# Psych 150/ Ling 155: Psychology of Language

Lecture 8

Learning aspects of sentences

## Announcements

Be working on HW2, due on 5/5/15.

Be working on the review questions for acquisition.

## Learning aspects of sentences

What are the syntactic categories?

How do you put them together to express more complex thoughts?

## Syntactic categorization

If you know the syntactic (grammatical) category of the word, then you will know how this word is used in the language. This will allow you to recognize other words that belong to the same category since they will be used the same way.

"This is a DAX."

DAX = noun

"He is SIBing."

SIB = verb

"He is very BAV."

BAV = adjective

"He should sit GAR the other dax."

GAR = preposition

## Category flexibility


**http://xkcd.com/1443/**

## Categorization: How?

How might children initially learn what categories words are?

Semantic bootstrapping hypothesis (Pinker 1984)

"…the child comes equipped with innate expectations of certain grammatical categories as well as built-in mappings between key concept types and grammatical categories. For example, children might jump-start syntactic learning with the innate knowledge that nouns tend to refer to objects, or that the subject of a sentence is typically the agent of the action that's being described." — Sedivy 2014, p.201

## Categorization: How?

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One practical application: Children can initially determine a word's category by observing what kind of entity in the world it refers to.

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objects, substance = noun (*goblins, glitter*)

action = verb (*steal, sing*)

property = adjective (*shiny, stinky*)

The word's meaning is then linked to innate grammatical category knowledge (nouns are objects/substances, verb are actions, adjectives are properties)

## Categorization: How?

How might children initially learn what categories words are?

Semantic bootstrapping hypothesis (Pinker 1984)

One problem: Mapping rules are not perfect

Ex: not all action-like words are verbs

"bouncy", "a kick"
action-like meaning, but they're not verbs

Ex: not all property-like words are adjectives

"they are shining brightly", "they glitter"
seem to be referring to properties, but these aren't adjectives

## Categorization: How?

How might children initially learn what categories words are?

Distributional Learning

Children can initially determine a word's category by observing the linguistic environments in which words appear.

Noun
Kittens are adorable.

Verb
Sarah was standing very close to him.

Adjective
I like the silliest goblin.

The king said that no girls would get through the Labyrinth.

Preposition

## Mintz 2003: Frequent frames

What categorization information is available if children track frequent frames?

Frequent frame: X___Y
where X and Y are words that frame another word and appear frequently in the child's linguistic environment

| Examples: | the__is | can___him |
|---|---|---|
| | the king is… | can trick him… |
| | the goblin is… | can help him… |
| | the girl is… | can hug him… |

## Mintz 2003: Frequent frames

What categorization information is available if children track frequent frames?

Data representing child's linguistic environment:
6 corpora of child-directed speech from the CHILDES database, which contains transcriptions of parents interacting with their children.

CHILDES Child Language Data Exchange System

http://childes.psy.cmu.edu

Corpus (sg.), corpora (pl). = a collection of data
[from Latin *body*, a "body" of data]

## Mintz 2003: Defining "frequent"

Definition of "frequent" for frequent frames:
Frames appearing a certain number of times in a corpus

"The principles guiding inclusion in the set of frequent frames were that frames should occur frequently enough to be noticeable, and that they should also occur enough to include a variety of intervening words to be categorized together…. a pilot analysis with a randomly chosen corpus, Peter, determined that the 45 most frequent frames satisfied these goals and provided good categorization."

## Mintz 2003: Defining "frequent"

Example of deciding which frames were frequent:

| Frame | How often it occurred in the corpus |
|---|---|
| (1) the___is | 600 times |
| (2) a___is | 580 times |
| (3) she__it | 450 times |
| … | |
| (45) they__him | 200 times |
| (46) we___have | 199 times |
| … | |

These frames considered "frequent"

## Mintz 2003: Testing the categorization ability of frequent frames

Try out frequent frames on a corpus of child-directed speech.

