Psych229: Language Acquisition

Lecture 19

Poverty of the Stimulus & Syntax

Seidenberg (1997): Innate Biases ≠ Grammatical Knowledge

But what about learning more abstract things (like syntax) and language-independent things that are hard (or impossible) to observe?

…future work for connectionist models.

And innate knowledge?

"Innate capacities may take the form of biases or sensitivities toward particular types of information inherent in environmental events such as language, rather than a priori knowledge of grammar itself."

"Brain organization therefore constrains how language is learned, but the principles that govern the acquisition, representation, and use of language are not specific to this type of knowledge"

Legate & Yang (2002): Poverty of the Stimulus Lives

The Logic of Poverty of the Stimulus

1) Suppose there is some data.
2) Suppose there is an incorrect hypothesis compatible with the data.
3) Suppose children behave as if they never entertain the incorrect hypothesis.

Conclusion: Children possess innate knowledge ruling out the incorrect hypothesis from the hypothesis space considered.

Example case: Yes/No question auxiliary fronting (structure-dependent rules only)

Is Hoggle t_{is} running away from Jareth?
Can someone who can solve the Labyrinth t_{can} show someone who can't how?

Legate & Yang (2002): Poverty of the Stimulus Lives

Child Input

Very frequent
Is Hoggle t_{is} running away from Jareth?

Very infrequent, if ever
Can someone who can solve the Labyrinth t_{can} show someone who can't how?

Hypotheses for frequent data type

Structure-independent (linear)
Front first auxiliary, Front last auxiliary, …

Structure-independent (hierarchical)
Front the first auxiliary following the first noun phrase, Front the first auxiliary preceding a verb phrase, …

Structure-independent (creative)
Front the auxiliary closest to a noun, Front the auxiliary that is an odd-numbered position, …

Legate & Yang (2002): Poverty of the Stimulus Lives

The Real Rule

Front the auxiliary following the subject noun phrase in the main clause.

But the unbiased child has to rule out all the other options, even ones that are simpler to compute. (For instance: front first auxiliary is much easier to compute.) We would expect to see errors of this type.

Is the dwarf who t_{is} talking to Jareth is going to give Sarah the peach?

Real Children

But kids don't seem to make this error (Crain & Nakayama, 1987).

Implication: They've already ruled out that hypothesis, even though they've likely not seen much data (if any at all) incompatible with it. This is due to an innate bias to look for structure-dependent rules.

Legate & Yang (2002): Poverty of the Stimulus Lives

Pullum & Scholz 2002 (P&S)

Claim: But there *is* enough disconfirming data available to children. So this situation is not true - poverty of the stimulus does not hold here.

Assumption: Only trying to rule out the front first auxiliary hypothesis, not all the other ones, too. (This isn't necessarily true, and the PoS argument is based on the idea that the hypothesis space contains many more potential hypotheses.)

What kind of data?

One kind of disconfirming data: yes/no questions with two auxiliaries, where first auxiliary is not fronted
"Is the dwarf who is talking to Jareth t_{is} going to give Sarah the peach?"
(rare)

Another kind: wh-questions with complex subject, where first auxiliary is not fronted
"How could anyone who has watched *Labyrinth* before t_{could} not wince at this part?"
(how frequent?)

Legate & Yang (2002): Poverty of the Stimulus Lives

Pullum & Scholz 2002 (P&S): Corpus Hunt

Data set = 500 sentences of the Wall Street Journal
"How fundamental are the changes these events portend?"
"Is what I'm doing in the shareholders' best interest?"
Not really a good sample of child-directed speech
Found that 1% are of this data type (5)

Child-directed speech (samples from Nina corpus of CHILDES)

"Where's the little blue crib that was in the house before?"
"Where's the other dolly that was in here?"
"Where's the other doll that goes in there?"

Estimate: 0.1%-1% of data are of this type

So data likely exists…

Legate & Yang (2002): Poverty of the Stimulus Lives

But Existence of Data ≠ Sufficiency of Data

We need to know if the amount of discomfirming (unambiguous data) is sufficient to learn the correct hypothesis by the time children seem to know it.

How much data is enough?

Gauging a threshold

Suppose we have two learning problems, Problem 1 and Problem 2.
Suppose both have only two hypotheses to choose from.
Suppose the frequency of unambiguous data for Problem 1 is Frequency 1 and the frequency of unambiguous data for Problem 2 is Frequency 2.

Idea: If children figure out Problem 1 and Problem 2 at the same time, and they're learning from the data alone, we would predict that Frequency 1 and Frequency 2 should be about equal.

Legate & Yang (2002): Poverty of the Stimulus Lives

Auxilary-Fronting Threshold

Auxiliary-fronting is acquired by 3 years, 2 months (Crain & Nakayama 1987)

Something else learned by about 3 years: Subject-drop (Valian 1991).

Except in special contexts, English speakers do not drop the subject.

She is going to eat the peach.
*Is going to eat the peach.

