Psychology of Language

2 Speech perception

Fall 2023
Tues/Thur 5:00-6:15pm

Road map

- Review from **1 Introduction**
- Unit 1: Development of Language
  - Overview
  - 2 Speech perception

Review from **1 Introduction**

- Turn to someone nearby—what do you recall from last time?

Review/new from **1 Introduction**

- **One definition of language:** Language is the knowledge you have (of words and rules) that allows you to construct meaningful expressions in real time (and understand them).
  - Russian & sign language are languages; gesture and emojis are other forms of communication
    - Language is not exclusive to a particular way of making expressions available to other speakers (Russian and sign language use different ***modalities***)
    - Language is…
      - Productive & creative – you can create and understand completely new sentences all the time. We use a finite set of elements to communicate infinite ideas and create an infinite number of new sentences
      - Universal (among typically developing humans) – all humans if exposed to language input will acquire language
      - Distinct from thought – read more about this one in the Fernández & Cairns pdf for class #1 on HuskyCT!
      - Distinct from animal communication – read more about this one in the Fernández & Cairns pdf for class #1 on HuskyCT!

Review/new from **1 Introduction**

- **Important distinctions we will revisit throughout the semester:**
  - Tacit vs. conscious knowledge: Language research is necessary because we can't just reflect consciously on how we *do* it
  - Descriptive vs. prescriptive rules: Because we want to know how we do language, we are interested in *descriptive* language use (the way people actually use language). We are not interested in the way other people tell us is the "right" way to use language (what you *should* do), which is *prescriptive* language use.
  - Domain general vs. domain specific: Are general cognitive abilities enough to learn and use language, or is there a special part of the brain dedicated to language?
  - Competence vs. performance: Knowledge of language (competence) can be distinguished from use (performance) of language.

1. The cheese smelled good.
2. The cheese **that the mouse ate** smelled good.
3. The cheese that the mouse **that the cat chased** ate smelled good.

What does adult knowledge of language consist of?

- What knowledge do adults have that babies need to acquire? In other words, what constitutes adult-like knowledge of language?
  - *Example: the syntax (grammar) of the language(s) they speak*
  - Sounds that are used in the language (phonemes)
  - How the sounds can be ordered (phonology)
  - The melody and prosody that are used (phonology)
  - How to *make* the sounds (how to move the articulators)
  - Lexical items and morphemes, and their mapping to meaning
  - How to string sentences together productively (syntax)
  - How to use language in conversation according to cultural norms (pragmatics)
- How do we learn all of this?

Unit 1: Development of Language

Discuss

1. When do kids start learning language?
2. How long does it take to acquire adult-like knowledge of language?
3. Do some languages take longer for children to learn than others?
4. Do children possess an innately specified property of the brain to help them acquire language (a Language Acquisition Device)?
5. Is language acquisition effortful, like learning to ride a bike?
6. Do caretakers have to teach language to children, or speak in a specific way so that kids can learn language (child-directed speech)?
7. Is acquisition of language affected by general intelligence and technological advances?
8. Do children who are learning the same language follow similar stages of acquisition or is everyone's acquisition path different?

Unit 1: Development of Language

2 Speech Perception: Perceiving the sounds of language

Ascent of Babel, Chapter 3

> "Speech perception is the extraordinarily rapid and automatic decoding of a physical acoustic signal into the mental units ultimately used to retrieve words from the lexicon." (Fernandez & Cairns, 2017, p. 185)

2 Speech perception

- How do babies perceive speech, and how can we know they do that?
- Learning objectives
  1. Describe problems infants face in perceiving and recognizing information in the speech signal
  2. State three dimensions on which consonants vary
  3. Define *categorical perception*
  4. Name a change that occurs to infants' abilities related to speech perception

