Solve this maze at your leisure.

Start at phil’s house. At first, you can only make right turns through the maze. Each time you cross the red zigzag sign (under Carl’s auto repair), the direction in which you turn changes. So, after the first time you cross that sign, you can then only make left turns; after the second time, you switch back to right turns only, etc. How can Carl’s auto repair be reached?
Language Part I
Speech Perception
Semantics
Levels of Language

- **Phonology**: The sound system of a language (phonemes)
- **Morphology & Semantics**: How a language expresses meaning (morphemes, words)
- **Prosody**: How melody used to create meaning
- **Syntax**: The structure of a language. Rules for combining words
- **Pragmatics**: How language is used

**Definitions**
- **Phonology**: The study of the sounds of a language, including the elements that make up the sounds (phonemes) and the rules that govern their combination.
- **Morphology & Semantics**: The study of how a language expresses meaning, including the formation of words (morphemes) and how they contribute to the overall meaning of a sentence.
- **Prosody**: The study of how melody is used to create meaning in language, including stress, intonation, and rhythm.
- **Syntax**: The study of the structure of a language, including the rules for combining words to form sentences.
- **Pragmatics**: The study of how language is used in context, including the social and cultural implications of language use.
Prosody and Intonation

• Aspects of a sentence’s sound that is not specific to the properties of the words in a sentence

DECLARATIVE: “You are going home”

INTERROGATIVE: “You are going home?” (voice is raised at end of sentence)

IMPERATIVE: “You ARE going home!” (are is emphasized)

Emotional State

“you made a big deal about it”
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)?

- "Hyvää huomenta" (two words)
- "Kiitoksia oikein paljon" (three words)
- "Ilmatyynyalukseni on täynnä ankeriaita" (four words)

**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

- **Categorical perception**: high level cognitive processes (i.e., categorization) can influence perceptual processes.
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)

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

D 0ms 20ms D

D 20ms 40ms T

T 40ms 60ms T

(slide courtesy of Lisa Pearl)
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

Listen to the wonderful singing of this child that has difficulty distinguishing l/r sound:
http://www.youtube.com/watch?v=wgrrQwLdME8
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

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Hindi /ta/ vs. /ta/</th>
<th>Salish /ki/ vs. /qi/</th>
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<tbody>
<tr>
<td>6–8 months</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>8–10 months</td>
<td>100%</td>
<td>40%</td>
</tr>
<tr>
<td>10–12 months</td>
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<td>0%</td>
</tr>
<tr>
<td>11–12 months</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Semantics
Semantics

• The meaning or interpretation of a word, phrase, or sentence
• Two main theories about how we abstract meaning
Definitional Theory of Word Meaning

• The full meaning of each word is captured by a set of features that are essential for membership in the class named by the word
Example of using definitional theory

bachelor:

[single]
[human]
[adult]
[male]
Problem with Definitional Theory

• A thing either fits or doesn’t fit definition
• Doesn’t capture the fact that some members of category are better exemplars than others

Alfred is an unmarried adult male. He has been living with his girlfriend for the last twenty-three years. Their relationship is happy and stable. Is Alfred a bachelor?
Prototype Theory of Word Meaning
Prototype Theory of Word Meaning

• **Family resemblance structure**
  – Features that appear to be characteristic of category members but may not be possessed by every member

• **Prototype**: the member of a set or category that captures the greatest number of category features
A new exemplar is classified based on its *similarity* to the prototype.
Support for prototype theory

• People are quicker at classifying typical than atypical members