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Understanding The Brain Through Language:
A Window Into Cognition
How does the brain understand and produce language?
### The motor homunculus:

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<table>
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<tbody>
<tr>
<td>A</td>
<td>Is a pictorial representation of the brain regions which control the body.</td>
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<tr>
<td>B</td>
<td>Shows that humans have a great emphasis on controlling mouth and hand movement.</td>
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<td>C</td>
<td>Diagram on the right indicates the location and amount of cortex devoted to each part of the body.</td>
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<tr>
<td>D</td>
<td>All of the above are true.</td>
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Language dominance (LH) vs. spatial visualization (RH)
What are you learning when you’re learning a language?
Language at age 3

• Good narrative skills
• Gestures
• [Over]generalizes concepts
  – Obi-Wan is a teacher, garage sale for robots
• Phoneme errors
  – Erratic production of final L sound
    • “well” followed by “wew”
  – sh --> s (siny guy, spacesip)
  – th --> f (He tried to do it *wifout seeing*, Darf Vader)
• Verb forms **overregularized** (“blowed up”)
• Frozen phrases (Don’t talk back to Darf Vader, he’ll get ya!)
What are you learning?

- Speech sounds
- Finding word boundaries
- Mapping words to meanings
- Syntax (grammar)
- Language in social context

*How do these things go together?*
Possible patterns

- Sequential

  - Speech sounds
  - Words
  - Grammar
  - Social context

- Overlapping

  - Speech sounds
  - Words
  - Grammar
  - Social context
Producing language

- **Speech sounds**
  - ~6-8 months: Babbling onset

- **Words**
  - 10-12 months: say first words

- **Grammar**
  - 18 months: “word spurt”

- **Social context**
  - This takes quite a while…

A caution: Perception precedes production.

“two-word speech”
Recognizing/comprehending language

By 10-12 months:
Only sensitive to speech sound changes in your native language (mostly)

Older idea: you need to have a small set of sound “symbols” (kind of like mental letters) to be able to store words in the brain—otherwise, information overload

BUT...

Show some word recognition at 6-9 months (Bergelson & Swingley, 2012)
Respond to word order at 17 months, before 2-word stage (Hirsh-Pasek & Golinkoff, 1993)
Show some social (?) responsiveness to language in infancy (Kinzler et al., 2007)
MANY studies showing non-adultlike sensitivity to differences in speech sounds, voices, vocal emotion, word stress patterns in preschool years and beyond
Finding word boundaries
Cues to word boundaries

• Stress
  – English: most nouns are stress-initial
  – ThePREttyBAbyWANTSaBOTtle
Cues to word boundaries

• Strong-initial vs. weak-initial words
  – Strong: BUTter, CANdle, PUPpy, SAUsage
  – Weak: baNAna, caBOOSE, reCLINE, aGREE

• Cutler and colleagues: “metrical segmentation strategy” (MSS)
  – Strong syllable is the start of a word
Cues to word boundaries

• Jusczyk, Houston & Newsome
  – Infants’ recognition of word forms
  – 7.5 months:
    • Stress-initial (kingdom) ✓
    • Stress not initial (guitar) ✗
  – 10.5 months:
    • Stress not initial (guitar) ✓
But...

• Not all languages have this kind of stress pattern.

• How do you know what the properties of words are if you don’t know what the words are?
• Lookattheprettybaby
• Whereisthebabynowprettygirl
• Thisbabyisprettysilly
• Look at the pretty baby
• Where is the baby now pretty girl
• This baby is pretty silly

• Given “ty”, what’s likely to come next?
• What about given “ba”? 
Statistical learning

• Saffran, Aslin & Newport (1996)
  – 8-month-old infants

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Statistical learning

• Play for 2 minutes
• Present kids with bidaku or piro.bi type words
• What do they listen to longer?
  bidaku < piro.bi
  – (novelty preference)
• At 8 months infants can segment words based on statistical cues
But what about stress?

- Johnson & Jusczyk (2001)
  - 8-month-olds
  - Stress vs. statistics: Stress wins
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- Thiessen & Saffran (2003)
  - Statistics wins @ 7 mos
  - Stress wins @ 9 mos
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• *Segmentation precedes stress.*
More questions about language development
How do you represent words’ sound patterns, if not as a string of speech sounds?

• Maybe as the whole word’s sound pattern itself

• Later, speech sounds (or something like them) emerge from the whole collection of words you know
  – Probably with a lot of help from speaking an alphabetic language
If learning is so slow, why are kids so good at learning language?

• Answer 1: we don’t know because there are a lot of variables at play
  – Social preferences, % time in new language
• Answer 2: they aren’t.
  – Slower vocabulary learning than adults in L2 situations
• Answer 3: because they’re doing it differently
  – Adults learning an L2 depend on their preexisting knowledge (“kind of like /d/ in English”)
  – Children (under age 6 or 7) are learning sound patterns of L2 from the ground up