Frame (1): the___is
Transcript: "…the radio is in the way…but the doll is…and the teddy is…"

radio, doll, teddy are placed into the same category by the___is

Frame (13): you___it
Transcript: "…you draw it so that he can see it… you dropped it on purpose!…so he hit you with it…"

draw, dropped, with are placed into the same category by you___it

## Mintz 2003: Some actual frequent frame results

Frame: you___it

Category includes:
put, want, do, see, take, turn, taking, said, sure, lost, like, leave, got, find, throw, threw, think, sing, reach, picked, get, dropped, seen, lose, know, knocked, hold, help, had, gave, found, fit, enjoy, eat, chose, catch, with, wind, wear, use, took, told, throwing, stick, share, sang, roll, ride, recognize, reading, ran, pulled, pull, press, pouring, pick, on, need, move, manage, make, load, liked, lift, licking, let, left, hit, hear, give, flapped, fix, finished, drop, driving, done, did, cut, crashed, change, calling, bring, break, because, banged

## Mintz 2003: Some actual frequent frame results

Frame: the___is

Category includes:
moon, sun, truck, smoke, kitty, fish, dog, baby, tray, radio, powder, paper, man, lock, lipstick, lamb, kangaroo, juice, ice, flower, elbow, egg, door, donkey, doggie, crumb, cord, clip, chicken, bug, brush, book, blanket, mommy

## Mintz 2003: How successful frequent frames were

Really precise! When a frequent frame clustered words together into category, they often did belong together. (Nouns were put together, verbs were put together, etc.)

…though not as complete: A frequent frame made lots of little clusters, rather than being able to cluster all the words into one category. (So, there were lots of Noun-ish clusters, lots of Verb-ish clusters, etc.)

Still, probably a good start to identifying useful categories.

## Wang & Mintz 2008

Computational model implementing a frequent frames strategy the way children might.

"Even with limited and imperfect memory, the learning algorithm can identify highly informative contexts after processing a relatively small number of utterances, thus yield[ing] a high accuracy of word categorization. It also provides evidence that frames are a robust cue for categorizing words."

Implication: Frequent frames could work really well for humans, who have non-trivial cognitive limitations.

## Mintz 2006: What about young children?

Testing 12-month-olds on their ability to use frequent frame information to group words together, using the head-turn preference procedure.



## Mintz 2006: What about young children?

Familiarization phase: Hear sentences using novel words in verb frames and noun frames for about 90 seconds.

Verb Frame Sentences with lonk and deeg

She wants *to deeg it*.
She wants *to lonk it*.
You *can deeg* .
You *can lonk* .
Can *you deeg the* room?
*I lonk you* now!

Noun Frame Sentences with gorp and bist

I see *the gorp in* the room.
I see *the bist in* the room.
That's *your gorp* .
That's *your bist* .
I put *his gorp on* the box.
Here's *a bist of* a dog.

## Mintz 2006: What about young children?

Test phase: Hear different sentences using novel words in the same verb frames and noun frames, and measure looking time.

Verb Frame Sentences, grammatical & ungrammatical

✓ Can *you lonk the* room?
✓ *I deeg you* now.
✗ Can *you bist the* room?
✗ *I gorp you* now.

Noun Frame Sentences, grammatical & ungrammatical

✓ I put *his bist on* the box.
✓ Here's *a gorp of* a dog.
✗ I put *his lonk on* the box.
✗ Here's *a deeg of* a dog.

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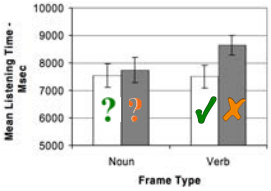



12-month-olds look longer at the ungrammatical utterances *only* with verbs (novelty preference), suggesting they used the frames to figure out how the novel verbs ought to behave and were surprised when these words behaved differently.

Upshot: 12-month-olds can use frequent frames to identify verbs — but not nouns.

## Recap: Categorization

Children may have some innate knowledge about how concepts map to syntactic categories, but it's not a perfect solution.

Frequent frame information can be useful for learning categories from realistic children's input.

Computational research suggests that a frequent frame strategy should be useful, even if cognitive resources are limited.

