Language Acquisition: Word Learning

SS16 - (Embodied) Language Comprehension

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Administration

• 2h Lecture + Exam (3CP)

• Exam date: 29th July

• http://www.coli.uni-saarland.de/~masta/SS16/embodiedLC_schedule.html

• Readings at the end of slides

• Contact me: masta AT coli
(Embodied) Language Comprehension

• Methods and recent insights into how “we understand language”

• Language is “embodied” & “situated”:
  • Language is inseparably bound to our body and our physical interaction with the world
  • Language is typically used and understood in context
“Embodied”

“To say that cognition is embodied means that it arises from bodily interactions with the world. From this point of view, cognition depends on the kinds of experiences that come from having a body with particular perceptual and motor capacities that are inseparably linked and that together form the matrix within which memory, emotion, language, and all other aspects of life are meshed. The contemporary notion of embodied cognition stands in contrast to the prevailing cognitivist stance which sees the mind as a device to manipulate symbols and is thus concerned with the formal rules and processes by which the symbols appropriately represent the world.” (Thelen et al., Behav. & Brain Sciences, 2001)
(Embodied) Language Comprehension

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(Embodied) Language Comprehension

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“Situated”

- “… the majority of contemporary findings in sentence processing point to a richly interactive cognitive processing system in which structural constraints and contents-based constraints have roughly equal timing and importance in their influence on real-time sentence comprehension. In this emerging theoretical framework, it is expected that any given linguistic process of interest will be best understood when analyzed not in isolation but embedded in the context in which it is typically situated.” (Spivey & Huette, in “Visually situated language comprehension”, 2016)
Overview of course

- 29.04.2016: Word learning 1
- 06.05.2016: Word learning 2 (verbs)
- 13.05.2016: Embodiment 1
- 20.05.2016: Embodiment 2
- 27.05.2016: NO CLASS
- 03.06.2016: Adult language comprehension: The VWP 1
- 10.06.2016: Adult language comprehension: The VWP 2
- 17.06.2016: Common Ground and Perspective-taking
- 24.06.2016: Speaker/Listener information 1
- 01.07.2016: Speaker/Listener information 2
- 08.07.2016: Social factors in language processing
- 15.07.2016: NO CLASS
- 22.07.2016: Applications in embodied language processing
- 29.07.2016: EXAM
Learning (a) language

• All (normal) human children...
  • learn a language.
  • can learn any language they are exposed to.
  • learn all languages at basically the same rate.
  • follow the same stages of language acquisition.

• But what is learned? And how exactly?
What is learned

• The sounds of a language (phonetics)
• The sound patterns of a language (phonology)
• Lexical items (words, morphemes, idioms, etc)
• Rules of word-formation (morphology)
• How words combine into phrases/sentences (syntax)
• How to derive meaning from a sentence (semantics)
• How to properly use language in context (pragmatics)
What is learned

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• **Lexical items** (words, morphemes, idioms, etc)
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Stages of learning

- **0-6 months: Prelinguistic**
  - no babbling yet
  - sensitive to native vs non-native sounds

- **6-12 months: Babbling**
  - pitch and intonation resemble native language

- **12-.. months: One-Word**
  - “holophrastic” sentences
  - competence better than performance

- **18-24 months: Two-Word**
  - ~50 words, “telegraphic” sentences

Lexical items / Words
Acquiring words & meanings

- Children learn single words
- Children learn the meaning of words
- What is the meaning??
  - “mummy”, “dog”, “tail”, “empty”
Acquiring words & meanings

• “mummy”
• “dog”
• “tail”
• “empty”
Word-to-World Pairings

- Children acquire a word by learning a word-to-world mapping - through experience

- Problems:
  - Hypothesis space is huge: Which word refers to which “thing”?
  - Subset problem: Wrong choice impedes falsification

“The fruit look yummy!”
Early hypothesis space...

- Maybe not as big as one might think
- Initially hands and mouth play an important role as well

(Yu et al., IEEE Trans. on Auton. Mental Dev., 2009)
(Yu & Smith, Cognition, 2012)
The Visual World & Grounding Language

- The visual world plays an important role in grounding language:
  - Children observe and experience concrete objects and events > mental representations
  - Naming these objects and events is the first linguistic activity children perform
  - This is how the arbitrary system of language is grounded in, i.e., connected to, the world (cf. lectures on Embodiment)
The Visual World as Diagnostic Tool

• The visual world paradigm is a good diagnostic for language-learning studies:
  
  • Looking at entities or events after they have been mentioned signals understanding
  
  • E.g. in baby studies: gaze one of few possibilities to measure language processing (preferential looking)
The Visual World as Information Source

• The visual world is a very important information cue for language learners, even more so than for native speakers:
  • On-line compensation for knowledge gaps
  • Word-learning cue
The Visual World as Information Source

- Word learning
  - Observational learning
  - Using the visual context and the embedding of the new word in linguistic context for inferencing
The monkey is observing a dax.
The monkey is observing a dax.

