Psych 150/ Ling 155: Psychology of Language

Lecture 5

Acquisition: Intro to Questions & Methods

Announcements

HW1 is due at the end of class today. Note the clarification for question 2, parts o and p, posted on the class message board, if you haven't already.

HW2 is now available, due on 5/5/15.

Review questions for acquisition are now available.

Language acquisition: The Basics

Who?

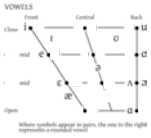
First language acquisition: Children learning their native language(s)

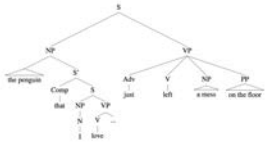
Second language acquisition: Adults learning a language once they already know their native language(s)

Language acquisition: The Basics

What?

Learning the systematic representations that underlie language.





Language acquisition: The Basics

Where?

Represented in the mind, instantiated in the brain.

Language acquisition: The Basics

When?

Typical first language acquisition:

Depending on the particular aspect of linguistic knowledge, sometime before approximately six years old.

Second language acquisition:

Depending on the particular aspect of linguistic knowledge, sometime between quickly and never.

Language acquisition: The Basics

Why?

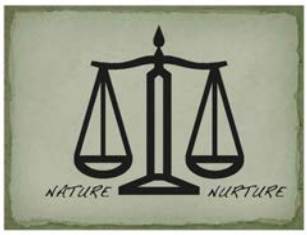
(Functional) To be able to communicate precise, complex ideas to each other.

(Individuals) Because that's what typical human brains do when exposed to a language-like communication system.

Language acquisition: The Basics

How?

Through an interaction between nature (innate capabilities) and nurture (input in the environment).



Getting some precision on when & how

When?

Basic question: What is the trajectory of language acquisition?

Methods: Experimental investigations

How?

Basic question: What is the process of language acquisition?

Methods: Experimental and computational investigations

Experimental Methods

"…all accounts of language acquisition phenomena…must be judged primarily on their ability to explain actual data collected from children and adults. Consequently it is useful for researchers to be familiar with as wide a range as possible of the experimental methods used in studying language acquisition, in order to enable them to select those that are most useful for studying particular phenomena."

- Ambridge & Rowland 2013

Computational Methods

"Computational modeling can be used to examine a variety of questions about the language acquisition process, because a model is meant to be a simulation of the relevant parts of a child's acquisition mechanism. In a model, we can precisely manipulate some part of the mechanism and see the results on acquisition….Importantly, some manipulations we can do within a model are difficult to do with children…modeling data are thus particularly useful because of the difficulty of getting those same data through experimental means."

- Pearl 2010

Experimental Methods

Naturalistic methods

Diary studies: keeping diaries of children's development. Charles Darwin did this with his son (Darwin 1877), who seemed to follow the progression we now expect.

Other diary studies: Clara & Wilhelm Stern's 1907 *Die Kindersprache* and Werner Leopold's (1939-1949) four volume account of his daughter's acquisition of English & German.

Modern diary studies: Braunwald 1976; Bowerman 1985, 1990; Dromi 1987; A. Gopnik & Meltzoff 1987; L. Bloom, 1993; Naigles, Vear, & Hoff 2002

A very modern diary study

http://www.ted.com/talks/deb_roy_the_birth_of_a_word.html

Beginning through about 4:15 (full video is about 17 minutes total)