The problems of speech perception

- What challenges do infants face in trying to perceive speech?
  - *Example: babies have to distinguish between the noise that is speech and other noises*
  - Recognize specific sounds used in the language input when the speech stream is continuous
  - Learn the patterns in the speech sounds and formulate rules for those patterns
  - Associate patterns with meanings
  - Produce equivalent patterns that are intelligible to their speech communities

Phonemes

- What is a phoneme? Give some examples
  - Can also think about what ISN’T a phoneme

Phonemes

- Phoneme: smallest individual speech sound (e.g., [p], [t], [k]) that you can change to make distinct words in a language
  1. Example 1: mat, bat, cat
     - [m], [b], [k]
     - the phoneme is [k]; the letter “c” can be associated with multiple phonemes (e.g., cat, nice)
  2. Example 2: two, due, new
     - [t], [d], [n]
     - “oo” sound is all the same phoneme, [u], despite different spellings!

How do adults distinguish phonemes?

- How do we learn to distinguish [t] and [d]?

- Pronounce the word *map*
  - Now emphasize the final sound by releasing air after [p]
  - Does this change in the final sound result in a minimal pair?

Features of articulation

- Consonants can be classified based on three features.

Guess what they are using the following pairs as a guide:

[k] vs. [t] **c**ap / **t**ap	[s] vs. [t] pa**ss** / pa**t**	[p] vs. [b] **p**at / **b**at
[f] vs. [θ] roo**f** / Ru**th**	[ʃ] vs. [tʃ] **sh**oe / **ch**ew	[s] vs. [z] hi**ss** / hi**s**

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The three features are

1. Manner of articulation
2. Voicing/Voice Onset Time (VOT)
3. Place of articulation

Features of articulation

- Consonants can be classified based on three features.

Guess what they are using the following pairs as a guide:

Place	Manner	Voicing/VOT
[k] vs. [t] **c**ap / **t**ap	[s] vs. [t] pa**ss** / pa**t**	[p] vs. [b] **p**at / **b**at
[f] vs. [θ] roo**f** / Ru**th**	[ʃ] vs. [tʃ] **sh**oe / **ch**ew	[s] vs. [z] hi**ss** / hi**s**
Where the sound is made	How the sound is made	Use of the vocal folds

Table 2.1 English phonetic inventory (based on Standard American English). Voiceless sounds are shaded; all other sounds are voiced. In each cell, a symbol from the International Phonetic Alphabet (IPA) is listed first, followed by one or two example words containing the sound, written in standard orthography (the underlined letters correspond to the sound).

Place of articulation

Consonants

Manner of articulation	*Bilabial*	*Labiodental*	*Dental*	*Alveolar*	*Postalveolar*	*Palatal*	*Velar*	*Glottal*
Oral stops	p pin b bin			t tin d din			k kin g gun	ʔ satin
Fricatives		f fin v vin	θ thin ð then	s sin z Zen	ʃ shin ʒ vision			h hen
Affricates					ʧ chin ʤ gin			
Nasal stops	m Pam			n pan			ŋ pang	
Approximants	w wind			r river l liver		j yen		
Flap				ɾ city				

Obstruents

Sonorants

Vowels

Vowel height	*Front*		*Central*		*Back*	
High	i	heat			u	hoot, who'd
	ɪ	hit			ʊ	hood
Mid			ʌ	hut		
	eɪ	hate	ə	ahead, sofa	oʊ	hope
	ɛ	head	ɝ	heard	ɔ	haw
			ɚ	heater		
Low	æ	hat			ɑ	hot
Diphthongs			aɪ	bite		
	ju	beaut, cute	aʊ	bough	ɔɪ	boy

Voiceless sounds are shaded

Fernández & Cairns, 2011, p. 32

Articulatory features in sign language

- Sign language articulation: manual parameters
  - Hand shape: *cute* vs. *sweet*

Videos from SignASL.org

Articulatory features in sign language

- Sign language articulation: manual parameters
  - Hand shape
  - Palm orientation: *stars* vs. *socks*

