### Abstractions or Exemplars?
#### How context filters the acoustic signal and guides sound change

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### Models of Speech Perception

- **Competing models of speech perception attempt to address the lack of invariance in the speech signal (Lieberman et al. 1967, etc.).**
- **Abstractionist models** (Chomsky & Halle 1968, Peterson 1961, Sussman 1986, Miller 1989, Liberman & Nearey 1999) propose that listeners discard phonetic variation and transform the speech signal into an abstracted representation before decoding it.
- **Exemplar models** (Johnson 1997, Goldinger 1998) propose that potentially all phonetic detail is stored in memory (though eventually decaying), and actually aids in, rather than interferes with, decoding the signal, with no need for abstraction.
- **Hybrid models** (Pierrrehumbert 2002, Goldinger 2007) in some way incorporate both abstract representations and exemplars. Some models suggest individual exemplars can contain both abstract and veridical information: Goldinger (2007): "[E]ach stored exemplar is actually a product of perceptual input combined with prior knowledge."

### Contextual Effects on Speech Perception

Many studies show effects of top-down processing, such that high level knowledge of a language (lexicon, phonotactic rules, semantic context) can influence the perception of the acoustic signal:
- Context aids in speech perception: (Miller, Heise & Lichten 1951, Pollack & Pickett 1963)
- Fluent restoration (Marslen-Wilson & Welsh 1978): subjects asked to shadow speech; more likely to reproduce errors near beginnings of words, ignore errors near ends
- Error detection task (Cole, Jakimik, & Cooper 1978, Marslen-Wilson & Welsh 1978): Errors noticed in onsets more often than codas
- Phonemic restoration (Warren 1970, Samuel 1981): Segments replaced with noises often go unnoticed and are perceptually restored in sentence context.
- Perhaps top-down processing acts to filter the acoustic signal?

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### Experiment #1: Contextual Predictability and Speech Perception

#### Contextual Predictability:

- Listeners may be able to determine a word before hearing it, based on semantic priming of preceding context.

**Predictable & Unpredictable Words:**
- Predictable Words: “Kings and queens live in castles”  
- Unpredictable Words: “The woman turned and saw the castles.”

**Hypothesis:** Listeners will process and store details of *unpredictable* speech more than predictable speech.

**Methodology:**
- Discriminability task: Subjects hear either predictable or unpredictable words (1) in context, then (2) repeated in isolation.
- Repeat word may be the same, or with longer VOT of initial /k/ (doubled) and raised pitch (25 Hz)
- Subjects determine if the repetition sounded the SAME or DIFFERENT as when heard in context, e.g.:  

<table>
<thead>
<tr>
<th>Subject Group</th>
<th>Predictable</th>
<th>Unpredictable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects 1</td>
<td>2156</td>
<td>2168</td>
</tr>
<tr>
<td>Subjects 2</td>
<td>243</td>
<td>170</td>
</tr>
<tr>
<td>Overall</td>
<td>241</td>
<td>181</td>
</tr>
</tbody>
</table>

#### Results

- Subjects made more errors discriminating predictable words as opposed to unpredictable words, suggesting their stored exemplars of unpredictable words contained more veridical (less abstracted) phonetic details.

#### Discussion

- Experiments (1) and (2) show the effect of word predictability on perception and in turn its effect on production.
- Experiment (3) shows listeners attend more to the details of content words as a whole, likely due to their lower predictability.

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### Experiment #2: Predictability and the Perception-Production Link

**Phonetic Accommodation / Imitation:** phenomenon whereby characteristics of speech (such as phonetic details) are influenced through perceiving the speech of others, i.e., we subconsciously drift towards sounding more like those we are hearing (Goldinger 1998)
- Link between perception and production
  - Change in subphonemic details (like VOT) from before and after hearing stimulus (Shockley, Sabaddini, & Fowler 2004, Tilsen 2009, Nielsen 2011)

**Hypothesis:** Subjects will imitate the details of unpredictable speech more closely since they store more phonetic details of unpredictable words.

**Methodology:**
- Task: subjects hear sentences with target words and are asked to repeat.
  - Condition #1: No instruction to imitate
  - Condition #2: Told to imitate (will this override the contextual effect?)
- Sentence list used in experiment #1
- /k/ initial words with VOT doubled, initial syllable pitch raised 25 Hz
- 20 subjects in both conditions: each heard 60 target stimuli + 40 fillers

**Results**

- Subjects had closer VOT to the model for unpredictable words when given no instruction to imitate (p = 0.001).
- When told to imitate, subjects were closer to the model, but there was no significant difference based on predictability (p = 0.25)

**Discussion**

- Experiments (1) and (2) show the effect of word predictability on perception and in turn its effect on production.
- Experiment (3) shows listeners attend more to the details of content words as a whole, likely due to their lower predictability.

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### References