This is in contrast to languages like Spanish, which can optionally drop the subject.

Ella va	a	comer	el	melocotón.
she goes-3rd-sg	*to*	*to-eat*	*the*	*peach*

Va	a	comer	el	melecotón.
goes-3rd-sg	*to*	*to-eat*	*the*	*peach*

Legate & Yang (2002): Poverty of the Stimulus Lives

Auxilary-Fronting Threshold: Comparative

Auxiliary-fronting: acquired by 3 years, 2 months (Crain & Nakayama 1987)
Subject-drop: acquired by about 3 years (Valian 1991).

Unambiguous data for subject-drop: 1.2% of the data

Another problem learned by about 3 years: Verb-Second movement in German and Dutch (German: Clahsen 1986, Yang 2000; Dutch: Lightfoot 1997, Yang 2000)

Sarah must solve the labyrinth.
German/Dutch:

Sarah must the labyrinth solve.
The labyrinth must Sarah solve.

Unambiguous evidence for Verb-Second movement: 1.2% of the data

Expectation: Auxiliary-fronting also needs 1.2% of the data to be unambiguous, in order for it to be learned by this age.

Legate & Yang (2002): Poverty of the Stimulus Lives

So how much data is there really?

Looking at the Nina corpus:
46,499 sentences
20,651 questions
14 unambiguous data examples (all of wh-question type)

Frequency of unambiguous data: 0.068% (much less than 1.2%)

Looking at the Adam corpus:
20,372 sentences
8,889 questions
4 unambiguous data examples (all of wh-question type)

Frequency of unambiguous data: 0.045% (much less than 1.2%)

Data is not frequent enough for children to learn by the time they do.

Legate & Yang (2002): Poverty of the Stimulus Lives

A larger point about data-driven learning

Problem: "…wild statistical disparities between what is presented to children and how children actually learn"

Example: Subject-drop (lots of "data", late generalization)
Almost all English sentences contain a subject, but children don't get it till 3.

Example: Verb-Raising in French (little "data", early generalization)
"She eats not the peach"
Only 7% of French sentences show this, but children acquire it by 1.5 years.

The point: Children come with innate biases that allow them to use data in specific ways to update their hypotheses.

Discussion: How different is this from Seidenberg's position?

Baker (2001): Complex Systems

Navajo Code Talker Paradox

English must be very different from Navajo
Japanese could decode English, but couldn't decode Navajo (when they didn't know it was Navajo).

English must be similar enough to Navajo
English can be translated into Navajo and back with no loss of meaning. (Languages are not just a product of the culture - pastoral AZ lifestyle couldn't have prepared them for Pacific Island high tech warfare, but translation was still possible.)

Baker (2001): Complex Systems

Language & Computers

HAL 9000 from 2001: A Space Odyssey (1968)
Perfect production and comprehension of English.

1960s: Language not considered one of the "hard" problems of artificial intelligence.

Reality: Still not even close now to human-like performance.

Contrast: Chess-playing. (Not about insufficient computational power.)

Baker (2001): Complex Systems

Levels of Variation Between Languages

Word sense (vocabulary selection):
English "think": think, know, wonder, suppose, assume, …
Navajo "carry":

aah (solid round-ish object)

kaah (open container with contents)

lé (flexible object)

Baker (2001): Complex Systems

Levels of Variation Between Languages

Sounds:
English "th", "f", "sh", …

Navajo "whispered l", "nasalized a", …

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Baker (2001): Complex Systems

Levels of Variation Between Languages

Prefix System:
English: invariant words

"Girl crying", "I am crying"

Navajo: no invariant forms (ex: 100-200 prefixes for verb stems)

At'ééd yicha. "Girl crying"

Yishcha. "I am crying" (yi + sh + cha)

Ninááhwiishdlaad. "I am again plowing" (ni + náá + ho + hi + sh + l + dlaad)

Baker (2001): Complex Systems

Levels of Variation Between Languages

Word order (syntax)
English: Subject Verb Object
"The boy saw the girl"

Navajo: Subject Object Verb, Object Verb Subject

Ashkii at'ééd **yi**yiiltsá
boy girl saw
"The boy saw the girl"

Ashkii at'ééd **bi**iltsá
boy girl saw
"The girl saw the boy"

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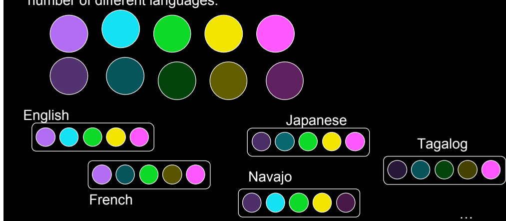
Similarities & Differences: Parameters

Chomsky: Different combinations of different basic elements (parameters) would yield the observable languages.

Idea: A relatively small number of parameters yields a large number of different languages.



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Similarities & Differences: Parameters

Chomsky: Children are born knowing the parameters of variation. This is part of Universal Grammar. Input from the environment determines what values these parameters should have.