Experimental research suggests that frequent frames are something very young children can and do use to help them categorize verbs.

## Putting words together

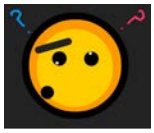
How do we know what rules children have inferred about how to put words together to form more complex thoughts?

One way: Look at children's error data.

Spontaneous utterances noted by Bowerman (1982)

"Don't giggle me." = make me giggle
"You can push her mouth open to drink her." = to make her drink
"She falled me." = made me fall

Seem weird?



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English has verbs just like this.

Don't melt the butter = make the butter melt

You can bounce the ball = make the ball bounce

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Cue to this kind of verb:
Can appear as both transitive (with object) and intransitive (no object).

I melted the butter.
The butter melted.

You can bounce the ball.
The ball can bounce.

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What happened with the verbs above? Heard in intransitive and generalized that transitive was okay, too.

I giggled.
She drank.
I fell.

## Putting words together

How do we know what rules children have inferred about how to put words together to form more complex thoughts?

Other examples of overgeneralization from Bowerman (1982) and Hudson Kam

I want Daddy choose me what to have.
Do you want to see us disappear our heads?
I want to comfortable you.
Can I fill some salt into the bear?
He's gonna die you, David.
Did I afraid you?
This is colding me.

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I want Daddy choose me what to have. = Daddy make me choose
Do you want to see us disappear our heads? = make our heads disappear
I want to comfortable you. = make you comfortable
Can I fill some salt into the bear? = I *pour* some salt into the bear
He's gonna die you, David. = He's going to make you dead = He's going to *kill* you
Did I afraid you? = I make you afraid = I *frighten* you
This is colding me. = This is making me cold

Sometimes we have actual words that can be put in these positions to express this thought…but other times, we don't seem to, even though it's a perfectly coherent thought to express.

## Constraints on putting words together

What constraints do children seem to have about how to put words together?

One example: English yes/no questions

Jareth can alter time.

Can Jareth alter time?

To turn the thought expressed by the sentence into a yes/no question, move the auxiliary verb ("can") to the front. Other examples of auxiliary verbs: *could, should, might, would, will, did, do, may*

The child's task: figure out a rule that will form yes/no questions from their corresponding sentences.

## Specific example: Yes/No question formation

Jareth can alter time.
Can Jareth alter time?

Rule?

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Anyone who can wish away their brother would be tempted to do it.
Would anyone who can wish away their brother be tempted to do it?

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Someone who can solve the labyrinth can show someone else who can't how.
Can someone who can solve the labyrinth show someone else who can't how?

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Rule???

Someone who can solve the labyrinth can show someone else who can't how.
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Need a rule that is compatible with *all* of these, since they're all grammatical English questions.

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Idea: Try looking at the sentence structure, not just the linear order of the words in the sentences.

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embedded clauses = additional descriptive sentences that are not part of the main clause

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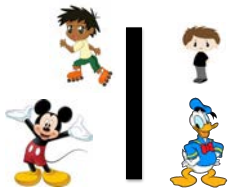
Can someone show someone else how?

Rule that works for all of these examples (and all English examples): Move the auxiliary verb in the main clause to make a yes/no question.

This is a rule dependent on the structure of the sentences, since it refers to "main clause".

## Children's knowledge

Crain & Nakayama 1987: Get children (three- to five-year-olds) to produce complex yes/no questions that require them to demonstrate how they deal with multiple auxiliaries.



"Ask Jabba if *the boy who can see Mickey Mouse is happy*."
"Ask Jabba if *the boy who is happy can see Mickey Mouse.*"

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Common errors that occurred:

(Restarts)
"Is the boy who can see Mickey Mouse, is he happy?"
"Can the boy who is happy, can he see Mickey Mouse?

(Initial *is* prefix)
"Is the boy who can see Mickey Mouse is happy?"
"Is the boy who is happy can see Mickey Mouse?"

