

Sounds and speech perception

- Productivity of language
- Speech sounds
- Speech perception
- Integration of information

Productivity

- Many (perhaps most) animals communicate
- What is the nature of their communication?
 - Vervet monkey calls
 - Specific calls for aerial and terrestrial predators



Vervet monkeys do not develop new topics of conversation when the environment changes.

Productivity in language

- No constraints on topics
 - We can talk about all kinds of new things
- We constantly add to the language
 - Object names: FAX, cell phone, compact disc
 - Actions: skateboard, dumpster dive
 - Novel combinations in sentences
 - The laboratory rat brought ripe cheese to the party.
- What enables human languages to be productive?
 - Why are we different from vervet monkeys?

Being productive

- Language is productive at many levels
 - Novel words created from sounds
 - Words for a variety of concepts
 - Sentences for novel ideas
- General principles of productivity
 - A finite number of basic elements
 - “Rules” for combining them
 - The system can be described by rules, but there may not be that specific rule inside your head.
- We will see these principles repeatedly

The sounds of language

- Think about the many words you know
 - They are made up of sounds
 - Many different words use the same sounds
 - work war William row power
 - All have the sound /w/ in them
 - The words do not have similarities in meaning
- The basic sounds of language are called *phonemes*
 - English has about 40 phonemes

Words

- First, think about words
 - What is a word?
- A word is an arbitrary symbol
- Connection between the form of the word and its meaning is arbitrary
 - Cat, /kæt/
- Humans learn words easily
- Different kinds of words
 - Nouns, verbs, adjectives, determiners



How are speech sounds made?

- Today, we focus on speech sounds
- Vocal tract
 - Vocal cords
 - Throat and mouth
 - Tongue
 - Nasal/sinus passages
 - Lips and teeth
- All effect sound made



Phonetic features

- Speech sounds differ on features
- Vowel/consonant
 - Is there an obstruction of the vocal tract
- For consonants (vowels have different features)
 - Voicing
 - Place of articulation
 - Where is the vocal tract constricted?
 - Manner of articulation
 - How is the vocal tract constricted
 - Stop vs. fricative

Categorical Perception

- Producing speech is hard
- There must be a lot of variability
 - Yet, we perceive different instances of a speech sound as being about the same.
 - Why is that?
- Categorical perception
 - Production and perception systems evolve together
 - The auditory system detects small differences in pitch
 - We do not hear variations within a phoneme
 - Demo of categorical perception

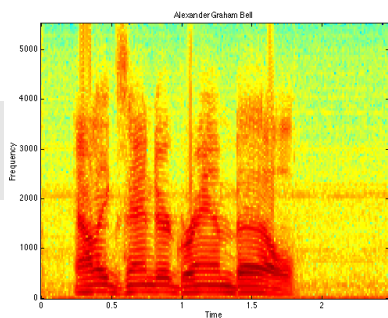
How do we perceive speech?

- Two prominent theories
 - Motor theory
 - Auditory theory
- Motor theory
 - We try to reconstruct the motor movements that would have been necessary to produce the speech heard.
- Auditory theory
 - Something about the sounds in the speech signal tells us what sound we are hearing

Might seem simple

- Where are the word and letter breaks?

- Formants
 - Bands of energy

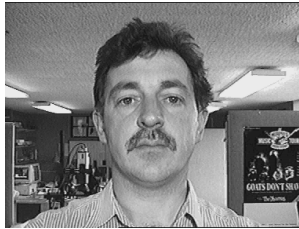


Problem for auditory theory

- It is difficult to find invariant parts of speech signal
 - Coarticulation effects
 - How you say a phoneme depends on context
- Infants also show categorical perception
 - High Amplitude Sucking Paradigm (Eimas)
 - Infants are actually sensitive to *more* distinctions than adults
 - Japanese infants show /r/ vs. /l/ distinction
 - Japanese adults do not

It gets worse

- We also integrate auditory and visual information
 - The McGurk Effect



Speech production and syntax

- The way we produce speech is also affected by what we want to say.
- Consider the contraction “gonna”
 - Short for “going to”
 - Can only be used when the words “going” and “to” are part of the same grammatical unit.
 - I am going to leave.
 - I am going to New York.
 - I am gonna leave.
 - *I am gonna New York.

Summary of speech perception

- Phonemes: Basic components of speech
 - Consist of a variety of features
- Categorical perception of speech
- Two competing theories
 - Auditory theory
 - Motor theory
- There are some other theories out there too
 - Fuzzy Logical Model of Perception (FLMP)
- Many unexplained phenomena