History of phonetics

“The history of phonetics—going back some 2.5 millennia—makes it perhaps the oldest of the behavioral sciences and, given the longevity and applicability of some of the early findings from these times, one of the most successful”

-- Prof. John Ohala, UC Berkeley, 1991
Early roots

- India
- Korea
Panini

- India ~ 7th - 4th centuries B.C.E.
- His work on Sanskrit was surprisingly modern and systematic
- Phonology/phonetics was explicitly dealt with
- Discovery of Panini's grammar helped develop today’s linguistic science
King Sejong of Korea

• Wanted his people to be literate, but knew that the existing (Chinese-based) system was too difficult

• Created (by himself!) an entirely new, scientific alphabet based on phonetics (see next slide →)

• Named this alphabet Hun Min Jong Um, “Accurate Sounds to Educate the People”

• His alphabet was largely neglected, almost until the 20th century

• Now in general use in both South and North Korea

1397-1450

Han’gul

Han-gul is written in syllabic units made up of two, three, or four letters.

<table>
<thead>
<tr>
<th>consonants</th>
<th>vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td>k/g</td>
<td>a</td>
</tr>
<tr>
<td>n</td>
<td>ã</td>
</tr>
<tr>
<td>t/d</td>
<td>ya</td>
</tr>
<tr>
<td>r/l</td>
<td>ò (3)</td>
</tr>
<tr>
<td>m</td>
<td>ë</td>
</tr>
<tr>
<td>p/b</td>
<td>o</td>
</tr>
<tr>
<td>s/sh</td>
<td>yó</td>
</tr>
<tr>
<td>ng (1)</td>
<td>u</td>
</tr>
<tr>
<td>ch/j</td>
<td>yo</td>
</tr>
<tr>
<td>ch’ (2)</td>
<td>yu</td>
</tr>
<tr>
<td>k’ (2)</td>
<td>ü (3)</td>
</tr>
<tr>
<td>t’ (2)</td>
<td>i</td>
</tr>
<tr>
<td>p’ (2)</td>
<td></td>
</tr>
<tr>
<td>h</td>
<td></td>
</tr>
</tbody>
</table>

[han-kuk-ô] (Korean language)

Sir William Jones

- British scholar, linguist, and lawyer
- Fluent in 7 languages by age 20
- Came to India as Supreme Court Judge
- In 1786, announced:
  …Sanskrit and the European languages “have sprung from some common source which, perhaps, no longer exists”
- Set a trend for studying Sanskrit as basis for the “Indo-European language family”
- Roots of historical linguistics

1746-1794
Henry Sweet

- English philologist and phonetician
- Authority on Anglo-Saxon and the history of the English language (Oxford, England)
- Pioneer in modern scientific phonetics
- His *History of English Sounds* (1874) was a landmark study.
- Thought to be the model for “Professor Higgins” in G. B. Shaw’s play *Pygmalion*

(although it was actually Daniel Jones…)

1845–1912
“Henry Higgins”

- Phonetician character in the play “Pygmalion” by George Bernard Shaw

↔ “Eliza Doolittle”
Daniel Jones

- Professor at University College London
- Used the term “phoneme” in the modern sense
- Promoted the term “cardinal vowel”
- A father of the IPA
- Suggested a two-parameter diagram to visualize how vowels are produced
- Popularized experimental phonetics
- Developed new alphabets for African and Indian languages

1881 - 1967
Lionel Logue (1880-1953)

- Australian “elocutionist” who worked with speech defects
- Consultant to King George VI
- Featured in 2010 movie


Abbot Rousellot

- 1843 – 1924
- An early innovator in experimental phonetics
- Professor with the College of France

Image accessed 5/20/16.
http://charente.confolens.free.fr/confolens/saint_claud/saint_claud/saintclaud0650e.html
Rousselot cylinders

- Speech sounds and articulatory information were recorded for analysis

- “It will be possible hereafter to note the pronunciation of any language, dialect, or idiom whatever, without relying upon the testimony of the ear, which distinguishes but slight differences between the modes of speaking of several individuals”
International Phonetic Alphabet (IPA)

• (1888) First published by the Association Phonétique Internationale, a group of French language teachers

• Modeled on an 1847 phonetic script for English

• Goal: To devise a system for transcribing speech sounds independent of any particular language and applicable to all languages
IPA - Uses

- Dictionaries, textbooks, phrase books
- Creating new writing systems for previously unwritten languages
- Non-native speakers learning English
- Clinicians in speech language pathology and related disciplines
Modern Phonetics

• **Phonetics** – Scientific study of speech sounds
• **Phonology** – Study of sound systems, patterns, and rules
• Phonetics and phonology are highly related… Both are within the field of …
• **Linguistics** – Scientific study of Language
Important terms: Communication, human language, speech

Phonetics is HERE!
Q: How do linguists study language?