"Ask Jabba if *the boy who can see Mickey Mouse is happy*."
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The error that didn't occur:

(Structure-independent auxiliary movement)
*"Can the boy who __ see Mickey Mouse is happy?"*
*"Is the boy who __ happy can see Mickey Mouse?*

"Ask Jabba if *the boy who can see Mickey Mouse is happy*."
"Ask Jabba if *the boy who is happy can see Mickey Mouse.*"

## Children's knowledge

Crain & Nakayama 1987: Get children (three- to five-year-olds) to produce complex yes/no questions that require them to demonstrate how they deal with multiple auxiliaries.

Conclusion: As young as three years old, children have some very specific constraints on the kind of rules they'll consider for putting words together to express complex thoughts.

Open question: Where do these constraints come from?
Are they derivable from prior linguistic experience or innate?

## Children's knowledge

What about other syntactic rules?

Another property of language: Long-distance dependencies

Dependencies can exist between two non-adjacent items, and these do not appear to be constrained by length (Chomsky 1965, Ross 1967).

What does Jack think __?
What does Jack think that Lily said __?
What does Jack think that Lily said that Sarah heard __?
What does Jack think that Lily said that Sarah heard that Jareth stole __?

## Syntactic islands: Dependencies that aren't okay

If the gap position appears inside certain structures (called "syntactic islands" by Ross (1967)), the dependency seems to be ungrammatical.

*What did you make [the claim that Jack bought __]?
*What do you think [the joke about __] offended Jack?
*What do you wonder [whether Jack bought __]?
*What do you worry [if Jack buys __]?
*What did you meet [the scientist who invented __]?
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*What did you meet [the scientist who invented __]? ← **wh syntactic island**
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## Children's knowledge of wh-island constraints

De Villiers 1995: comprehension task with 3- to 6-year-olds

"Once there was a boy who loved climbing trees in the forest. One afternoon he slipped and fell to the ground. He picked himself up and went home. That night when he had a bath, he saw a big bruise on his arm. He said to his Dad, 'I must have hurt myself when I fell this afternoon.'"

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When did the boy say he fell?

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When did the boy say he fell? **No island: Two interpretations possible**
—> When did the boy say __ he fell? **When did the saying happen?**
—> When did the boy say he fell __? **When did the falling happen?**

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When did the boy say he fell? **No island: Two interpretations possible**

—> When did the boy say __ he fell? **That night**

—> When did the boy say he fell __? **This afternoon**

Children allow both these structures (and their interpretations), too.

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When did the boy say how he fell?

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When did the boy say [how he fell ]? **wh-island: Only one interpretation**

—> When did the boy say __ [how he fell]? **When did the saying happen?**

X *When did the boy say [how he fell __]? When did the falling happen?*

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When did the boy say [how he fell ]? **wh-island: Only one interpretation**

—> When did the boy say __ [how he fell]? **At night**

X *When did the boy say [how he fell __]? In the afternoon*

Children allow only the top structure (and its interpretation), too.

## How could children learn this and other syntactic islands?

*What did you make [the claim that Jack bought __]?
*What do you think [the joke about __] offended Jack?
*What do you wonder [whether Jack bought __]?
*What do you worry [if Jack buys __]?
*What did you meet [the scientist who invented __]?
*What did [that Jack wrote __] offend the editor?
*What did Jack buy [a book and __]?
*Which did Jack borrow [__ book]?

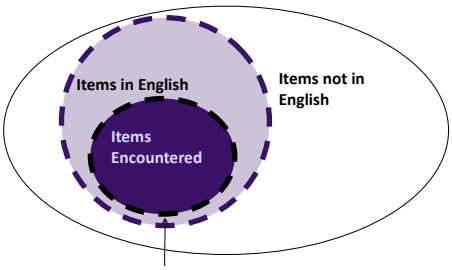
## One issue: Children's input doesn't look so helpful

Pearl & Sprouse 2013: Analysis of child-directed speech (Brown-Adam, Brown-Eve, Suppes, Valian) from CHILDES:

| | |
|---|---|
| 76.7% | *What did you see __?* |
| 12.8% | *What __ happened?* |
| 5.6% | *What did she want to do __?* |
| 2.5% | *What did she read from __?* |
| 1.1% | *What did she think he said __?* |
| … | |