CHILDES

CHILDES Child Language Data Exchange System

http://childes.psy.cmu.edu

Video/audio recordings of spontaneous speech samples, along with transcriptions and some structural annotation. Extremely valuable resource to the language acquisition community.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@Loc:   Eng-NA-MOR/Rollins/al12.cha
@PID:   11312/c-00017262-1
@Begin
@Languages:     eng
@Participants:  CHI Target_Child , MOT Mother
@ID:    eng|rollins|CHI|||||Target_Child|||
@ID:    eng|rollins|MOT|||||Mother|||
@Media: al12, video
@Activities:    Free Play
*MOT:   you haven't seen this . +
%mor:   pro|you aux|have-neg|not part|see&PASTP pro:dem|this .
%gra:   1|4|SUBJ 2|4|AUX 3|2|NEG 4|0|ROOT 5|4|OBJ 6|4|PUNCT
*MOT:   that looks pretty cool . +
%mor:   det|that n|look-PL adv:int|pretty adj|cool .
%gra:   1|2|DET 2|0|INCROOT 3|4|JCT 4|2|XMOD 5|2|PUNCT
*MOT:   do you know how to work that . +
%mor:   mod|do pro|you v|know adv:wh|how inf|to v|work pro:dem|that .
%gra:   1|3|AUX 2|3|SUBJ 3|0|ROOT 4|3|OBJ 5|6|INF 6|4|XCOMP 7|6|OBJ 8|3|PUNCT
*MOT:   yes you do . +
%mor:   co|yes pro|you v|do .
%gra:   1|3|COM 2|3|SUBJ 3|0|ROOT 4|3|PUNCT
```

CHILDES

CHILDES Child Language Data Exchange System

http://childes.psy.cmu.edu

"In terms of its impact on the field of language development, CHILDES is a game-changer. It allows researchers with limited resources to test hypotheses using an extremely rich data set. It allows for comparison across many different languages, which makes it possible to look for universal cross-linguistic patterns in language development….because the transcripts also include language by the adults that the children are interacting with, it also allows researchers to test detailed quantitative predictions about the relationships between a child's input and her language production." — Sedivy 2014, p.224

General considerations

One issue with naturalistic studies: The diarist can only record what the child chooses to say.

"It is important to bear in mind, however, that even full sampling—or the most assiduous diarist—does not record everything that the child *could* say, only everything that she *does* say. Thus, if the goal is to investigate acquisition of less frequent (or novel) items and structures, then additional, less naturalistic paradigms will be needed." - Ambridge & Lieven 2013

General considerations

One issue with naturalistic studies: The diarist can only record what the child chooses to say.

Because of this, it is hard to make claims that children don't use/know a particular structure based on its absence in spontaneous speech samples. It could be that they simply didn't say that structure when they were being recorded.

Assessments based on spontaneous speech

Still, we can get standardized assessments of children's performance.

Use coding systems like Mean Length of Utterance (MLU), which correlates with measures of children's grammatical and phonological development. This is done by tracking the average number of morphemes in the child's speech.

Ex: "He likes me" = 4 morphemes ("he", "like", "-s", "me")

Use estimates that caregivers provide of children's performance, such as the MacArthur-Bates Communicative Development Inventories (CDIs): 8-16 months, 16-30 months, 30-36 months. These include checklists of words, gestures, and word combinations children produce or comprehend.

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Pragmatics

Ensure the task makes communicative sense.

"Children are unlikely to respond willingly or appropriately to questions that they consider unnecessary or nonsensical. They are particularly sensitive to the difference between test questions and those that constitute a genuine request for information, and even children aged as young as 2 years 6 months are able to take the speaker's prior knowledge into consideration when responding to questions and requests."

— Ambridge & Lieven 2013

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Pragmatics

Ensure the task makes communicative sense.

Eliciting statements, general approach:

Set up a game where the child is describing the scenario to a puppet who can't see what's going on but needs to know to complete some other task, such as noting down what's in the scene.

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Pragmatics

Ensure the task makes communicative sense.

Eliciting questions, general approach:

Set up a scenario where the child does not know the answer but needs to ask a puppet (because the puppet saw what happened, for instance).

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Error type matters

When children make errors, make sure to note down what kind of error it is. Errors can differentiate between different theories of acquisition and/or what developmental stage a child is in.

Example: Eliciting wh-questions

Target: *What can she eat?*

Error 1: **What she can eat?*	[missing reordering]
Error 2: **What she eat?*	[missing auxiliary]
Error 3: *What can she can't eat?*	[doubling]

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Elicitation prompt matters

Certain errors may result because of the nature of the prompt used. Check to see if these errors occur at the same rate with different prompts.

Example: Eliciting wh-questions

Target: *What can she eat?*

Prompt: I wonder *what she can eat.* Ask the dog *what she can eat.*

Error 1: **What she can eat?*	[missing reordering — higher rate]
Error 2: **What she eat?*	[missing auxiliary]