Videos from SignASL.org

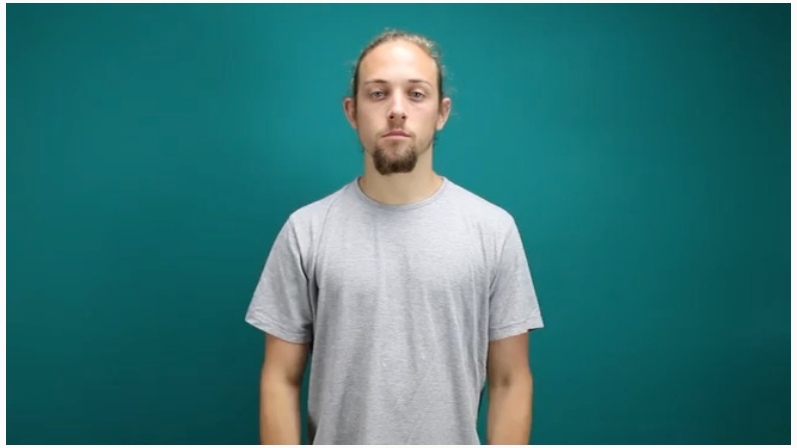
Articulatory features in sign language

- Sign language articulation: manual parameters
  - Hand shape
  - Palm orientation
  - Location: *mother* vs. *father*

Videos from SignASL.org

Articulatory features in sign language

- Sign language articulation: manual parameters
  - Hand shape:
  - Palm orientation
  - Location
  - Movement: *game* vs. *challenge*



Videos from SignASL.org

The challenges of speech perception

- What challenges are infants faced with in trying to perceive speech?
  - In order to do any of this, infants need to know which differences between speech sounds are important and which are not

coarticulation

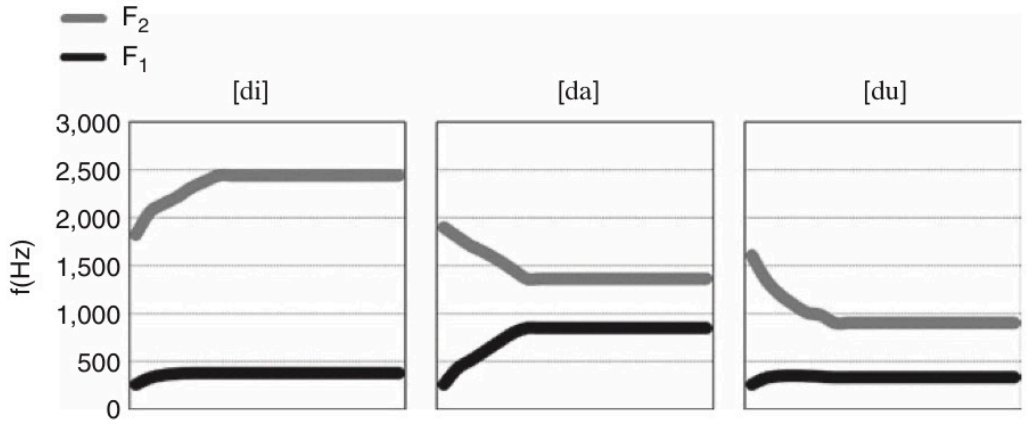


Figure 6.3 F_1 and F_2 measurements for three syllables, [di], [da], and [du], uttered by a female speaker of American English. The measurements show the transitions and steady-state formants for those three syllables. Notice that, in all three syllables, F_2 moves away from the same frequency.

Fernández & Cairns, 2011, p. 175

Variability in the speech signal

- What additional challenges are infants faced with in trying to perceive speech?
  1. *Example*: Context of the sound: coarticulation (what other sounds are around it?)
  2. Variability among speakers
     - Voices are unique identifiers like fingerprints and retinas, yet we are able to understand sounds from voices we've never heard before
     - Native and non-native speakers
  3. Variability within speakers
     - Fast and slow speech, speaking while eating, whispering, shouting, emotion, tiredness, drunkenness
  4. Ambient noise

Fernández & Cairns, 2011

How do babies distinguish phonemes?