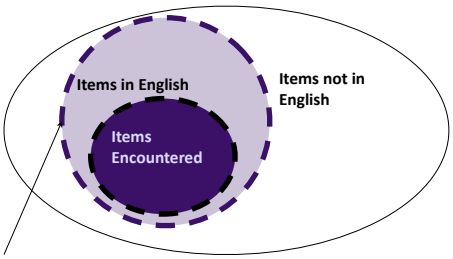
Most of it is fairly simple dependencies — and importantly, dependencies that are grammatical. How could children form the appropriate generalizations about what *isn't* allowed?

## Syntactic islands: How to generalize?



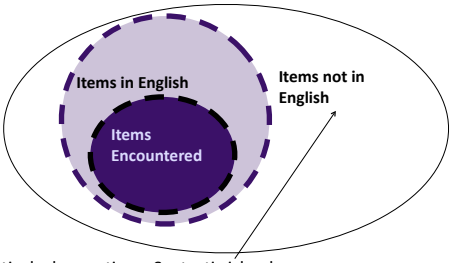

Wh-questions in input
- What did you see?
- What happened?
- …

## Syntactic islands: How to generalize?




Grammatical wh-questions
- What did you see?
- What happened?
- Who did Jack think that Lily saw?
- What did Jack think happened to Lily in the park?

## Syntactic islands: How to generalize?




Ungrammatical wh-questions: Syntactic islands
- *What did you make [the claim that Jack bought __]?
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## Syntactic islands: One answer for some of the islands

- *What did you make [the claim that Jack bought __]?
- *What do you think [the joke about __] offended Jack?
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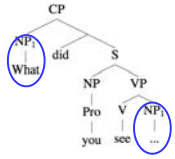
- *Which did Jack borrow [__ book]?

Pearl & Sprouse 2013: Learn what you can from the dependencies you do actually observe in the data and apply it to make a judgment about the dependencies you haven't seen before, like these syntactic islands.

- What did you see?
- What happened?
- What did she want to do?
- What did she read from?
- What did she think he said?

## Pearl & Sprouse 2013

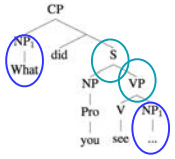
Strategy:
(1) Pay attention to the structure of dependencies you do see.




How to describe this dependency:
What phrases is the gap inside but the wh-word isn't inside?

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies you do see.




How to describe this dependency:
What phrases is the gap inside but the wh-word isn't inside?

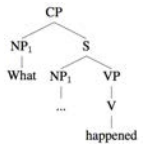
What did you see __?
= What did [S you [VP see __]]?
= S-VP

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies you do see.

What did you see __?
= What did [$_S$ you [$_{VP}$ see __]]?
= S-VP

What __ happened?
= What [$_S$ __ happened]?
= S



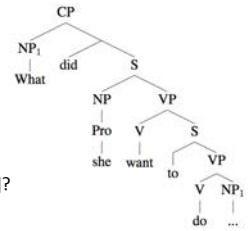

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies you do see.

What did you see __?
= What did [$_S$ you [$_{VP}$ see __]]?
= S-VP

What __ happened?
= What [$_S$ __ happened]?
= S

What did she want to do __ ?
= What did [$_S$ she [$_{VP}$ want [$_S$ to [$_{VP}$ do __]]]]?
= S-VP-S-VP




## Pearl & Sprouse 2013

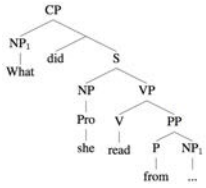
Strategy:
(1) Pay attention to the structure of dependencies you do see.