Error 3: *What can she can't eat?*	[doubling]

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Children's awareness of the linguistic structure

Generally it can be helpful if children are aware of the structure they're being asked to generate. However, if this is not desired, fillers can be used so that children don't know the exact structure being targeted.

Example: Eliciting wh-questions — filler

Target: *Did she eat?*

Prompt: I wonder *if she ate.* Ask her if she ate.

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Novel or familiar items?

Both have advantages and disadvantages.

Novel items: Advantage when compared to familiar items

Don't have interference from native language familiarity with test item.

Example = eliciting English regular past tense -ed

Prompt: "Did she blick it?"

Target: "She blicked it."

The child hopefully hasn't heard the novel word *blick* before, so her production of *blicked* could only occur because of her knowledge of the past tense *-ed* ending in English, not because she heard *blicked* before.

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Novel or familiar items?

Both have advantages and disadvantages.

Novel items: Disadvantage when compared to familiar items

Additional complexity to the experimental setup (training the child).

Example = eliciting English regular past tense -ed

Prompt: "Did she blick it?"

Target: "She blicked it."

The child has to learn in the experiment what *blick* means to be able to answer whether the she blicked it or not.

Production methods

Idea: Instead of waiting for the child to spontaneously produce the item in question, entice her to produce it via a careful experimental setup.

Important consideration: Novel or familiar items?

Both have advantages and disadvantages.

Novel vs. Familiar items: Summary

Better to use familiar items if you can, but you can't always because prior knowledge of the familiar item can be an experimental confound for the question being investigated.

Production methods

Some specific ways to assess children's production abilities:

(1) elicited production:

"What's Ernie doing?" "What happened to the ball?"

(2) repetition/imitation elicitation:

"Say this: 'After she ate the peach, Sarah feel asleep.'"

(3) syntactic priming: Modeling a syntactic construction with one utterance, and having the child produce a novel utterance that uses that same construction

Passive example:

"…the ball is being bounced by Ernie…Oh look! What's happening to that peach?"

(Intended response: "The peach is being eaten by Sarah.")

Comprehension methods

"Comprehension methods do not require children to produce any language, but simply to respond to a presented sentence in some manner such as pointing—or simply visually attending to—a picture, animation or audio stimulus such as a sentence. Such methods are extremely valuable when children are too young to complete a production task." — Ambridge & Lieven 2013

Comprehension methods

Important consideration: Pragmatics

The task should make communicative sense.

(Similar to production methods.)

Comprehension methods

Important consideration: Enough data

Because comprehension tasks typically have binary dependent variables (ex: preferentially look at one of two pictures, preferentially listen to one of two sounds), you typically need more test data to infer something useful. Since children have limited attention spans, this often means recruiting more children to participate in the experiment.

Important consideration: Counterbalanced trials

Since the measure is typically a choice between one of two stimuli (ex: looking at a picture that matches what's being said), it's important to make sure any extraneous cues to "targethood" (which side the picture is on, what order the pictures are presented, who the subject of the action is, etc.) are removed. The typical way to do this is to make sure the target occurs equally in all possible options.

Comprehension methods

Some specific ways to assess children's comprehension abilities:

(1) Use examiner-administered tests like the Peabody Picture Vocabulary Test, where the child points at a picture matching the word(s).

(2) Pointing tasks: The child points at the picture that matches the linguistic description (words or sentences).

(3) Act-out tasks: The child is given toys and a linguistic description, and must make the toys act out the appropriate scenario.

"The dog that jumps over the pig bumps the lion."

Comprehension methods

Some specific ways to assess children's comprehension abilities:

(4) Intermodal preferential-looking: Instead of making a specific response (like pointing), the duration of the child's gaze tracked. This exploits listeners' natural tendency to spontaneously look to a word or picture that matches the language being heard.

"Find where the boy is glorping the girl."

(5) Looking while listening: Similar to intermodal preferential-looking, except that how long it takes for the child to look at the appropriate target (*latency*) is measures.

(6) Conditioned head-turn preference procedure (preferential-listening): Similar to intermodal preferential-looking, except the child chooses how long to listen to an auditory stimulus instead of how long to look at a target.

Comprehension methods

Some specific ways to assess children's comprehension abilities:

(7) Functional neuroimaging: Measuring brain responses to linguistic stimuli.

fMRI: Functional Magnetic Resonance Imaging, measuring changes in blood oxygenation

