Building was completed in the year in which Nora Ivers married a future Prime Minister.
(40) The Empire State Building was completed in the year in which what actress married a future Prime Minister?
Constraints on nonlocal dependencies

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

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

(41) *What actress was the Empire State Building completed in the year in which ___ married a future Prime Minister?
Some characteristics of the syntax of human languages

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

(42) The men and the women (and the children (and the birds…))

NP → NP and NP

(43) The (misleading, (devious, (bad-smelling, (nervous, (suspicious, (unfriendly, …)))))) landlord

NP → Adj NP

(44) The guy who said that [he was great] wouldn’t listen to anyone who didn’t think [he was great].
Some characteristics of the syntax of human languages

- Phrase structure and recursion (the heart of productivity in human languages)
- Nonlocal dependencies
- Constraints on these
Nonlocal dependencies

- Nonlocal dependencies can involve other aspects of form and meaning

(45) 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.”


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

Nested dependencies
(46) Who didn’t you say that anyone was going to invite?

(47) (center embedding:) And the only thing the doctors they had in there ever treated was stab wounds'


Cross-serial dependencies (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.’
Recursion and nonlocal dependencies

(49) [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 [of₁ [what₂ [administration members₃ [who₄ tried₄ to discredit [journalistic [reports of the massacre]]] knew₃ _₂ at the time]]] and [of₁ what actually took place there]]]]]

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
Animal communication in controlled settings

MD Hauser, N Chomsky, and WT Fitch (‘The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?’ Science 298, 22 Nov 2002) claimed that recursion was the central property that distinguishes human from non-human language abilities.

Center-embedding recursion

Examples:

AB
AABB
AAABBB
AAAABBBB

...  
A^nB^n

Modeled by a context-free phrase structure grammar:

S \rightarrow ASB, S \rightarrow e  \quad (since\ S\ \text{appears\ on\ the\ left\ and\ right\ of\ the\ arrow\ in\ at\ least\ 1\ rule},\ \text{this\ grammar\ is\ recursive})
Starlings and recursion

European starlings were rewarded for pressing a bar in response to $A^nB^n$ strings of starling-generated sounds, such as [rattle rattle warble warble], and were withheld the reward for responses to the $(AB)^n$ grammar (and vice versa for another group of starlings). Nine of eleven birds eventually (after 10,000–50,000 trials) learned to discriminate reliably between the two grammars. (G Marcus 2006)

Starlings and recursion

- Training data: AABB
- Testing stimuli: AAABBB, AAAABBBBB

Starlings have learned to count to four?

Finite-state grammar for \((AB)^n\)

\[
\begin{align*}
S_{\text{start}} & \rightarrow a \rightarrow S_1 \\
S_1 & \rightarrow b \rightarrow S_{\text{end}}
\end{align*}
\]
Starlings and recursion

• Training data: AABB
• Testing stimuli: AAABBBB, AAAABBBBB

Starlings have learned to count to four?

Finite-state grammar for $A^2B^2$:

```
a     a
S_{start} -> aabb
S_{end}  
```

Context-free grammars for $A^2B^2$:

1. $S_{start} \rightarrow aabb$
2. $S_{start} \rightarrow aS_1b$
   $S_1 \rightarrow ab$
Starlings and recursion

- Training data: AABB
- Testing stimuli: AAABBB, AAAABBBB

Starlings have learned to count to four?

Finite-state grammar for $A^2B^2 \cup A^3B^3 \cup A^4B^4$:

```
Context-free grammars:

1. $S_{start} \rightarrow aabb, aaabbb, aaaaabbb$
2. $S_{start} \rightarrow aS_1b$
   $S_1 \rightarrow aS_2b$
   $S_2 \rightarrow aS_3b, S_{end}$
   $S_3 \rightarrow ab, S_{end}$
```

So what did the birds learn?
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
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 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
Language (mental grammar) is complex

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

“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.”


• No animal communication system has this kind of complexity
But what is (a) language, then?

- I-language
  (Individual, internal)

- E-language
  (External)

(N. Chomsky, 1986, *Knowledge of Language*)
Which language has the most words?

English has "as much as two million" 185,000 for German, 130,000 for Russian, and under 100,000 for the poor French

What’s (in) a word?

In the beginning was the word (John 1:1)  

Am Anfang war das Wort  

Contractions are words?  

am = an dem (‘in the’), cf. French au < à le  
won’t < will not
What’s (in) a word?

Different forms of the ‘same’ word are different words?

*he = him?*

If not, then German has 4 cases x 4 genders (3 sing + 1 pl) = 16 ways to say ‘the’ (der, die, das, die, den, die, das, die, dem, der, dem, den, des, der, des, der) (or only 6?)

*be=am=are=is=was=were=being=been?*
*go=goes=went=going=gone?*
*play=plays=played=playing?*

If not, then Greek has 6 persons x 2 aspects x 2 voices x 2 tenses = 48 forms for every verb
What’s (in) a word?

What about compounds?

fire
fireman
fire-truck
fire hydrant
fire insurance
fire retardant
fire X
What’s (in) a word?

fire
department
defartment property
defartment property insurance
defartment property insurance policy
defartment property insurance policy sales
defartment property insurance policy sales agent
defartment property insurance policy sales agent phone
defartment property insurance policy sales agent phone line
defartment property insurance policy sales agent phone line component

defartment property insurance policy sales agent phone line component manufacturer

defartment property insurance policy sales agent phone line component manufacturer workplace insurance …
What’s (in) a word?

fire
fire department
fire department property
fire department property insurance
fire department property insurance policy
fire department property insurance policy sales
fire department property insurance policy sales agent
fire department property insurance policy sales agent phone
fire department property insurance policy sales agent phone line component
fire department property insurance policy sales agent phone line component manufacturer
fire department property insurance policy sales agent phone line component manufacturer workplace insurance …

*In German:* Feuerwehr-eigentumsversicherungsverkäufer-telefonkabelkomponentenherstellerarbeitsplatzversicherung…
How many ‘words’ do you know?

• In his complete works, Shakespeare used 31,534 different words
• Shakespeare knew approximately 66,534 words.

How many ‘words’ do you know?

Homework for Thursday:
   Estimate the number of ‘words’ you ‘know’

Method:

Take an unabridged dictionary of English. Open to a random page: count the number of entries on that page. Ask yourself for each entry whether you 1. would understand the word if you heard it in the context of a sentence (\(=x\)), and 2. whether you have ever yourself used the word in speech or writing (\(=y\)). Multiple \(x\) and \(y\) by (1) the number of pages in the dictionary that have entries and then (2) (the total number of claimed entries in the dictionary [found on the cover or in the introduction]) divided by (the total number of entries on the page you looked at).

Repeat, but now counting every form of every word on the page (for nouns: plural vs singular; for adjectives: comparative, superlative; for verbs: all parts). Take results with large grain of salt.