LSci 51/Psych 56L: Acquisition of Language

Lecture 17
Development of syntax I
Announcements

HW 5 is due 11/25/19 - be working on it

Be working on the review questions for morphology and syntax

Consider taking language science courses next quarter (LSci)!
Adult knowledge:
The target state for syntax
Adult knowledge:
The target state for syntax
Adult knowledge: The target state for syntax

"No" is a complete sentence.

"No" is a complete sentence. "No" is a complete sentence. "No" is a complete sentence.

Creativity of human language

Ability to combine signs with simple meanings to create
(1) Utterances with complex meanings
(2) Novel expressions
(3) *Infinitely* many

Sentences never heard before...

“*Some tulips are starting to samba across the chessboard.*”
Creativity of human language

Ability to combine signs with simple meanings to create
(1) Utterances with complex meanings
(2) Novel expressions
(3) *Infinitely* many

Sentences of prodigious length…

“Sir Didymus said…”
Creativity of human language

Ability to combine signs with simple meanings to create
(1) Utterances with complex meanings
(2) Novel expressions
(3) *Infinitely* many

Sentences of prodigious length…

“Sir Didymus said that he thought…”
Creativity of human language

Ability to combine signs with simple meanings to create
(1) Utterances with complex meanings
(2) Novel expressions
(3) *Infinitely* many

Sentences of prodigious length...

"Sir Didymus said that he thought that the odiferous leader of the goblins had it in mind..."
Sentences of prodigious length...

“Sir Didymus said that he thought that the odiferous leader of the goblins had it in mind to tell the unfortunate princess...”
Creativity of human language

Ability to combine signs with simple meanings to create

(1) Utterances with complex meanings
(2) Novel expressions
(3) Infinitely many

Sentences of prodigious length...

“Sir Didymus said that he thought that the odiferous leader of the goblins had it in mind to tell the unfortunate princess that the cries that she made during her kidnapping from the nearby kingdom ...”
Creativity of human language

Ability to combine signs with simple meanings to create
(1) Utterances with complex meanings
(2) Novel expressions
(3) *Infinitely* many

Sentences of prodigious length…

“Sir Didymus said that he thought that the odiferous leader of the goblins had it in mind to tell the unfortunate princess that the cries that she made during her kidnapping from the nearby kingdom that the goblins themselves thought was a general waste of countryside …”
Creativity of human language

Ability to combine signs with simple meanings to create

1. Utterances with complex meanings
2. Novel expressions
3. \textit{Infinitely} many

“So there is another hidden abstraction here which children with autism find a lot of difficulty coping with, and that's the fact that you can modify words and you can arrange them to have different meanings, to convey different ideas. Now, this is what we call grammar. And grammar is incredibly powerful, because grammar is this one component of language which takes this finite vocabulary that all of us have and allows us to convey an infinite amount of information, an infinite amount of ideas. It's the way in which you can put things together in order to convey anything you want to.”

https://www.ted.com/talks/ajit_narayanan_a_word_game_to_communicate_in_any_language
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”
(The way words are put together is determined solely by what they mean)
Syntax is more than meaning

Nonsense sentences with clear syntax

Colorless green ideas sleep furiously. (Chomsky)
A verb crumpled the ocean.
I gave the question a goblin-shimmying egg.

...which are incomprehensible when the syntax is nonsense
  *Furiously sleep ideas green colorless.
  *Ocean the crumpled verb a.
  *The question I an egg goblin-shimmying gave.
Oh spoons may dangle from a cow
With laughter ten feet tall;
But all I want to know is how
It makes no sense at all.

Oh shirts may sing
to books who pout
In rather rigid lines;
But all I want to turn about
Is how the world unwinds.
Famous nonsense sentences with clear syntax

‘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 Jubjub bird, and shun
The frumious Bandersnatch!”