NIRS: Near Infrared Spectroscopy, measuring changes in blood oxygenation

EEG: Electroencephalography, measuring voltage fluctuations as a result of neuronal firing

Some have better spatial resolution (fMRI, NIRS let you know where things are happening better) while some have better temporal resolution (EEG lets you know when things are happening better).

Judgment methods

Idea: Participants judge the grammaticality (syntax) or truth value (semantics) of a stimuli.

"…the primary reason for selecting a judgment task over an alternative is not that it is easier for children to complete (though this may sometimes be the case), but that it maps more directly onto a particular theoretical claim." — Ambridge & Lieven 2013

Judgment methods

Idea: Participants judge the grammaticality (syntax) or truth value (semantics) of a stimuli.

Grammaticality: Is this a silly thing to say?

Every penguin ate two fish. 

Every penguin went two fish. 

Judgment methods

Idea: Participants judge the grammaticality (syntax) or truth value (semantics) of a stimuli.

Grammaticality: Is this a silly thing to say?

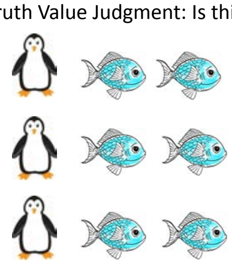
Important consideration: Understanding the judgment scale

Train the child on the scale, so they understand how to use the scale and we know how to interpret their judgments.

Judgment methods

Idea: Participants judge the grammaticality (syntax) or truth value (semantics) of a stimuli.

Truth Value Judgment: Is this true? 



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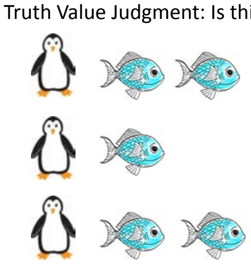

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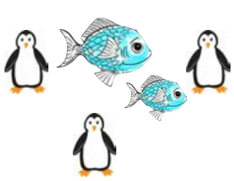


Every penguin ate two fish.

Judgment methods

Idea: Participants judge the grammaticality (syntax) or truth value (semantics) of a stimuli.

Truth Value Judgment: Is this true? 

Important consideration: Counterbalancing

Make sure there are an equal number of true and false test trials, so that children can't automatically give one answer all the time in order to be correct.

Judgment methods

Idea: Participants judge the grammaticality (syntax) or truth value (semantics) of a stimuli.

Important consideration: Pragmatics

For both grammaticality judgment and truth value judgment tasks, make sure the communicative context makes sense. Otherwise, children may behave unusually (since they're trying to figure out why you're asking them the question you're asking).

Computational Methods

Computational modeling

Basic idea: Create a computer program that takes the data children hear as input and see if it can learn the same knowledge children do from that input. Usually, the program will implement some learning theory's assumptions about how learning works (ex: what learning strategies children might use), and therefore test that theory empirically.

Ex: Learning to identify words in fluent speech (word segmentation): Swingley 2005, Gambell & Yang 2006, Pearl, Goldwater, & Steyvers 2011, Phillips & Pearl 2012, Phillips & Pearl 2014a, Phillips & Pearl 2014b

húwzəfɹéjdəvðəbígbædwʌ́lf

↓

húwz əfɹéjd əv ðə víg bǽd wʌ́lf

who's afraid of the big bad wolf

Computational modeling

Intuition: 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.

Some important considerations (among those described by Marr 1982):

(1) What exactly is the problem to be solved?

(2) What sequence of steps will solve the problem, transforming the input to the desired output form?

Computational modeling

What exactly is the problem to be solved?

Theoretical linguistic studies can often tell us what needs to be learned about language. Experimental studies can often tell us about when children seem to know different kinds of language knowledge. This defines the goal of language acquisition:

Learn the appropriate what by the appropriate when.

Computational modeling

What sequence of steps will solve the problem, transforming the input to the desired output form?

Well, for any given acquisition problem, we need to know what the input is and what the desired output is. Then we can figure out what sequence of steps (algorithm/procedure) will work to get from input to output.

Computational modeling

Input: The CHILDES database has a wealth of child-directed speech transcripts and videos from a number of different languages. This can help us figure out what children's input looks like.

CHILDES Child Language Data Exchange System

http://childes.psy.cmu.edu/

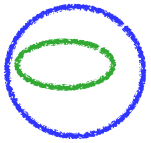
Computational modeling

Related issue: Input vs. Intake

How does the child use the input encountered? Does she learn from all of it or instead filter out some of it?

Linguistic input: The data the child is exposed to.

Linguistic intake: The data the child actually learns from.



Computational models can help us figure this out!

(Pearl & Weinberg 2007, Pearl 2009, Pearl 2011)

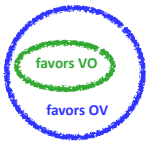
Computational modeling

Related issue: Input vs. Intake

How does the child use the input encountered? Does she learn from all of it or instead filter out some of it?

Pearl & Weinberg 2007:

Testing a theory of language acquisition that said Old English changed from Object-Verb to Verb-Object word order because Old English children's intake was not the entire input. Instead, it was a smaller set that favored Verb-Object word order.



Object-Verb: He penguins liked

Verb-Object: He liked penguins

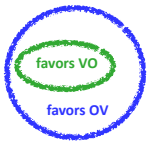
Computational modeling

