The psychological reality of phrase structure

- In speaking and writing we string words together linearly (we have no choice)
- But in our minds, we represent sentences as hierarchical structures

Evidence that we mentally represent sentences as hierarchical structures

- Our own analysis of yes-no questions

The man who is watching the Simpsons is laughing.
The man who is watching the comedian who is impersonating Bush is laughing.
The man is laughing at the comedian who is impersonating Bush.

Evidence that we mentally represent sentences as hierarchical structures

- Our own analysis of yes-no questions

- Intuitions about structural ambiguity
Structurally ambiguous sentences

a. The spy saw the cop with the binoculars.

b. The lifeguard rescued the swimmer with no clothes on.

c. John said Bill left yesterday.

d. Wallace decided to visit Gromit in the bathtub.

What determines HOW you can string words together?

Since we can understand one string of words as having 2 different meanings, we must represent intermediate levels of structure mentally.
An Account that Won’t Work

• “You just string words together in an order that makes sense”

  in other words...

Syntax is determined by Meaning

Syntax is More than Meaning (I)

• Well-formed sentences with no meaning
  1a. Colorless green ideas sleep furiously. (Chomsky)
  1b. A verb crumpled the milk.
  1c. I gave the question a scuba-diving egg.

• Ill-formed sentences with no meaning
  2a. *Furiously sleep ideas green colorless.
  2b. *Milk the crumpled verb a.
  2c. *The question I an egg scuba-diving gave.

Syntax is More than Meaning (I)

• Well-formed sentences with no meaning

  ’Twas brillig and the slithy toves
  Did gyre and gimble in the wabe;
  All mimsy were the borogroves,
  And the mome raths outgrabe
  Beware the Jabberwock, my son!
  The jaws that bite, the claws that catch!
  Beware the Jujub bird, and shun
  The frumious Bandersnatch!”

  Lewis Carroll, Jabberwocky

Syntax is More than Meaning (I)

• Ill-formed sentences with no meaning

  ’Toves slithy the and brillig ’twas
  wabe the in gimble and gyre did...

  Lewis Carroll, Jabberwocky
Syntax is More than Meaning (II)

• Ill-formed sentences that make perfect sense (3d)
  3a. Wendolene put the sweater on.
  3b. Wendolene put on the sweater.
  3c. Wendolene put it on.
  3d. *Wendolene put on it.

Syntax is More than Meaning (II)

• Ill-formed sentences that make perfect sense (4d)
  4a. Tony gave a book to her.
  4b. Tony gave her a book.
  4c. Tony donated a book to her.

Syntax is More than Meaning (II)

• Ill-formed sentences that make perfect sense (5d, 5e, 5f, 5g)
  5a. Wallace made Gromit leave.
  5b. Wallace let Gromit leave.
  5c. Wallace saw Gromit leave.
  5e. *Wallace made Gromit to leave.
  5f. *Wallace let Gromit to leave.
  5g. *Wallace saw Gromit to leave.
  5h. Wallace wanted Gromit to leave.

Syntax is More than Meaning (II)

• Cross-language Variation
  If syntax was entirely determined by meaning, then we should not expect to find syntactic differences between languages of the world.
  6a. English: John sees that book.
Syntax is More than Meaning (III)

• Cross-language Variation
  If syntax was entirely determined by meaning, then we should not expect to find syntactic differences between languages of the world.

7a. English: John speaks with Bob.

Syntax is More than Meaning (III)

• Cross-language Variation
  If syntax was entirely determined by meaning, then we should not expect to find syntactic differences between languages of the world.

8a. English: Bob put the money in the cupboard.
8b. Selayerese:

So...

What DOES determine how you can string words together?

Answer: SYNTAX.
That is, our knowledge of the possible FORMS of sentences in our language

Goals of Syntactic Theory

• Build a grammar that generates all possible sentences of English: A Generative Grammar
• Explain cross-language universals and cross-language variation in the possible forms of sentences

*It would be a HUGE BONUS if the theory could explain how children acquire syntactic knowledge so quickly and with so few errors
A Template

• A sentence consists of a Noun Phrase followed by a Verb Phrase

• $S \rightarrow NP\ VP$

Terminology

A phrase structure rule

• $S \rightarrow NP\ VP$

Terminology

• $S \rightarrow NP\ VP$

A phrase structure tree

Fred
the cat
fed the dog
tiptoed through the tulips
left
said that he thought that
the weather was turning
out better than expected
kicked the bucket

seven Peruvian llamas
Samantha
a feeling
the strangest story that
you ever did hear

slept
fed the dog
tiptoed through the tulips
left
said that he thought that
the weather was turning
out better than expected
kicked the bucket
Types of NPs