• By describing a **grammar**
  
  *(mental representation of language knowledge)*

**GOAL:**

Language-particular → Universal

Q: What are the components of grammar?

*(next slide)*
Levels of the grammar

We are HERE!
Types of phonetics

1. **Articulatory** – *How speech sounds are produced in the human vocal tract*
2. **Acoustic**
3. **Linguistic/Perceptual**
Source-filter theory

Vocal source vocal tract filter speech
Source-filter system – cont’d

Illustration by Wiley, Composition Services Graphics

Features

- Feature – A component of a sound with a discrete phonetic property – “smallest systematic part” of a speech sound
- Binary (+ or -)
- Graded

Articulatory features

THE BIG THREE!

- Voicing
- Place
- Manner
Voicing - anatomy

Illustration by Wiley, Composition Services Graphics
Voicing

• Property of vibrating vocal folds
• Occurs at the glottis (literally, a hole or aperture)
Laryngoscopy - video


http://auditoryneuroscience.com/vocal_folds
The speech articulators

Places of articulation, parts of tongue

Place – where sounds are produced


*** Note- Not GAE

***Note- Not English (but e.g., in French and Arabic)
Manner – **How** sounds are produced

- **Stop**: Nasal vs. oral
- **Also** – fricative, affricate, approximant, tap/flap
## Consonants of GAE

<table>
<thead>
<tr>
<th>Manner</th>
<th>Voicing</th>
<th>Voiced (+)</th>
<th>Voiceless (−)</th>
<th>Bilabial</th>
<th>Labio-Dental</th>
<th>Dental</th>
<th>Alveolar</th>
<th>Palato-Alveolar</th>
<th>Palatal</th>
<th>Velar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop (nasal)</td>
<td>+</td>
<td>m</td>
<td></td>
<td></td>
<td></td>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop (oral)</td>
<td>−</td>
<td>p</td>
<td></td>
<td></td>
<td></td>
<td>t</td>
<td></td>
<td></td>
<td></td>
<td>k</td>
<td></td>
</tr>
<tr>
<td>Stop (oral)</td>
<td>+</td>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td>d</td>
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<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>−</td>
<td>f</td>
<td>θ</td>
<td>s</td>
<td>j</td>
<td>h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>+</td>
<td>v</td>
<td>ð</td>
<td>z</td>
<td>ʒ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affricate</td>
<td>−</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Affricate</td>
<td>+</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td>−</td>
<td>m</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Approximant</td>
<td>+</td>
<td>w</td>
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<td></td>
<td>j</td>
<td>w</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(lateral)</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>l</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>l</td>
</tr>
</tbody>
</table>

Also /ʔ/ and /ɾ/
How to draw ‘em!

Figure 3-5: How to draw some of the common made-up IPA symbols.

The voiceless “w” (/ʍ/)

https://www.youtube.com/watch?v=xzBQlWBDJMM

Other features: Central vs. lateral

Markedness

• We do not mark the more usual case
• Thus, the less frequent a feature, the more “marked”

Example:
I’m going to the store to get cow milk
I’m going to the store to get soy milk
Let’s relate the features to the anatomy

<table>
<thead>
<tr>
<th>Manner</th>
<th>Voicing</th>
<th>Place of articulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voiced (+)</td>
<td>Voiceless (-)</td>
</tr>
<tr>
<td>Stop (nasal)</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Stop (oral)</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Stop (oral)</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Affricate</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Affricate</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>(lateral)</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of the human vocal tract](image)
Great! Now on to vowels
The setting

Figure 3-2: Vowel quadrilateral superimposed on a person's vocal tract.

GAE vowel quadrilateral

Diphthongs: /ai/ /au/ /ɔi/
This should help?