- Lewis Carroll, *Jabberwocky*
'It seems very pretty,' she said when she had finished it, 'but it's RATHER hard to understand!' (You see she didn't like to confess, even to herself, that she couldn't make it out at all.) 'Somehow it seems to fill my head with ideas -- only I don't exactly know what they are! However, SOMEBODY killed SOMETHING: that's clear, at any rate --'
Syntax is more than meaning

And these same nonsense sentences with nonsense syntax are incomprehensible…

‘Toves slithy the and brillig ‘twas wabe the in gimble and gyre did…
Syntax is more than meaning

Ungrammatical sentences that make perfect sense

Jareth put the cape on.
Jareth put on the cape.

Jareth put it on.
*Jareth put on it.
Syntax is more than meaning

Ungrammatical sentences that make perfect sense

Sarah gave a ring to the Wiseman.
Sarah gave him a ring.

Sarah donated a ring to the Wiseman.
*Sarah donated him a ring.
Syntax is more than meaning

Ungrammatical sentences that make perfect sense

Jareth made Hoggle leave.
Jareth let Hoggle leave.
Jareth saw Hoggle leave.
*Jareth wanted Hoggle leave.

*Jareth made Hoggle to leave.
*Jareth let Hoggle to leave.
*Jareth saw Hoggle to leave.
Jareth wanted Hoggle to leave.
Syntax is more than meaning

Ungrammatical sentences that make perfect sense

Hoggle poked at the wall.
Hoggle hit at the wall.
*Hoggle touched at the wall.

*Hoggle poked the stick against the wall.
Hoggle hit the stick against the wall.
*Hoggle touched the stick against the wall.
Syntax is more than meaning

Cross-linguistic variation

If syntax was entirely determined by meaning, then we should not expect to find syntactic differences between languages of the world….but we do see variation.

English: Sarah sees that book.

Korean: Sarah ku chayk poata.
          Sarah that book see
Syntax is more than meaning

Cross-linguistic variation

If syntax was entirely determined by meaning, then we should not expect to find syntactic differences between languages of the world….but we do see variation.

English:
Baso put the money in the cupboard.

Selayarese (spoken in Indonesia):
Lataroi doe injo ri lamari injo i Baso.
put money the in cupboard the Baso
So…what does determine how you string words together?

Answer: Syntax!
(That is, our knowledge of the possible *forms* of sentences in our language.)

“Syntax is determined by *Meaning*”
(The way words are put together is determined solely by what they mean.)
A template

A sentence often consists of a **Noun Phrase** followed by a **Verb Phrase**

\[ S \rightarrow \text{NP} \text{ VP} \]

Phrase Structure Rule

Phrase Structure Tree
<table>
<thead>
<tr>
<th>Noun Phrase</th>
<th>Verb Phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoggle</td>
<td>slept</td>
</tr>
<tr>
<td>The chicken</td>
<td>tricked the guards</td>
</tr>
<tr>
<td>Seven goblins</td>
<td>left</td>
</tr>
<tr>
<td>Sarah</td>
<td>said that Ludo thought that pixies were nasty</td>
</tr>
<tr>
<td>A feeling</td>
<td>kicked the bucket</td>
</tr>
<tr>
<td>The strangest story</td>
<td>got drunk on dwarf wine</td>
</tr>
<tr>
<td>that you ever did hear</td>
<td></td>
</tr>
</tbody>
</table>
A template

Noun Phrase

Hoggle
The chicken
Seven goblins
Sarah
A feeling
The strangest story that you ever did hear

Verb Phrase

slept
tricked the guards
left
said that Ludo thought that pixies were nasty
kicked the bucket
got drunk on dwarf wine

6 Sentences
A template

Noun Phrase
Hoggle
The chicken
Seven goblins
Sarah
A feeling
The strangest story
that you ever did hear

Verb Phrase
slept
tricked the guards
left
said that Ludo thought that
pixies were nasty
kicked the bucket
got drunk on dwarf wine

36 Sentences
A template

Noun Phrase

NP --> Det N
"the penguin"
NP "a kitty"

