Psych 156A/ Ling 150: Acquisition of Language II

Lecture 2

Introduction to Language Acquisition

Announcements

Review questions available for introductory material

Be working on HW1

Linguistic Productivity Means We Need Rules

Infinite number of phrases & sentences

⇧

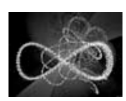
Large but finite number of words

⇧

Smaller amount of morphemes (ex: -ing, -s)

⇧

Several dozens of sounds (phonemes)
(ex: /s/, /z/)



Linguistic Infinity

The point: our minds store words and meanings and the patterns into which they can be placed (grammar).

Sentence Patterns:

Hoggle has *n* jewels.

An X is not a Y.

Since an X is not a Y, a Z is not a W.

The argument for mental grammar

"In short, in order for us to be able to speak and understand novel sentences, we have to store in our heads not just the words of our language but also the patterns of sentences possible in our language. These patterns, in turn, describe not just patterns of *words* but also patterns of *patterns*. Linguists refer to these patterns as the *rules* of language stored in memory; they refer to the rules as the *mental grammar* of the language, or *grammar* for short." - Jackendoff (1994)

Possible objections to a mental rule set

"Why should I believe I store a set of rules unconsciously in my mind? I just understand sentences because they make sense."

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"Why should I believe I store a set of rules unconsciously in my mind? I just understand sentences because they make sense."

But why do some sentences make sense and others don't?

Hoggle has two jewels.
*Two Hoggle jewels has.

Possible objections to a mental rule set

Why can we recognize patterns even when some of the words are unknown?

'Twas brillig, and the slithy toves
did gyre and gimble in the wabe...

Possible objections to a mental grammar

"What about people who speak ungrammatically, who say things like 'We ain't got no bananas'? They obviously don't have grammars in their heads."

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Prescriptive vs. Descriptive Grammar

Prescriptive: what you have to be taught in school, what is prescribed by some higher "authority", what you don't learn by listening to native speakers having conversations

"Don't end a sentence with a preposition."
" 'Ain't' is not a word."

Possible objections to a mental grammar

"What about people who speak ungrammatically, who say things like 'We ain't got no bananas'? They obviously don't have grammars in their heads."

Prescriptive vs. Descriptive Grammar

Descriptive: what you pick up from being a native speaker of the language, how people actually speak in their day-to-day interactions

Who does Sarah first talk **with**?

"You're horrible!" "No, I **ain't** - I'm Hoggle!"

Possible objections to an unconscious rule set

"When I talk, the talk just comes out - I'm not consulting any rule set."

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Analogy: wiggling your fingers

When you want to wiggle your fingers, you "just wiggle them".

But your finger-wiggling intention was turned into commands sent by your brain to your muscles, and you're never conscious of the process unless something interferes with it. Nonetheless, there *is* a process, even if you're not aware of it.

Learning hard things

Suppose we have mental grammars in our heads - how did they get there?

"Many people immediately assume that the parents taught it. To be sure, parents often engage in teaching *words* to their kids: "What this, Amy? It's a *BIRDIE*! Say 'birdie,' Amy!" But language learning can't entirely be the result of teaching words. For one thing, there are lots of words that it is hard to imagine parents teaching, notably those one can't point to: "Say 'from', Amy!" "This is *ANY*, Amy!" - Jackendoff (1994)

Learning hard things

Some other things that are hard to teach: interpretations

Joan

Moira

Joan appeared to Moira to like herself.	M thinks J likes J
Joan appeared to Moira to like her.	M thinks J likes M
Joan appealed to Moira to like herself.	J wants M to like M
Joan appealed to Moira to like her.	J wants M to like J

Learning hard things

Some other things that are hard to teach: interpretations

Joan

Moira

"How do we come to understand these sentences this way? It obviously depends somehow on the difference between ordinary pronouns such as "her" and reflexive pronouns such as "herself," and also on the differences between the verbs "appear" and "appeal." But how?…sure no one is ever taught contrasts like this by parents or teachers…" - Jackendoff (1994)

Learning patterns

Not so clear that children learn grammatical patterns from their parents

(From Martin Braine)

Child: Want other one spoon, Daddy.
Father: You mean, you want the other spoon.
Child: Yes, I want other one spoon, please Daddy.
Father: Can you say "the other spoon"?
Child: Other…one…spoon.
Father: Say "other".
Child: Other.
Father: "Spoon."
Child: Spoon.
Father: "Other spoon."
Child: Other…spoon. Now give me other one spoon?

Children don't just imitate what they've heard

From Edward Klima & Ursula Bellugi

Use of past tense verbs
(U-shaped curve of performance)

Stage 1
walked
played
came
went

Stage 2
walked
played
comed
goed
holded

Stage 3
walked
played
camed
wented

Stage 4
walked
played
came
went
held

Time/Age

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Time/Age

Main points

Children learn (hard) things about language that are not easy to explain.

The patterns they produce during learning are often stripped-down versions of the adult pattern, but they make mistakes that cannot be attributed directly to the input.

Children don't just imitate what they've heard - they're trying to figure out the patterns of their native language. Also, they may not notice or respond to explicit correction.