/a/

/ɛ/

Homework/ Reading

• First e-learning homework set!
Lecture 2

• More issues on broad transcription of GAE consonants and vowels
• Finishing up concepts from text, chapters 1-3
Mono – vs. Diphthongs

- **Monophthongs** – constant vowel quality
- **Diphthongs** – sweep across the vowel space

Q: Could there be a ...(shudder)..<br>Triphthong?

A: Yes!

- **Bernese German** (a [Swiss German](#) dialect):
  - [iə̯w] as in *Gieu* 'boy'
  - [yə̯w] as in *Gfüeu* 'feeling'
  - [uə̯w] as in *Schueu* 'school'
  - [yə̯j] as in *Müej* 'trouble'

- **Spanish**:
  - [wej] as in *buey* 'ox'
  - [waj] as in *Uruguay*
Tense vs. Lax vowels in English

• English lax vowels: /ɪ/, /ɛ/, /æ/, /ʊ/, /ʌ/
• Originally thought to be physiologically distinct
• Now considered a phonological property
• (Lax vowels cannot occur in stressed, open syllables)
• Thus: “You are really veh!” (is not English)
Tense/lax - examples

- “beat” versus “bit”
- “bait” versus “bet”
- “Luke” versus “look”

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Stressed Open Syllable</th>
<th>Closed Syllable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tense</td>
<td>/i/</td>
<td>bee /bi/</td>
</tr>
<tr>
<td>Lax</td>
<td>/i/</td>
<td>bih /bi/ (not a real word)</td>
</tr>
</tbody>
</table>
Tense

• Some tense vowels show offglide qualities:

  /e/ = /eɪ/ ✓
  /u/ = /uw/
  /i/ = /ij/
  /o/ = /ou/ ✓

• I prefer the simpler set on the left

• Our lab CD includes examples from checked set on the right
GAE vowel “r-coloring” (blending)

<table>
<thead>
<tr>
<th>IPA</th>
<th>Example</th>
<th>American English</th>
</tr>
</thead>
<tbody>
<tr>
<td>/i/</td>
<td>seer</td>
<td>/siː/ or /siɛː/</td>
</tr>
<tr>
<td>/u/</td>
<td>fear</td>
<td>/fuː/</td>
</tr>
<tr>
<td>/e/</td>
<td>payer</td>
<td>/pe.ə/ or /peɛə/</td>
</tr>
<tr>
<td>/ɛ/</td>
<td>fair</td>
<td>/fɛ.ə/</td>
</tr>
<tr>
<td>/ɔ/</td>
<td>fur</td>
<td>/fɔː/</td>
</tr>
<tr>
<td>/u/</td>
<td>poor</td>
<td>/pʊ.ə/</td>
</tr>
<tr>
<td>/ɔ/</td>
<td>sore</td>
<td>/sɔ.ə/</td>
</tr>
<tr>
<td>/ɑ/</td>
<td>far</td>
<td>/fɑ.ə/</td>
</tr>
<tr>
<td>/ai/</td>
<td>fire</td>
<td>/faɪ.ə/</td>
</tr>
<tr>
<td>/au/</td>
<td>flower</td>
<td>/flau.ə/</td>
</tr>
<tr>
<td>/ɔɪ/</td>
<td>foyer</td>
<td>/fɔɪ.ə/</td>
</tr>
</tbody>
</table>
Vowel neutralization

\(/o/-/ɔ/ \text{ and } /i/-/ɪ/\)

→ before /ɹ/,/l/ and nasals

Some examples:

“sore” /sɔɹ/ 

“selling” /ˈsɛlɪŋ/
English diphthongs

American English

British English

(contains one more diphthong)

Segmental vs. supra-segmental

**Segmental**: consonants, vowels

**Supra-segmental**:
- features larger than the individual segment
- includes stress, intonation ("prosody")
Homework set #2

• e-learning, second set

• Keep practicing with CDs and lab materials
Lecture 3

- What is a phoneme?
- What are allophones?
- Why should we care?
Phoneme

• “Smallest systematic unit of sound that changes meaning in a language”
• Abstract
• Psychological
• Can be illustrated in a minimal pair:
  /bæt/ - /bit/
  /bit/ - /biz/
Allophone

• Systematic variant of a phoneme

• Show complementary distribution (context-dependent variation)

(...like these guys...)

Allophone example

- In GAE, the phoneme /t/ can be...