NP --> N
"penguins"
NP "Sigmund"

Verb Phrase

VP --> V NP
"ate a fish"
"hugged a kitty"

VP --> V
"sneezes"
"slept"
A tiny little grammar

5 Rules

S → NP VP

NP → Det N

NP → N

VP → V NP

VP → V

9 Words

Det: the, four, some

N: goblins, crystals, peaches

V: understood, ate, approached

468 Sentences
A tiny little grammar

5 Rules

S --> NP VP
NP --> Det N
NP --> N
VP --> V NP
VP --> V

30 Words
10 Determiners
10 Nouns
10 Verbs

122,100 Sentences
Additional VP Rule

Hoggle thought Sarah ate the peach.

VP $\rightarrow$ V S

Can be used to create a sentence-inside-a-sentence = example of recursion

Recursion = a phrase of one kind inside a phrase of the same kind (a sentence is a kind of phrase, so a sentence-inside-a-sentence fits this definition)
Recursion: the LingSpace

http://www.thelingspace.com/episode-86,
https://www.youtube.com/watch?v=q9g77Wj5wr0

1:34-2:30 = recursion
Recursion: the LingSpace

http://www.thelingspace.com/episode-86,
https://www.youtube.com/watch?v=q9g77Wj5wr0

5:07-5:31 = long recursive example

Fred’s belief that the people who live on the station that Alex calls home refused to surrender influenced whether the inhabitants running out of water is as crazy as it sounds.
Recursion

Additional VP Rule

Hoggle thought Sarah ate the peach.  
VP → V S

Infinitely many sentences can be generated!

Ludo said Hoggle thought Sarah ate the peach.  
The fairy claimed Ludo said Hoggle thought Sarah ate the peach.  
The Wiseman’s birdhat hoped the fairy claimed Ludo said Hoggle thought Sarah ate the peach.
Recursion

We can also see this property in English noun phrases

\[ NP \rightarrow NP\text{'s} \text{ Noun} \]

Sarah’s friend is a dwarf.
Sarah’s friend’s uncle is a dwarf.
Sarah’s friend’s uncle’s neighbor is a dwarf.
I met a traveler from an antique land who said: "I met a traveler from an antique land, who said: "I met..."
Recursion

http://xkcd.com/1739/

WHAT ARE YOU WORKING ON?

TRYING TO FIX THE PROBLEMS I CREATED WHEN I TRIED TO FIX THE PROBLEMS I CREATED WHEN I TRIED TO FIX THE PROBLEMS I CREATED WHEN...
"What if I know what I don't know, but I don't know how to know what I need to know to know what I don't know?"
Recursion

http://hyperboleandahalf.blogspot.com/2010/02/please-stop.html

Me: "It's a free country! I can sit on your bed if I want!"

My sister: "PLEASE STOP!"

Me: "PLEASE STOP SAYING PLEASE STOP!"

My sister: "PLEASE STOP TELLING ME TO PLEASE STOP SAYING PLEASE STOP!"

Me: "PLEASE STOP TELLING ME TO PLEASE STOP TELLING YOU TO PLEASE STOP SAYING PLEASE STOP!"

We had discovered a glitch in the system -- Please Stop was flawed. It could be used against itself infinitely, thereby becoming useless. We were in a goddamn Mexican standoff.
Complementizers: the LingSpace

http://www.thelingspace.com/episode-86,
https://www.youtube.com/watch?v=q9g77Wj5wr0

2:31 - 4:30 = complementizers

Note: In structure examples,

\[ DP = NP \]

\[ TP = S \]

\[ CP = S' \]

for our purposes
Clauses as subjects or objects: 
the LingSpace

http://www.thelingspace.com/episode-86, 
https://www.youtube.com/watch?v=q9g77Wj5wr0

4:56 - 5:07 = clauses as subjects or objects
Complementizer

Complementizer (Comp): words like THAT, IF, and WHETHER that allow one sentence to be the subject or object of another sentence

Hoggle realized that Sarah ate the peach. Whether Sarah ate the peach didn’t matter.