Related issue: Input vs. Intake

How does the child use the input encountered? Does she learn from all of it or instead filter out some of it?

Pearl & Weinberg 2007:

So, over time, as Old English children became Old English adults who provided the linguistic input for new generations of Old English children, Old English became Verb-Object.



Object-Verb: He penguins liked

Verb-Object: He liked penguins

Computational modeling

Output: Theoretical linguistics and experimental studies can tell us what the output should look like by observing adult and child knowledge of various linguistic phenomena.

Example problem: word segmentation

húwzəfɹéjdəvðəbígbædwʌ́lf ← input

↓

húwz əfɹéjd əv ðə bíg bæd wʌ́lf ← output

who's afraid of the big bad wolf

Computational modeling

Algorithm/Procedure: Computational modeling can often help us figure out how children are getting from the input to the output. We may think of this as the learning strategy the child uses.

húwzəfɹéjdəvðəbígbædwʌ́lf

↓ What goes here?

húwz əfɹéjd əv ðə bíg bæd wʌ́lf

who's afraid of the big bad wolf

Computational modeling

Example learning strategy for word segmentation: Group syllables together that often follow each other, since these are likely to belong to the same word.

Bonus: Experimental evidence suggests infants can track this kind of transitional probability information (Saffran, Aslin, & Newport 1996). So, this is a plausible piece of information for a learning strategy to use.

húwzəfɹéjdəvðəbígbædwʌ́lf

What goes here?

húwz əfɹéjd əv ðə bíg bæd wʌ́lf

who's afraid of the big bad wolf

Computational modeling

Important consideration: Linking to empirical data

Models are most informative when they're grounded empirically.

This is why most models make use of the child-directed speech data available through databases like CHILDES.

Many models will try to make cognitively plausible assumptions about how the child is representing and processing input data:

- Processing data points as they are encountered
- Assuming children have memory limitations (ex: memory of data points may decay over time)
- Using information children of the age being modeled are capable of using (ex: transitional probabilities)
- Using representations children of the age being modeled likely have (ex: syllable-like units for word segmentation)

General modeling process

(1) Decide what kind of learner the model represents (ex: normally developing 6- to 8-month-old child learning first language)

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(2) Decide what data the child learns from (ex: Bernstein corpus from CHILDES) and how the child processes that data (ex: divide speech stream into syllables)

General modeling process

(1) Decide what kind of learner the model represents (ex: normally developing 6- to 8-month-old child learning first language)

(2) Decide what data the child learns from (ex: Bernstein corpus from CHILDES) and how the child processes that data (ex: divide speech stream into syllables)

(3) Decide what hypotheses the child has (ex: what the words are) and what information is being tracked in the input (ex: transitional probability between syllables)

General modeling process

(4) Decide how belief in different hypotheses is updated (ex: based on transitional probability between syllables)

General modeling process

(4) Decide how belief in different hypotheses is updated (ex: based on transitional probability between syllables)

(5) Decide what the measure of success is
ex: achieving a certain knowledge state by the end of the learning period

- Recognizing words in a fluent speech stream

The goal of modeling

Remember: the goal is generally to see if a particular learning strategy will allow the child to go from the input to the output. This then tells us about the how of language acquisition.

húwzəfɹéjdəvðəbígbǽdwʌ́lf

What goes here?

húwz əfɹéjd əv ðə bíg bǽd wʌ́lf

who's afraid of the big bad wolf

Computational methods

"The main advantage is the ability to precisely manipulate the language acquisition process and see the results of that manipulation. Generally, the manipulation should be something difficult to do with traditional experimental techniques – such as controlling the hypotheses children entertain, how children interpret the available data, and how they use the data to shift belief between competing hypotheses." — Pearl 2010

Computational methods

"The main disadvantage of modeling is that we can never be absolutely sure our model is really showing how acquisition works in children's minds. Perhaps some crucial information has been left out of the model's knowledge. Perhaps some critical oversimplifications have been made about how the model interprets the available data. Perhaps the output of the model lacks the nuances that children's behavior has. This is why empirical grounding is key. The more checkpoints on the model, the more we can believe what the model shows us about acquisition. This is where drawing from the results of experimental work can help." — Pearl 2010

Recap

Some basic questions about language acquisition = *what* children are learning, *when* they learn the *what*, and *how* children learn the appropriate *what* by the appropriate *when*.

Theoretical methods:
What knowledge is being learned

Computational methods:
How it's being learned

Experimental methods:
When it's being learned and what from

You should be able to do up through 16 on the acquisition review questions and up through 2 on HW2.