  - [t] [bɪt]
  - [tʰ] [tʰɪp]
  - [ɹ] [ɪrɪt]
  - [ʔ] [bʌʔn]
Complementary distribution

[t] [bɪt] syllable final
[tʰ] [tʰɪp] syllable initial
[r] [lɪr̥] btwn stressed & unstressed syllable

* NOTE: As opposed to “free distribution”
## Phoneme/allophone

<table>
<thead>
<tr>
<th>Language 1</th>
<th>Language 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dəˈsit/</td>
<td>V. “to catch”</td>
</tr>
<tr>
<td>/ˈʃeləti/</td>
<td>Adj. “clever”</td>
</tr>
<tr>
<td>/ˈʃəloʊk/</td>
<td>N. “debate”</td>
</tr>
<tr>
<td>/dəˈʃi/</td>
<td>V. “uncover”</td>
</tr>
</tbody>
</table>

- In one language there are **two separate phonemes**, /s/ and /ʃ/.
- In the other, /s/ and /ʃ/ seem to be **allophones** of one underlying phoneme.

**Q:** WHICH IS WHICH, AND WHY?
Real language example – Find the phonemes vs. the allophones

Example 2: Papago (Focus: [t, ð], d, dʒ)

1. [ˈbidʒim] ‘turn around’ 12. [ˈhiwgid] ‘smell’
2. [ˈtaspan] ‘split’ 13. [tʃihaŋ] ‘hire’
4. [tʃikid] ‘vaccinate’ 15. [ˈwidiʃut] ‘swing’
6. [tʃuku] ‘become black’ 17. [kiːtʃud] ‘build a house for’

Look at vowel context....

**Left Contexts Only: No Pattern**

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>t̃</th>
<th>d</th>
<th>d̃3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,8,14,16,20</td>
<td>4,6,13,21,22</td>
<td>3,4,5,12</td>
<td>1</td>
<td>i</td>
</tr>
<tr>
<td>15</td>
<td>u___</td>
<td>i:__</td>
<td>15</td>
<td>u___</td>
</tr>
<tr>
<td>5</td>
<td>a___</td>
<td></td>
<td>7,11,18</td>
<td>u___</td>
</tr>
<tr>
<td>16,19</td>
<td>a:__</td>
<td>18</td>
<td>o:__</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>m___</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Right Contexts Only**

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>t̃</th>
<th>d</th>
<th>d̃3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,16,19</td>
<td>13</td>
<td>__i</td>
<td>3,18</td>
<td>__o</td>
</tr>
<tr>
<td>8,14</td>
<td>__o</td>
<td>4</td>
<td>__i</td>
<td>9</td>
</tr>
<tr>
<td>10,15</td>
<td>___</td>
<td>6,17</td>
<td>___u</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>___w</td>
<td>u</td>
<td>___i:</td>
<td>11</td>
</tr>
<tr>
<td>16,19</td>
<td>___a</td>
<td>v</td>
<td>___i:</td>
<td></td>
</tr>
</tbody>
</table>

---

1 Data and analysis assembled by Bruce Hayes, based on Saxton, Dean, Lucille Saxton, and Susie En (1983) *Dictionary: Papago/Pima-English, English-Papago/Pima*, University of Arizona Press, Tucson.
Answer

• “The palato-alveolar affricates occur before high vowels, and the alveolar stops occur elsewhere”

(or, as formalized....)

\[
\text{Alveolar Palatalization} \\
\begin{array}{c}
\text{[stop alveolar]} \\
\text{[affricate palato-alveolar]} / \text{[vowel high]}
\end{array}
\]
<table>
<thead>
<tr>
<th>Language</th>
<th>IPA Symbols</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>/p/ --&gt; [pʰ] or [p]</td>
<td>[pʰɛt] “pet”</td>
</tr>
<tr>
<td>Thai</td>
<td>/p/, /pʰ/</td>
<td>[pʰa:] “forest”</td>
</tr>
<tr>
<td>Spanish</td>
<td>/p/</td>
<td>[ˈpɛɾo] “but”</td>
</tr>
</tbody>
</table>
How are phonemes acquired?

- Infants are born capable of learning any sounds of any language
- They learn the phonemes of their language by ~ 9 - 12 months
  - (by learning to ignore distinctions that are not phonemic)
Q: What about adults?

Are we each a prisoner of our phonemic inventory (?)

- Second language issues
- “Phonemic misperception” for disordered speech