S’ → Comp S
VP → V S’
S → S’ VP
Complementizer (Comp): words like THAT, IF, and WHETHER that allow one sentence to be the subject or object of another sentence.

Hoggle realized that Sarah ate the peach. Whether Sarah ate the peach didn’t matter.

Example of Recursion 1:
S expands to include S’
S’ expands to include S

S → S’ VP → Comp S VP
Complementizer (Comp): words like THAT, IF, and WHETHER that allow one sentence to be the subject or object of another sentence.

Hoggle realized that Sarah ate the peach. Whether Sarah ate the peach didn’t matter.

Example of Recursion 2:
S expands to include VP
VP expands to include S’
S’ expands to include S

S \rightarrow S’ \rightarrow S’ V S’ \rightarrow S’ V Comp S
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Hoggle likes jewels.
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Hoggle likes jewels.

S --> NP VP
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Hoggle likes jewels.

S  --> NP VP
NP  --> N
VP  --> V NP
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Hoggle likes jewels.

\[
\text{S} \quad \rightarrow \text{NP VP} \\
\text{NP} \quad \rightarrow \text{N} \\
\text{VP} \quad \rightarrow \text{V NP} \\
\text{N} \\
\text{V} \\
\text{NP} \\
\text{NP} \quad \rightarrow \text{N} \\
\text{V} \\
\text{NP} \\
\text{NP} \quad \rightarrow \text{N} \\
\text{N}
\]
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Hoggle likes jewels.

S  -->  NP  VP
NP  -->  N
VP  -->  V  NP
N
V
NP
Hoggle
likes
NP  -->  N
jewels
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Hoggle likes jewels.

```
S
   /  \
NP   VP
   /  \    
N   V    NP
   /      /
Hoggle  likes
   /  \     
   N   jewels
```
A slightly bigger grammar

9 Rules

\[ S \rightarrow NP\ VP \]
\[ S \rightarrow S'\ VP \]
\[ NP \rightarrow \text{Det}\ N \]
\[ NP \rightarrow N \]
\[ VP \rightarrow V\ NP \]
\[ VP \rightarrow V \]
\[ VP \rightarrow V\ S \]
\[ VP \rightarrow V\ S' \]
\[ S' \rightarrow \text{Comp}\ S \]

Sentences it can generate:

Sarah thought that she solved the Labyrinth.
A slightly bigger grammar

9 Rules

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

Sentences it can generate:
Sarah thought that she solved the Labyrinth.
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

S --> NP VP

NP --> N

VP --> V S’
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

S  --> NP VP
NP  --> N
VP  --> V S'
N  V  S'
Sarah  thought
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

\[
\begin{align*}
S &\rightarrow NP \ VP \\
NP &\rightarrow N \\
VP &\rightarrow V \ S' \\
S' &\rightarrow \text{Comp} \ S \\
\end{align*}
\]
A slightly bigger grammar

9 Rules

\[ S \rightarrow NP \ VP \]
\[ S \rightarrow S' \ VP \]
\[ NP \rightarrow Det \ N \]
\[ NP \rightarrow N \]
\[ VP \rightarrow V \ NP \]
\[ VP \rightarrow V \]
\[ VP \rightarrow V \ S \]
\[ VP \rightarrow V \ S' \]
\[ S' \rightarrow Comp \ S \]

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

Sarah \[ NP \rightarrow N \]
\[ VP \rightarrow V \ S' \]
\[ Comp \ S \]
A slightly bigger grammar

9 Rules

- $S \rightarrow NP \ VP$
- $S \rightarrow S' \ VP$
- $NP \rightarrow \text{Det N}$
- $NP \rightarrow N$
- $VP \rightarrow V \ NP$
- $VP \rightarrow V$
- $VP \rightarrow V \ S$
- $VP \rightarrow V \ S'$
- $S' \rightarrow \text{Comp S}$

Sentences it can generate:

- Sarah thought that she solved the Labyrinth.