What did you see __?
= What did [$_S$ you [$_{VP}$ see __]]?
= S-VP

What __ happened?
= What [$_S$ __ happened]?
= S

What did she want to do __ ?
= What did [$_S$ she [$_{VP}$ want [$_S$ to [$_{VP}$ do __]]]]?
= S-VP-S-VP

What did she read from __ ?
= What did [$_S$ she [$_{VP}$ read [$_{PP}$ from __]]]]?
= S-VP-PP




## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

S-VP =
*begin*-S-VP
S-VP-*end*

S =
*begin*-S-*end*

S-VP-S-VP
= *begin*-S-VP
S-VP-S
VP-S-VP
S-VP-*end*

S-VP-PP
= *begin*-S-VP
S-VP-PP
VP-PP-*end*

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

S-VP =
*begin*-S-VP
S-VP-*end*

S =
*begin*-S-*end*

S-VP-S-VP
= *begin*-S-VP
S-VP-S
VP-S-VP
S-VP-*end*

S-VP-PP
= *begin*-S-VP
S-VP-PP
VP-PP-*end*

*begin*-S-VP = 86/100
S-VP-*end* = 83/100
*begin*-S-*end* = 13/100
S-VP-S = 6/100
VP-S-VP = 6/100
S-VP-PP = 3/100
VP-PP-*end* = 3/100
...

Note that some of these trigrams already appear in multiple dependencies that commonly occur in children's input.

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

(3) Use trigram frequency to calculate the probability of that trigram occurring in a dependency.

| | |
|---|---|
| *begin*-S-VP = 86/100 | p(*begin*-S-VP) = 0.86 |
| S-VP-*end* = 83/100 | p(S-VP-*end*) = 0.83 |
| *begin*-S-*end* = 13/100 | p(*begin*-S-*end*) = 0.13 |
| S-VP-S = 6/100 | p(S-VP-S) = 0.06 |
| VP-S-VP = 6/100 | p(VP-S-VP) = 0.06 |
| S-VP-PP = 3/100 | p(S-VP-PP) = 0.03 |
| VP-PP-*end* = 3/100 | p(VP-PP-*end*) = 0.03 |
| ... | |

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

(3) Use trigram frequency to calculate the probability of that trigram occurring in a dependency

(4) When you see a new dependency, break it down into its trigrams and then calculate its probability, based on the trigram probabilities.

What does Jack want __?
= What does [$_S$ Jack [$_{VP}$ want __]]?
= S-VP
= *begin*-S-VP
S-VP-*end*

p(S-VP) = p(*begin*-S-VP)*p(S-VP-*end*)
= 0.86 * 0.83 = 0.71

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

(3) Use trigram frequency to calculate the probability of that trigram occurring in a dependency

(4) When you see a new dependency, break it down into its trigrams and then calculate its probability, based on the trigram probabilities.

What does Jack want to do that for __?
= What does [$_S$ Jack [$_{VP}$ want [$_S$ to [$_{VP}$ do that [$_{PP}$ for __]]]?
= S-VP-S-VP-PP
= *begin*-S-VP
S-VP-S
VP-S-VP
S-VP-PP
VP-PP-*end*

p(S-VP-S-VP-PP) = p(*begin*-S-VP)*p(S-VP-S)*p(VP-S-VP)*p(S-VP-PP)*p(VP-PP-*end*)
= 0.86*0.06*0.06*0.03*0.83 = 0.000071

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

(3) Use trigram frequency to calculate the probability of that trigram occurring in a dependency

(4) When you see a new dependency, break it down into its trigrams and then calculate its probability, based on the trigram probabilities.

What do you think that the joke about __ offended Jack?
= What do [$_S$ you [$_{VP}$ think [$_{CP}$ that [$_S$ [$_{NP}$ the joke [$_{PP}$ about __]]]]]] offended Jack?
= S-VP-CP-NP-PP
= *begin*-S-VP
S-VP-CP
VP-CP-S
CP-S-NP
S-NP-PP
NP-PP-*end*

p(S-VP-CP-S-NP-PP) = p(*begin*-S-VP)*p(S-VP-CP)*p(VP-CP-S)*p(CP-S-NP)*p(S-NP-PP)*p(NP-PP-*end*)
= 0.86*0.01*0.001*0.00*0.00*0.02 = 0.00

## Pearl & Sprouse 2013

Strategy:
(1) Pay attention to the structure of dependencies.

