Sounds of silence

- speech production and perception
“Speech is special”

• "the brain can hear speech content in sounds that have only the remotest resemblance to speech...159" For a demo of this, go to my homepage under language and visit Haskins Lab.
All speech is an illusion

• "We simply hallucinate word boundaries when we reach the edge of a stretch of sound that matches some entry in our mental lexicon. 159-160"
Speech perception “biological miracle”

• "to take advantage of the auditory medium, speech has to overcome the problem that the ear is a narrow informational bottleneck...ten to fifteen phonemes per second....., each moment of sound must have several phonemes packed into it.. 161"
Phonemes are a different kind of linguistic object

• "the meaning of dog is not predictable from the meaning of d....a finite inventory of phonemes is sampled and permuted to define words...."
Speech anatomy, articulation, and acoustics

- Voicing
- Harmonics
- Resonance
- Types of sounds
- The IPA system
Voicing 164, 171
• Natural objects-- when energized -- vibrate at a fundamental frequency (ff) and the harmonics of the ff. Harmonics are whole number multiples of the ff. A male ff of 100 Hz can have harmonics at 200, 300, and so on up to over 4000Hz.
Harmonics 2

- Not all of these harmonics will have significant energy and indeed the variation in energy at each harmonic is how different speech sounds are produced. "...it is the raw material that the rest of the vocal tract sculps into vowels and consonants."
Resonance 165-6

• (Formants are bands of resonating energy. They show up as dark bands on spectrograms.)
• "the brain interprets the different patterns of amplification and filtering as different vowels. 166"
• "the nose is another resonant chamber 169" [Do his examples! Observe your velum's function.]
Types of sounds

• "The total inventory of phonemes across the world numbers in the thousands, but they are all defined as combinations of the six speech organs and their shapes and motions..171

• Lips, tongue, teeth, velum, larynx, jaw?
vowels
Stop consonants

• "The sounds of silence"--consonants differ in 'obstruency' --the degree to which they impede the flow of air
..169
Voice onset time -- a controlled vocal movement

- VOT is a timing feature of consonants that distinguished “voiced” from “unvoiced” consonants. Language differ in this feature.
- Thus /b/, /d/, /g/ differ from /p/, /t/, /k/ primarily in the length of time after the release burst of the stop until the voicing begins.
- /b/ is said to be voiced as VOT is quick -- a few milliseconds.
- /p/ is said to unvoiced as VOT is delayed -- maybe 100 or more milliseconds.
Example of /p/ compared with /b/

“See Pat bat.”

(Note how the spectrogram reveals the cues to the phonemic segment)
See “bat” time-pressure wave and spectrogram

“See Pat bat.”  “…bat.”  (VOT >5 ms.)
See “Pat” time-pressure wave and spectrogram

(0.028396 0.030 0.057901)

(The blue line estimates the fundamental frequency; here about 170 Hertz (Hz.). The red lines estimate the formants.)

..Pat…” (VOT = 300ms)
nasals
The IPA

- The international phonetic alphabet was designed to enable linguists to write down the relevant movements for any language. See their website.
IPA chart

<table>
<thead>
<tr>
<th>The International Phonetic Alphabet (revised to 1993)</th>
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<tbody>
<tr>
<td><strong>Consonants (Preliminary)</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Consonant</td>
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<td>-------------</td>
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<td>Plosive</td>
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<td>Nasal</td>
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<td>Trill</td>
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<td>Tap or Flap</td>
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<td>Fricative</td>
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<td>Lateral</td>
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<tr>
<td>Approximant</td>
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</tbody>
</table>

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.
The sound pattern of a language

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- Possible syllables
- Possible words
- Phonological rules
Phonological rules

• "The assemblies of phonemes in the morphemes and words stored in memory undergo a series of adjustments before they are actually articulated as sounds,...these adjustments give further definition to the sound pattern of a language. 175
More on phonological rules

• "...phonological rules "see" features, not phonemes, and they adjust features, not phonemes...179"
• "By making speech patterns predictable, they add redundancy to a language..181"
• Redundancy- same info in various ways
Co-articulation

• "phonemes also sound very different depending on how much they are stressed and how quickly they are spoken...each phoneme;s sound signature is colored by the phonemes that come before and after...consonant and vowels are being signaled simultaneously..181-2"

• Compare constrain and construe
Bottom-up and top-down perception?

• "top down theory of speech perception....confirms the relativist philosophy that we hear what we expect...ultimately that we are not in direct contact with any objective reality...185"

• "though we may call upon high-level conceptual knowledge in noisy or degraded circumstances...our brains seem designed to squeeze every last drop of phonetic information out of the sound itself....it is a sense, something that
Is writing reform desirable?

• "Obviously alphabets do not, and should not correspond to sounds; at best they correspond to phonemes in the mental lexicon...the actual sounds are different in different contexts, so true phonetic spelling would only obscure their underlying identity...190"
"electric-electricity"-"..the similar spellings, despite differences in pronunciation, are there for a reason: they identifying two wards as being based on the same root morpheme...sometimes a sequence of letters is specific to a morpheme...a morphemic writing system is more useful than you might think....191"