Fast-Mapping (Carey, 1978)
The monkey is observing a dax.
The monkey is observing a dax.
The monkey is observing a dax.

There’s a dax!
The monkey is observing a dax.

There's a dax!

Cross-Situational Word Learning (Quine, 1960; Yu & Smith, 2007)
There’s a dax!
There’s a dax!

Social Cues (e.g., pointing, gaze; Baldwin, 1993; Tomasello, 2000)
Is that it?

- Fast mapping vs CrossSWL

- CrossSWL can deal with uncertainty
  - But: Multiple hypotheses would need to be tracked...

- Is that really the case?
Propose-but-verify

• Tracking only a single hypothesis to keep memory load feasible (Medina et al., 2011; Trueswell et al., 2013)

• Unrealistic to assume that a learner can keep track of everything!
The monkey is observing a dax.
The monkey is observing a dax.

There's a dax!
Single Hypothesis Tracking

- Trueswell et al. (2013)
  - No memory for unselected potential referents
  - Only last selection memorized
  - Propose-but-Verify Account
The monkey is observing a dax.

There’s a dax!

![Graph showing proportion correct](image)
The monkey is observing a dax.

There’s a dax!
Single Hypothesis Tracking

- Trueswell et al. (2013)
  - No memory for unselected potential referents
  - Only last selection memorized
  - Propose-but-Verify Account
- Too fragile to account for learning of ambiguous words
- Memory for all past selections? (Robust Propose-but-Verify Account)
"Oh look! A heek!"

(Koehne, Trueswell & Gleitman, CogSci 2013)
* 2-8 other trials in between!
The telephone is 100% referent: it occurs every time, “heek” is presented.
The chair is the 50% referent for "heek", it occurs in half of the six heek trials.

Condition PPPAAA: 50% referent present in first three exposures.
Condition PAPAPA:
50% referent present in first, third, and fifth exposure
Condition AAAPPP:
50% referent present in last three exposures
Condition APAPAP:
50% referent present in second, fourth, and sixth exposure
Test phase

• What is the “heek”?
• Telephone not depicted!
• Second best candidate detected? (even though there was perfect referent)
Predictions

- Selection of 50% referent (chair) in test:
  - *Cross-Situational Account* - Independent of condition and learning path
  - *Fragile Propose-but-Verify Account* - Only if it was the very last proposal for a noun, i.e., only possible in Conditions AAAPPP and APAPAP
  - *Robust Propose-but-Verify*: Only if it was proposed at some point during learning, possibly the more recent the better
Results

(Embodied) Language Comprehension

Word Learning

Results

34%​
27%​
23%​
16%​

chance 12.5%

AAAPPP
APAPAP
PAPAPA
PPPAAA

50% referent selected in test

Error bars: 95% CI
Results

![Bar chart showing the percentage of referents selected in any encounter for different conditions. The conditions are labeled AAAPPP, APAPAP, PAPAPA, and PPPAAA. The bars are colored green (no) and red (yes) with error bars indicating 95% CI.](image)
Results

• The 50% referent (chair) was only selected if it had been selected in previous *encounter*, independent of Condition (PPPAAA, PAPAPA, APAPAP, AAAPPP)

• Supports the Robust Propose-but-Verify Account

• Selecting the 50% referent (chair) was still above chance when learners had *additionally* chosen the 100% referent (telephone) two to five times

• Multiple-Proposal Memory rather than Multiple-Hypotheses Memory
Learning mechanisms

• Cross-situational word learning
  • Multiple hypotheses

• Fast mapping
  • Fragile vs Robust Propose-but-verify (multiple proposals can enter memory)
  • Fast mapping - slow learning…
Back to children

- Fast mapping and disambiguation
  - Is the tendency to assign novel words to novel objects in place from the beginning?
  - Does the ability to disambiguate relate to word learning (i.e. word-object association later on)?
18, 24, 30 months old children tested in looking-while-listening procedure
Summary

- Children acquire words and their meaning in various ways:
  - through one-time associations (“proposals”),
  - using disambiguation to exclude referents,
  - that are refined (“verified”) probabilistically, across situations
- What about abstract words without direct empirical mappings?
References