(2) Break these dependency structures into smaller pieces made up of three units (trigrams) that you can track the frequency of in the input you encounter.

(3) Use trigram frequency to calculate the probability of that trigram occurring in a dependency

(4) When you see a new dependency, break it down into its trigrams and then calculate its probability, based on the trigram probabilities.

(5) Use calculated dependency probabilities as the basis for grammaticality judgments. Lower probability dependencies are dispreferred, compared to higher probability dependencies.

p(S-VP) = 0.71
p(S-VP-S-VP-PP) = 0.000071
p(S-VP-CP-S-NP-PP) = 0.00

## Pearl & Sprouse 2013

This works really well for learning about these four syntactic island constraints, according to the computational modeling study by Pearl & Sprouse (2013)!

*What did you make [the claim that Jack bought __]?
*What do you think [the joke about __] offended Jack?
*What do you wonder [whether Jack bought __]?
*What do you worry [if Jack buys __]?
*What did you meet [the scientist who invented __]?
*What did [that Jack wrote __] offend the editor?
*What did Jack buy [a book and __]?
*Which did Jack borrow [__ book]?

## Silent things


http://itre.cis.upenn.edu/~myl/languagelog/archives/002155.html

Do they need people to decorate?

Typical: People are the ones doing the decorating.
Possible: People are the ones being decorated.

## Silent things

Sometimes, certain verbs will allow partial or incomplete sentences to follow them that do not have tense (these are called non-finite clauses, and they're signaled in English by "to" before a verb):

The girl tried to save her brother.

The king hopes to win the game.

The goblins wanted to keep the boy.

The dwarf decided to help the girl.

## Silent things

| | Implied Subject |
|---|---|
| The girl ~~tried~~ [ ] to save her brother. | the girl |
| The king ~~hopes~~ [ ] to win the game. | the king |
| The goblins ~~wanted~~ [ ] to keep the boy. | the goblins |
| The dwarf ~~decided~~ [ ] to help the girl. | the dwarf |

The subject of the embedded clause (the sentence following the main verb) is implied, not overtly stated.

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl is *afraid* to see .

Who/what is doing the seeing (subject of see)?

Who/what is being seen (object of see)?

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *afraid*~~ [ ] to see .

Who/what is doing the seeing (subject of see)?
The girl.

Who/what is being seen (object of see)?

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *afraid*~~ [ ] to see [ ].

Who/what is doing the seeing (subject of see)?
The girl.

Who/what is being seen (object of see)?
Something unspecified.

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *afraid*~~ [ ] to see [ ].

Who/what is doing the seeing (subject of see)?
The girl.

Who/what is being seen (object of see)?
Something unspecified.
This sentence means approximately something like
"The girl is afraid to see (something)."

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl is *easy* to see .

Who/what is doing the seeing (subject of see)?

Who/what is being seen (object of see)?

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *easy* to see~~ .

Who/what is doing the seeing (subject of see)?

Who/what is being seen (object of see)?
The girl.

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *easy* to see~~ .

Who/what is doing the seeing (subject of see)?
Someone not mentioned.

Who/what is being seen (object of see)?
The girl.

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *easy* to see~~ .

Who/what is doing the seeing (subject of see)?
Someone not mentioned.
This sentence means the same thing as
"It is easy (for someone) to see the girl."

Who/what is being seen (object of see)?
The girl.

## More complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *easy* to see~~ .

How can children learn which words allow which structures and meanings?

## Learning more complicated silent things

Sentences that have both an implied subject and implied object.

The girl ~~is *easy* to see~~ .

"…the main reported finding is that children err in their interpretation of these constructions until quite late in development, around age 6 to 10 years (C. Chomsky 1969, Cromer 1970, i.a.). More recent investigations (Anderson 2005) have likewise found that children give at best inconsistent interpretations, and at worst consistently incorrect interpretations, until age 5 or 6 years." — Becker, Estigarribia, & Gylfadottir 2012

Error: (girl = implied subject) "It is easy for the girl to see someone else."

