How we can tell what children are actually learning about language and whether it's crazy

KATIE KHUU
FACULTY MENTOR: DR. LISA S. PEARL
DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF CALIFORNIA, IRVINE

How do infants learn language as well and as fast as they do?

WITHOUT SUPERVISION
- Learning by themselves, without someone to tell them what to say or how to say things

SYNTACTIC CATEGORY ACQUISITION
- A way of representing the functions of words (how we use them) in language

How does one learn syntactic categories?

“How WUG”
“I have a wug.”
“I wug cats.”

ADULT KNOWLEDGE

NOUN
VERB

Chocolate
Glass
Paper
Hop
Jog
Run
Sweet
Buttery
Happy
“I wug cats.”

Pronoun  Verb  Noun

“They chase rabbits.”

“He wants cookies.”

“She craves chicken.”

“WUG”

“I have a wug.”  “I wug cats.”

Infants, aged 12-14 months, have basic knowledge of syntactic categories.

• How might they learn it?
• What cues do they use?

Infants, aged 12-14 months, have basic knowledge of syntactic categories.

DISTRIBUTIONAL HYPOTHESIS

- Words that appear in similar contexts tend to have the same functions
- use the surrounding words – the distribution of words – to help determine what a particular word’s function is

“I have a wug.”  “I wug cats.”

“I have a cat.”  “I hug cats.”

“I have a penguin.”  “I like cats.”
Distribution of words is a cue to help children learn syntactic categories.

Word order is a kind of distributional cue.

Word order = distributional cue
Involves the words before and the words after – looks at the distribution of words

"Wugs are nice."
"i wug cats."
"I like wugs."

Word order differs by utterance type.
How?

What is an utterance?
• Utterance: smallest, continuous unit of speech

What are utterance types?
• Utterances differ by communicative purposes (e.g. statement, question, command).
What are utterance types?

Word order differs by utterance types. How?

Utterance Types

“Do you like penguins?”
“Does he want cookies?”
“What did she take?”
“What do they need?”

PRONOUN VERB (DETERMINER) NOUN

Summary of syntactic category cues

Distributional Learning
which words appear together
Utterance Type
affects word order

Word Order
sequence of words is important

information for a possible strategy to learn syntactic categories
Frank, Goldwater, & Keller (FGK) (2013)

DISTRIBUTION | WORD ORDER | UTTERANCE TYPES

SIMULATED CHILD

How does FGK’s strategy work?

• Input = child-directed speech

“Are you sleepy?”

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[Diagram showing word order and categories]

How does FGK’s strategy work?

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[Diagram showing inferred categories]

How does FGK’s strategy work?

• Input = child-directed speech

“Are you sleepy?”

[Diagram showing infered categories]
How are we further testing this strategy?

Methods
- Age-appropriate dataset
- Evaluation methods
  - inferred category mappings
  - perplexity

Age-appropriate dataset

Age range of children receiving the input
- FGK: 18 months – 3 years old
- Me: 6 months – 12 months

Infants, aged 12-14 months, have basic knowledge of syntactic categories.
• How might they learn it?

Why does age matter?
- Complexity of utterances changes as children get older.

(Booth and Waxman, 2003)
Why does age matter?

6 months – 12 months
"Do you see the light?"

18 months – 3 years old
"Shall we build an arch for the tractor to drive through?"

Important: FGK’s strategy hasn’t yet been tested on realistic data of this kind.

Methods

- Age-appropriate dataset
- Evaluation methods
  - Qualitative analysis: inferred category mappings
  - Quantitative analysis: perplexity

VM score

- how well did the simulated child match the adult categories?

How does FGK’s strategy work?

- Input = child-directed speech

```
Are you sleepy?
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VM score – don’t expect perfect

- We don’t expect perfect scores, because children at this age likely have preliminary category knowledge, rather than full adult knowledge.
VM score – how well did the simulated child match the adult categories?

Range: 0.0 – 1.0

Frank, Goldwater, & Keller (2013): 0.6-0.7
My score: 0.48

When using more realistic data, the strategy doesn’t seem to do so well.
WHY? WHAT IS THE SIMULATED CHILD ACTUALLY DOING?

SIMULATED CHILD

Methods
- Age-appropriate dataset
- Evaluation methods
  - Qualitative analysis: inferred category mappings
  - Quantitative analysis: perplexity

Qualitative analysis: inferred category mappings
FINDINGS

It does match some adult categories well.
- matches some adult categories to exactly one inferred category

ADJECTIVES
Happy
Cheerful
Little
Big

It does map some adult categories well.
- matches some adult categories to exactly one inferred category

ADJECTIVES
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Little
Big

CATEGORY 5
Happy
Cheerful
Little
Big
It believes some adult categories belong together.
- Some verbs and interjections put together

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It believes some adult categories belong together (and it makes sense).
- Verbs and interjections put together – words are utterance-initial exclamation markers

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It splits an adult category into two.

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<td>friend</td>
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It splits an adult category into two (and it’s reasonable).

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<tr>
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<th>CATEGORY 1</th>
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It has no clue what should belong to these other categories.

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IMPORTANT: The simulated child is doing some reasonable (not crazy) things in trying to learn these syntactic categories.

**Methods**
- Age-appropriate dataset
- Evaluation methods
  - Qualitative analysis: inferred category mappings
  - Quantitative analysis: perplexity

**Results: Perplexity Measure**
- How predictable is the data given the inferred categories

***Predictable data is easier to process (Levy 2008).***

**Results: Perplexity Measure**
- Range: $1 - +\infty$

Lower perplexity score = more predictable data

Higher perplexity score = more confusing data

Data = child-directed speech data

Using adult categories: 772
Using inferred categories: 728

Inferred categories make language processing easier!
Is what children are learning about language crazy?

Conclusion – NOT CRAZY!!!!
The inferred categories ARE useful (even if they’re not the ones adults have).

Future Directions
- More sophisticated perplexity measure to evaluate how useful the categories are
- Current limitation: utterance types are currently derived from adult knowledge
  - Current plan: Use utterance types that 12-month-olds would use

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QUESTIONS? Comments? Concerns?
😊