- Somehow, the speech perception mechanism overcomes variability, even in infants
  - Knowledge of the phonetic inventory for the language is important for this
- One big issue is in distinguishing which features are important to attend to, and which are not
- **Example**: Voice Onset Time (VOT)
  - It is a continuum, yet in English, consonants are either voiced or voiceless (it's categorical)
    - So from [t] to [d] there is a continuum from voiceless to voiced

How do babies distinguish phonemes?

How do babies distinguish phonemes?

cat dog

How do babies distinguish phonemes?

cat dog

How do babies distinguish phonemes?

cat

dog

How do babies distinguish phonemes?

/da/ …..... /ta/

Categorical perception

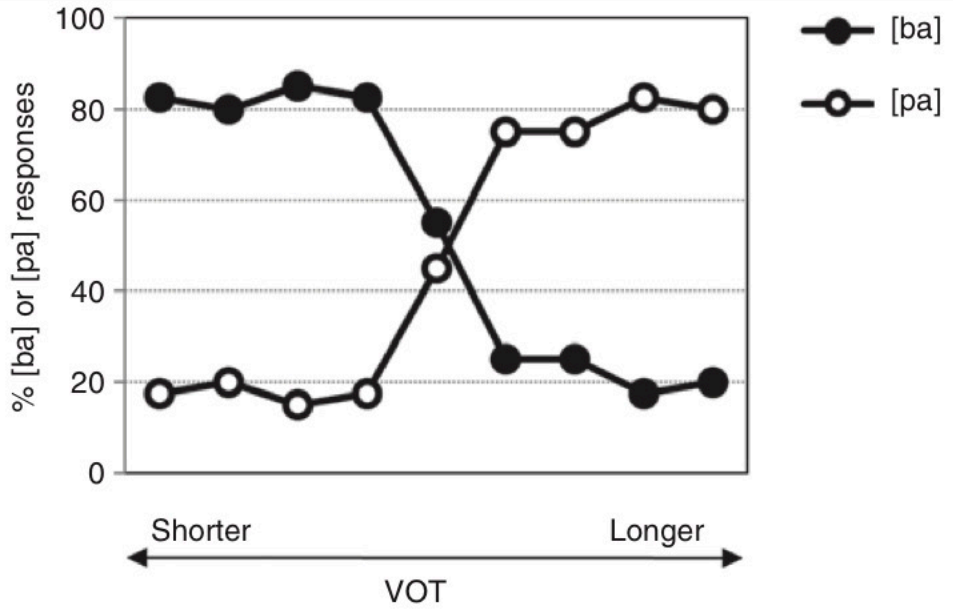


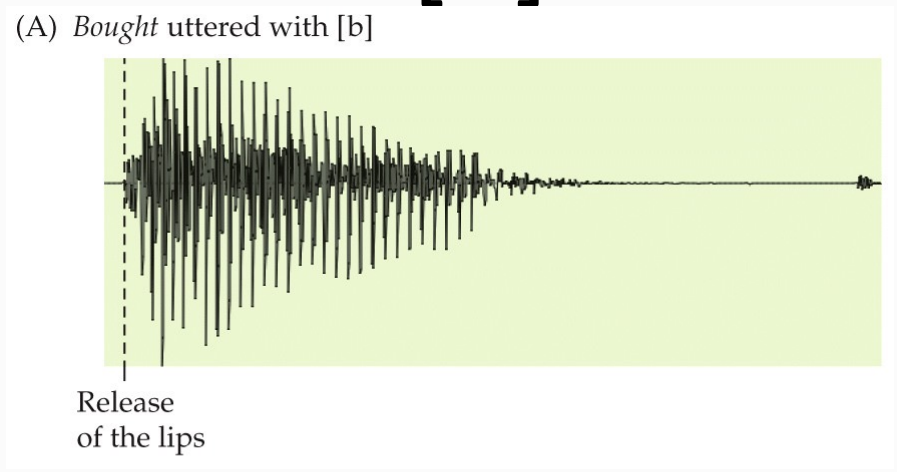
Figure 6.5 Hypothetical results of a categorical perception experiment, for participants listening to nine syllables in a VOT continuum, and asked to indicate whether they have heard [ba] or [pa]. The horizontal *x*-axis plots responses for each of the 9 syllables, varying from short VOT (left) to long VOT (right). The vertical *y*-axis indicates the percent of [ba] or [pa] responses for each signal.