Levels of Representation
Marr (1982)

Describing vs. Explaining in Vision

"…it gradually became clear that something important was missing …neurophysiology and psychophysics have as their business to *describe* the behavior of cells or of subjects but not to *explain* such behavior.…What are the problems in doing it that need explaining, and what level of description should such explanations be sought?" - Marr (1982)

On Explaining (Marr 1982)

"But the important point is that if the notion of different types of understanding is taken very seriously, it allows the study of the information-processing basis of perception to be made *rigorous*. It becomes possible, by separating explanations into different levels, to make explicit statements about what is being computed and why…"

On Explaining (Marr 1982)

"But the important point is that if the notion of different types of understanding is taken very seriously, it allows the study of the information-processing basis of perception to be made *rigorous*. It becomes possible, by separating explanations into different levels, to make explicit statements about what is being computed and why…"

Our goal: Substitute "language learning" for "perception".

The three levels

Computational
What is the goal of the computation? What is the logic of the strategy by which is can be carried out?

Algorithmic
How can this computational theory be implemented? What is the representation for the input and output, and what is the algorithm for the transformation?

Implementational
How can the representation and algorithm be realized physically?

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping a pair of numbers to another number.

$(3,4) \longrightarrow 7$ (often written (3+4=7))
Properties: (3+4) = (4+3) [commutative], (3+4)+5 = 3+(4+5) [associative], (3+0) = 3 [identity element], (3+ -3) = 0 [inverse element]

True no matter how numbers are represented: this is what is being computed

The three levels: An example with the cash register

Computational
What does this device do?
Arithmetic (ex: addition).
Addition: Mapping a pair of numbers to another number.

Algorithmic
What is the input, output, and method of transformation?
Input: arabic numerals (0,1,2,3,4…)
Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition, where least significant digits are added first and sums over 9 have their next digit carried over to the next column

$$\begin{array}{r} 99 \\ \underline{+\ \ 5} \end{array}$$

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$$\begin{array}{r} 99 \\ \underline{+\ \ 5} \\ 14 \end{array}$$

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$$\begin{array}{r} {}^{1} \\ 99 \\ +\ \ 5 \\ \hline 4 \end{array}$$

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$$\begin{array}{r} {}^{1} \\ 99 \\ +\ \ 5 \\ \hline 104 \end{array}$$

The three levels: An example with the cash register

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Algorithmic
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Output: arabic numerals (0,1,2,3,4…)
Method of transformation: rules of addition

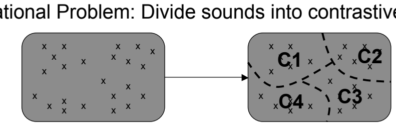
Implementational
How can the representation and algorithm be realized physically?
A series of electrical and mechanical components inside the cash register.

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the "how" of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Divide sounds into contrastive categories



Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the “how” of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Divide spoken speech into words

húwzəfɹéjdəvðəbígbǽdwə́lf

↓

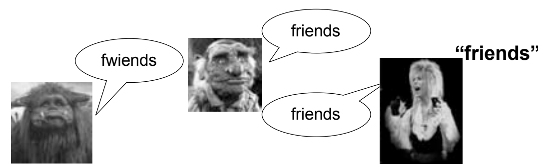
húwz əfɹéjd əv ðə bíg bǽd wə́lf
who‘s afraid of the big bad wolf

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the “how” of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Map word forms to speaker-invariant forms



Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the “how” of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Identify grammatical categories

“This is a DAX.” 

DAX = noun

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the “how” of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Identify word affixes that signal meaning.

What do you have to change about the verb to signal the past tense in English? (There are both regular and irregular patterns.)

blink~blinked confide~confided
blɪŋk blɪŋkt kənfajd kənfajdəd

drink~drank
dɹɪŋk dɹejŋk

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the “how” of language learning

First, we need a computational-level description of the learning problem.

Computational Problem: Identify the rules of word order for sentences.

Jareth juggles crystals
Subject Verb Object

English
Subject Verb Object

Kannada
Subject t_{Object} Verb Object

German
Subject Verb $t_{Subject}$ Object t_{Verb}

Mapping the Framework: Algorithmic Theory of Language Learning

Goal: Understanding the “how” of language learning

Second, we need to be able to identify the algorithmic-level description:

Input = sounds, syllables, words, phrases, …

Output = sound categories, words, words with affixes, grammatical categories, sentences, …

Method = statistical learning, algebraic learning, prior knowledge about how human languages work, …

Recap: Levels of Representation

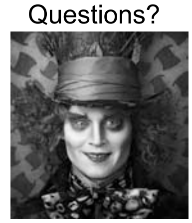
Language acquisition can be viewed as an information-processing task where the child takes the native language input encountered and uses it to construct the adult rule system (grammar) for the language.

Main idea: The point is not just to describe what children know about their native language and when they know it, but also how they learned it.

Three levels:

- computational: what is the problem to be solved
- algorithmic: what procedure will solve the problem, transforming input to desired output form
- implementational: how is that procedure implemented/instantiated in the available medium

Questions?



Use the rest of this class period to look over the review questions and work together on HW1