Language Part I
Speech Perception
Language and Cognition
## Levels of Language

<table>
<thead>
<tr>
<th>Phonology</th>
<th>Morphology &amp; Semantics</th>
<th>Prosody</th>
<th>Syntax</th>
<th>Pragmatics</th>
</tr>
</thead>
<tbody>
<tr>
<td>The sound system of a language (phonemes)</td>
<td>How a language expresses meaning (morphemes, words)</td>
<td>How melody used to create meaning</td>
<td>The structure of a language. Rules for combining words</td>
<td>How language is used</td>
</tr>
</tbody>
</table>
Phonology

• The study of the sound patterns of language

• Phoneme: The smallest unit of sound that can be altered to change the meaning of a word

• In English, the words *gin, kin, pin, tin, win* all have different meaning due to the fact that the initial sound, or phoneme, is different
Speech Perception

• The first step in comprehending spoken language is to identify the words being spoken, performed in multiple stages:

  1. Phonemes are detected (/b/, /e/, /t/, /e/, /r/, )
  2. Phonemes are combined into syllables (/be/ /ter/)  
  3. Syllables are combined into words ("better")
  4. Word meaning retrieved from memory
Spectrogram: I owe you a yo-yo
How many words were spoken (in Finnish)?

Sound clip 1

Sound clip 2

Sound clip 3
Speech perception: two problems

• Words are not neatly segmented (e.g., by pauses)

• Difficult to identify phonemes
  – Coarticulation = consecutive speech sounds blend into each other due to mechanical constraints on articulators

  – Speaker differences; pitch affected by age and sex; different dialects, talking speeds etc.
Similarly, /M/ in “Tim” vs. “/M/ in “mad” lead to different frequency characteristics.
How do listeners deal with variability in acoustic input?

- Use of semantic and lexical context: Phonemic restoration
- Use of visual cues: McGurk effect
- Continuous changes in input are mapped on to discrete percepts: Categorical perception
## Phonemic restoration

<table>
<thead>
<tr>
<th>Auditory presentation</th>
<th>Perception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legislature</td>
<td>legislature</td>
</tr>
<tr>
<td>Legi*lature</td>
<td>legislature</td>
</tr>
<tr>
<td>Legi_lature</td>
<td>legi lature</td>
</tr>
</tbody>
</table>

It was found that the *eel was on the axle. wheel
It was found that the *eel was on the shoe. heel
It was found that the *eel was on the orange. peel
It was found that the *eel was on the table. meal

Video (5 secs): McGurk Effect
Speech perception affected by visual information


YOUTUBE:
http://www.youtube.com/watch?v=aFPtc8BVdJk
http://www.youtube.com/watch?v=ypd5txtGdGw
McGurk Effect

• McGurk effect in video:
  – lip movements = “ga”
  – speech sound = “ba”
  – speech perception = “da” (for 98% of adults)

• Demonstrates parallel & interactive processing: speech perception is based on multiple sources of information, e.g. lip movements, auditory information.

• Brain makes reasonable assumption that both sources are informative and “fuses” the information.
Video (11 secs):
another example of the McGurk Effect

Categorical Perception

Differences among items that fall into different categories are exaggerated, and differences among items that fall into the same category are minimized.
Categorical Perception

Adult categorical perception: Voice Onset Time (VOT)

[da]

[ta]

60 ms

(slide courtesy of Lisa Pearl)
Categorical Perception

Identification: Discontinuity at Boundary

Decision between da/ta

Time to make decision

(slide courtesy of Lisa Pearl)
Categorical Perception

• Within-category discrimination is hard, across-category discrimination is easy
What Happened?

Physical World

Perceptual Representation
Categorical Perception depends on language

- In one language a difference in sound may make a difference – leads to perception of different phonemes; in another, it might not

- Example: several Asian languages do not distinguish between /l/ and /r/

- Different languages have different sets of phonemes
Examples of different phonemes non-existent in English

**Hindi**
- Dental Stop
- Retroflex Stop

**Salish**
- Uvular
- Velar

(Native North American—Canadian—language)
Infant Speech Perception

• Infants (not adults) can perceive most and perhaps all phonemes found in human language

• Ability is quickly lost because some sounds not needed
Diminished Sensitivity to Foreign Language Contrasts (babies growing up in English environment)

- Hindi /ta/ vs. /ta/
- Salish /ki/ vs. /qi/

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Hindi vs. Hindi</th>
<th>Salish vs. Salish</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8 months</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>8-10 months</td>
<td>80%</td>
<td>70%</td>
</tr>
<tr>
<td>10-12 months</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>11-12 months</td>
<td>0%</td>
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Language and Cognition
Benjamin Whorf: Linguistic Relativity Hypothesis

• The structure of one’s language influences the manner in which one perceives and understands the world. Therefore, speakers of different languages will perceive the world differently.

• Two versions of Whorfian hypothesis

  – Strong version: language *determines* our thinking; without a word to describe an experience, you cannot think about it

  – Weak version: Language *influences* our thinking
Question

• Does our vocabulary of color words influence our perception of color?
Experiment: participants place colored chips into specific categories
How English speakers tend to divide these up.
How members from the Berinmo tribe (New Guinea) divide the colors
Language Influencing Perception in Color?

• Berinmo divides the color space differently than English. Do Berinmo speakers perceive color differently?

• If categorical effects are restricted to linguistic boundaries, the 2 populations should show markedly different responses across the 2 category boundaries (green-blue and nol-wor)

• If categorical effects are determined by the universal properties of the visual system, then both populations should show the same response patterns.
Within category

Across category

(Davidoff 2001)
Recognition Memory Task

• Subjects were given a specific munsell color chip to remember. After a 30 second delay, they were given two target chips (the old one and a new one) and had to recognize the original chip.

Roberson & Davidoff (2000)
Results on Recognition Memory Task

- English speakers showed better performance for targets from across-category pairs than for those from within-category pairs for the *green-blue* boundary, but not for the *nol-wor* boundary. Berinmo speakers had the opposite pattern.

- This appears to support the Whorf hypothesis ...
But is this an effect on perception?

- But maybe this is a result of people naming the colors in order to make their decision. So the effect of language is not on perception of color but *on strategy for encoding color*.

- Subjects could just remember stimulus by repeating color names to themselves (“nol,nol,nol….”).
A control condition

- Eliminate effect of verbal encoding
  - Verbal interference condition: subjects had to read color words during retention interval

- Visual interference condition: subjects looked at a multicolored dot pattern

For more details, see: http://www.gold.ac.uk/media/davidoff-language-perceptual-categorisation.pdf

Roberson & Davidoff (2000)
Verbal interference only affects across-category identification. This suggests that subjects are using language to help them make decisions about colors that fall into different linguistic categories.

Roberson & Davidoff (2000)
Categorical Color Perception?

• Conclusion: While language has an effect on the way humans *remember* colors, it does not seem to alter their *perception* of the physical stimulus.
Language and Thought

• No compelling evidence for the strong version of the Whorfian hypothesis – we can perceive the world independently of the language we use to describe the world

• But… language can sometimes influence some aspects of cognition (e.g. memory)