- $S \rightarrow NP \ VP$
- $NP \rightarrow N$
- $VP \rightarrow V \ S'$

- $S \rightarrow NP \ VP$
- $NP \rightarrow N$
- $VP \rightarrow V \ S'$

- Sarah
- thought
- that
- Comp S
A slightly bigger grammar

9 Rules

**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**

Sentences it can generate:

Sarah thought that she solved the Labyrinth.
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

\[
\begin{align*}
S &\rightarrow NP \ VP \\
S &\rightarrow NP \ VP \\
NP &\rightarrow N \\
VP &\rightarrow V \ S' \\
NP &\rightarrow N \\
VP &\rightarrow V \ S' \\
NP &\rightarrow N \\
VP &\rightarrow V \ S' \\
NP &\rightarrow N \\
VP &\rightarrow V \ S' \\
S &\rightarrow NP \ VP
\end{align*}
\]
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

\[
\begin{align*}
S & \rightarrow \text{NP VP} \\
\text{NP} & \rightarrow \text{N} \\
\text{VP} & \rightarrow \text{V S'} \\
\text{N} & \rightarrow \text{V S' Comp} \\
\text{S} & \rightarrow \text{NP VP} \\
\end{align*}
\]
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.
A slightly bigger grammar

9 Rules

- **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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

Sarah thought that NP VP

NP --> N
VP --> V S'

NP --> Det N

she solved the Labyrinth
A slightly bigger grammar

9 Rules

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

Sentences it can generate:

Sarah thought that she solved the Labyrinth.

Sarah thought that she solved the Labyrinth.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

S $\rightarrow$ NP VP
S $\rightarrow$ S' VP

NP $\rightarrow$ Det N
NP $\rightarrow$ N

VP $\rightarrow$ V NP
VP $\rightarrow$ V
VP $\rightarrow$ V S
VP $\rightarrow$ V S'

S' $\rightarrow$ Comp S

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

\[
\begin{array}{c}
\text{Sarah thought that Hoggle was a cheat.}
\end{array}
\]
Figuring out structure: bottom-up

9 Rules

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

Sentence: Sarah thought that Hoggle was a cheat.
Figuring out structure: bottom-up

9 Rules

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

That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

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

Comp   N   V   V   N
That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

S  --> NP VP
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NP  --> Det N
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That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

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VP   --> V
VP   --> V S
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S'   --> Comp S

That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

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

\[
\text{Comp} \quad \text{N} \quad \text{VP} \quad \text{VP} \\
\text{Comp} \quad \text{N} \quad \text{V} \quad \text{V} \quad \text{N} \\
\text{That} \quad \text{Hoggle} \quad \text{lied} \quad \text{surprised} \quad \text{Sarah}.
\]
Figuring out structure: bottom-up

9 Rules

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

That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

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

That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

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

That Hoggle lied surprised Sarah.
Figuring out structure: bottom-up

9 Rules

\[
\begin{align*}
S & \to NP \ VP \\
S & \to S' \ VP \\
NP & \to Det \ N \\
NP & \to N \\
VP & \to V \ NP \\
VP & \to V \\
VP & \to V \ S \\
VP & \to V \ S' \\
S' & \to Comp \ S
\end{align*}
\]

That Hoggle lied surprised Sarah.
Syntax recap

The structure of language (syntax) involves more than simply the meaning of the words. It involves rules about how the words themselves are allowed to go together.

It isn’t enough to know the list of possible sentences in the language. Because adults can generate novel sentences and sentences of infinite length, adults need to know a rule system that can generate sentences.

Adults know (unconsciously) a system of rules for generating the word orders they use. A fairly small set of rules can generate a fairly large set of sentences.
Questions?

You should be able to do up through question 6 on the review questions, and up through question 8 on HW5.