The girl ~~is *easy*~~ to see .

## Learning more complicated silent things

Becker et al. 2012: The animacy of subjects may help distinguish these constructions from each other. When children hear inanimate subjects (like "apple") used many times with a construction, they could assume the subject is the implied object.

"Is the apple greppy to see?"

## Learning more complicated silent things

Becker et al. 2012: The animacy of subjects may help distinguish these constructions from each other. When children hear inanimate subjects (like "apple") used many times with a construction, they could assume the subject is the implied object.

"Is the apple greppy to see?"

Important insight: Only adjectives like *easy* or *tough* (called *tough*-adjectives as a class) allow inanimate subjects.

The apple is *easy* to see.
*The apple is *eager* to see.

## Learning more complicated silent things

Becker et al. 2012: The animacy of subjects may help distinguish these constructions from each other. When children hear inanimate subjects (like "apple") used many times with a construction, they could assume the subject is the implied object.

"Is the apple greppy to see?"

When the child encounters a new adjective with an inanimate subject like "the apple", the child could assume it's *tough*-adjective like "easy".

The apple is *greppy* to see.

## Learning more complicated silent things

Becker et al. 2012: The animacy of subjects may help distinguish these constructions from each other. When children hear inanimate subjects (like "apple") used many times with a construction, they could assume the subject is the implied object.

"Is the apple greppy to see?"

This means that the subject "the apple" is the implied object of "see", and so the interpretation is "It is easy for someone to see the apple."

The apple ~~is *greppy* to see~~ .

## Learning more complicated silent things

Is animacy a good cue to *tough*-adjectives like *easy* and *tough*?

Becker et al. 2012 analysis of five major corpora from CHILDES

| | *animate subjects* | *inanimate subjects* |
|---|---|---|
| *tough*-adjectives | **0** | **48** |
| *other adjectives like* eager | **10** | **0** |

The frequencies are a bit low, but they're definitely signaling the right answer — only *tough*-adjectives appear with inanimate subjects like *easy*.

## Learning more complicated silent things

Testing children's ability to learn novel words like *greppy* in context.

Becker et al. 2012 learning: Children between the ages of 4 and 7 watch a video about two puppets having a conversation that uses the novel word a number of times.

A: The chair is greppy to push.

B: Really? The chair is greppy to push?

A: Yeah! The chair is greppy to push.

B: Wow! What about the book? Is the book greppy to push?

A: No, the book is not greppy to push.

## Learning more complicated silent things

Testing children's ability to learn novel words like *greppy* in context.

Becker et al. 2012 test: Children attempt to answer questions that use the novel words as a *tough*-adjective vs. another kind of adjective.

Idea: Ungrammatical questions take longer to answer because they're weird.

Is it *greppy* to move a piece of plastic?

(Fine if this word is like *easy,* a *tough*-adjective)

(Strange if this word is like *afraid*, which is not)

adjectives with inanimate subjects =

Faster! (~2.7sec)

Is the nurse *greppy*?

(Fine if this word is like *afraid,* which is not a *tough*-adjective)

(Strange if this word is like *easy*, which is)

adjectives with inanimate subjects =

Slower! (~3.1sec)

## Learning more complicated silent things

Testing children's ability to learn novel words like *greppy* in context.

Becker et al. 2012 implications: Inanimate subjects seem to not only be a useful cue (based on corpus analysis of which adjectives they're used with) but also a cue that children actually do use to help them decide how to interpret a new word in context.

"Is the apple greppy to see?"

## Recap: Putting words together

Children infer rules about how to put words together from the input they hear.

While they generalize from the input, which allows them to generate things they haven't heard, they do seem to have constraints on what kinds of rules they'll hypothesize.

Several aspects of sentences that children learn can be quite subtle, such as syntactic islands and sentences with *tough*-adjectives.

By focusing on key aspects of the input, children can extract very useful information about these subtle aspects.

You should be able to do all the acquisition review questions and all of HW2.