NP
N
dog, dogs,
fieldmice,
quiche,
sheep
Oswald
Ruby, I, me,
he, we, us

NP
Det N
the dog, a boy
those cats,
these people,
that guy

Types of VPs

VP
V NP
chased me,
saw fieldmice,
love Ruby,
hate dogs
dogs,
fieldmice,
sheep
Oswald
Ruby, me, us

VP
V
slept, left,
arrived,
smiled,
coughed
waved
ate

Types of VPs

VP
V NP
chased the
dog, saw a boy,
love these
people,
hate that guy

Types of VPs

VP
V
slept, left,
arrived,
smiled,
coughed
waved
ate

A Tiny Grammar

• 5 Rules

VP
V
slept, left,
arrived,
smiled,
coughed
waved
ate

NP
N

NP
Det

• 9 Words

Det: the, four, some
N: dogs, cats, slugs
V: understood, ate, approached

How Many Sentences?
468

NPs:
dog, dogs,
fieldmice,
quiche,
sheep
Oswald
Ruby, I, me,
he, we, us

VPs:
slept, left,
arrived,
smiled,
coughed
waved
ate

NPs:
the dog, a boy
those cats,
these people,
that guy

VPs:
chased the
dog, saw a boy,
love these
people,
hate that guy

A Tiny Grammar

• 5 Rules

VP
V
slept, left,
arrived,
smiled,
coughed
waved
ate

NP
N

NP
Det

• 9 Words

Det: the, four, some
N: dogs, cats, slugs
V: understood, ate, approached

How Many Sentences?
468
A Tiny Grammar

- 5 Rules
- 30 Words

\[
\begin{align*}
S & \rightarrow NP \ VP \\
NP & \rightarrow \text{Det} \ N \\
NP & \rightarrow N \\
VP & \rightarrow V \ NP \\
VP & \rightarrow V \\
\end{align*}
\]

Det: 10
N: 10
V: 10

How Many Sentences?
122,100

Embedded Sentences

Gromit ate the cheese.
Wallace thinks Gromit ate the cheese.
Wendolene said Wallace thinks Gromit ate the cheese.
And so on ad infinitum…

Question: What new rule do sentences like this call for?
- VP → V S

Recursion

- VP → V S
- S → NP VP

The leap to hyperspace: Recursion

A recursive rule is one which can be applied over and over again to its own output.

Recursive rules make the generative power of a system infinite!
Complementizer
Words like THAT, IF, WHETHER that allow one sentence to be the subject or object of another sentence

- Wendolene realized that Wallace fed Gromit
- S' → Comp S
- VP → V S'

Our mini grammar

S  → NP VP
S  → S' VP
NP → Det N
NP → N
VP → V NP
VP → V
VP → V S
VP → V S'
S' → Comp S

Complementizer
Words like THAT, IF, WHETHER that allow one sentence to be the subject or object of another sentence

- That Wallace fed Gromit was patently obvious.
- S → S' VP

Structurally ambiguous sentences

- a. The spy saw the cop with the binoculars.
- PP→> P NP
Structurally ambiguous sentences

a. The spy saw the cop with the binoculars.

How should we expand our mini grammar?

\[
\begin{align*}
S & \rightarrow NP \ V P \\
S & \rightarrow S' \ V P \\
NP & \rightarrow \text{Det} \ N \\
NP & \rightarrow N \\
NP & \rightarrow NP \ PP \quad \text{(NP modifier rule)} \\
PP & \rightarrow P \ NP \\
VP & \rightarrow V \ NP \\
VP & \rightarrow V \\
VP & \rightarrow V \ S \\
VP & \rightarrow V \ S' \\
VP & \rightarrow VP \ PP \quad \text{(VP modifier rule)} \\
S' & \rightarrow \text{Comp}
\end{align*}
\]

Are any of these new rules recursive?

Trees Program
So you plug these little trees together like puzzle pieces to get more and more complex structures

Homework #2

By Wednesday you should have attempted 2) through 4)

Note: 4e) requires you to use a new Phrase Structure Rule. See if you can figure out what it is.

Hand in everything on Monday, Feb. 28th