Fernández & Cairns, 2011, p. 177

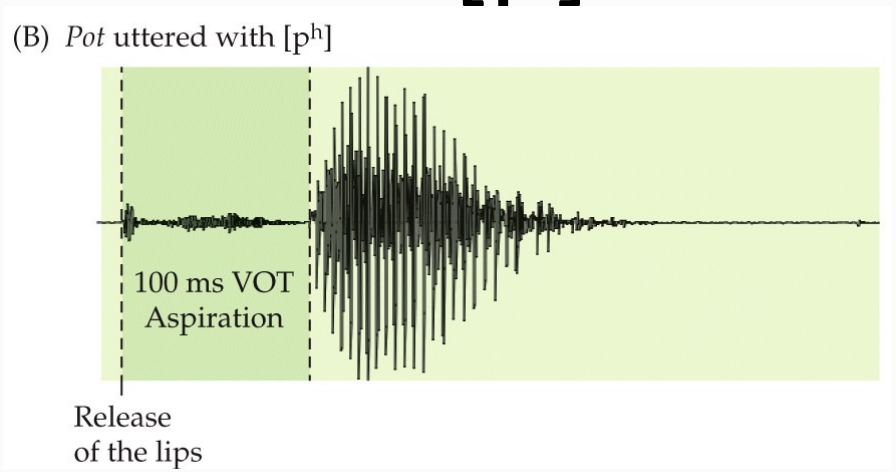
Categorical perception

Perceiving sounds that change along a continuum as belonging to two distinct categories

[b]



[p]



The continuum: voice onset time

Liberman et al., 1957

Categorical perception

- Two-month-old infants perceive speech sounds categorically[1]
- They can perceive *all* categories relevant in *any* language
  - What might this suggest about categorical perception and categories in speech signals? (innate? learned?)
- Infants lose this ability around 10 months of age. They ignore differences that are irrelevant to the language(s) in their environment[2]
- Infants (and adults!) can also adapt to all of the variability that we discussed earlier (more on this to come later this semester!)

[1]Männel & Friederici, 2008; [2]Werker & Lalonde, 1988

Review (speech perception content)

1. What do you think are the most important concepts from this class?
2. What challenges face infants when learning the sounds of their language?
3. What is a phoneme? What ISN'T a phoneme?
4. Give an example of a minimal pair.
5. What are the three ways consonants can be classified?
6. Describe what categorical perception is.
7. What change occurs to infants' abilities in relation to speech perception?

Key concepts

- ✓Phoneme
- ✓Minimal pair
- ✓Articulatory properties of consonants
  - Place of articulation, manner of articulation, voicing (VOT)
- ✓Variability in the speech signal (e.g., coarticulation)
- ✓Categorical perception (and experiment to test it)
- ✓Changes over time in children's speech perception

Next…

- Infants must not only learn the phonetic inventory of the target language, they also have to learn legal and illegal combinations of those sounds!
  - And in fact, knowing something about the legal combinations in the language additionally helps to learn the phonemic inventory
    - Swahili: ***mb****ili*
    - English: *li****mb****ic*
- How do they do this?
  - Next week, we will see that learning begins even before birth!