Phonetics and Phonology
24.900: Introduction to Language
class notes: week of March 4, 2002

- Problem set 4: Due Monday, 3/11/02
- Handout of the head for identification of the parts of the vocal track

In review[1]:

- Your mental/neurological/linguistic representations of speech sounds involve discrete sound categories

- You hear speech sounds largely in terms of the way that you might produce them

- Your representations of speech sounds exhaustively decompose into ("distinctive") phonological pieces

A. Linguists can provide a *Unified account of the three properties of speech sounds noted above:*

• Phonological representations – the form in which you store your knowledge of the sound structure of the units – consist of structures of "distinctive (phonological) features."

• Phonological rules (principles, constraints) of the grammar operate in terms of these features.

B. Speech sounds are perceived in terms of these features, so speech perception is in terms of discrete sound categories cf. categorical perception

• These features largely categorize speech sounds in terms of the way in which they are produced

• Constituents of sound representations such as "phonemes" are constructed from these features.

[1] The distinction between "phonetics" and "phonology" is not made in a consistent manner within linguistics and involves some real scientific disputes about the role of physics (for movement of speech articulators) and low-level auditory perception within the mental grammar.

I will try to use "phonetics" consistently when talking about the acoustics of speech ("acoustic phonetics") or about the movements of speech articulators ("articulatory phonetics"). I will use "phonology" consistently when talking about grammatical operations on sound representations ("phonological rules") or about the form in which you store sound information about morphemes ("phonological representations").

NB: Phonemes are not primitives in the system. They are constructs.

Start with the last point…

• lip-s	• rib-z
• cat-s	• pad-z
• back-s	• bag-z
• cliff-s	• cave-z
• bath-s	• lathe-z
• Bach-s	• chanteur-z

Generalization?
• Plural /s/ goes after [-voice] sounds; plural /z/ goes after [+voice] sounds. In fact, of course, /s/ is [-voice] and /z/ is [+voice], so this is an example of "assimilation," where sounds come to share a feature.

• Additionally:

1. day-z, ball-z, fur-z, cow-z…

Two arguments for features as constitutive of sounds rather than mere properties of sounds:
• **First**: Formal statement of what you know about the plural. If /s/ and /z/ didn't decompose into features, with the two sounds sharing all the same features with the exception of [+/-voice], then it would be difficult to explain why you simply alternate between /s/ and /z/, with /s/ in the[-voice] environment and /z/ in the [+voice] environment.

What notion of **"similarity"** between sounds would account for this alternation?
– Best answer: **identity**

• That is, /s/ and /z/ are identical except for [voice]; they literally decompose into all the same features except for the value of [voice]

• You get /s/ from /z/ by changing [+voice]into [-voice]

Second argument for decomposition:
• Natural classes and the operation of phonological processes
– Feature define classes – all segments sharing a feature make up a "natural class"
– Phonological stuff happens to natural classes
• e.g., /z/ after [+voice] class, /s/ after [-voice] class

• If features were mere properties of phonemes rather than constituents of phonemes
– then it would be as natural to say, /z/ after /d/ as it would be to say, /z/ after [+voice]

• Since features are constituents of phonemes and
phonemes merely constructs

1. it's much more difficult to represent the generalization /z/ after /d/ than to represent /z/ after [+voice]

Note the difference in complexity:

• /z/ after [+voice]
[+anterior]
[-continuant]
[+coronal]

…

• /z/ after [+voice]

Moreover…

• Children generalize on the basis of features automatically – they don't first learn on a "phoneme by phoneme" basis

• We generalize on the basis of features to speech sounds that are not part of our language and that we may not have heard before (cf. Bach-s, chanteur-z)

Discreteness of phonetic categories

• Categorical perception
– you hear sounds as belonging to discrete categories
– you have difficulty discriminating sounds within a discrete category

• Discreteness of phonological processing

2. neither probability of category membership nor "blends" between categories ever play a role in the grammar

1. Phonetics

Main points for today:
• Articulators
• Place of articulation
• Manner of articulation
• Acoustic correlates of articulation

a. **Articulators**
• Vocal cords (glottis)
• Velum (open/close nasal cavity)
• Tongue root (dorsum)
• Tongue tip (corona/coronal sounds)
• Lips

i. **Vocal cords/glottis**
• [+/-voice] (+/-spread glottis and +/-constricted glottis) [+voice] = -spread, -constr
• aspiration: t vs. t^h
+spread glottis

• glottal stops
+constricted glottis

• Regular vowels = -spread glottis

• Whispered vowels = +spread glottis
    • [h] = whispered vowel

ii. **Velum**
• Raise the velum = [-nasal]

• Lower the velum = [+nasal]
    • Note: vowels as well as stop consonants can be nasal.
    • In English, vowels before nasal consonants are nasalized.
    • In French, nasal and non-nasal vowels contrast

iii. **Dorsum**
• Can make contact with uvula (no such sounds in English) or velum
velar sounds g, k, ŋ

• [+/-high] [+/-low] for vowels refer to the position of the velum
• g, k,ŋ are [+high] [-low]

iv. **Coronal/tongue blade**

⁎coronal sounds may be [+/- anterior], lateral, sibilant (s,z,s,z)

v. **Lips/labial sounds**

• Labial sounds may be [+/-round]

• Labial stops/fricatives in English are generally [-round]: b, p, m, f, v

• But say, "moo" and watch/feel your lips

• [+back] [-low] vowels in English are [+round]

• In French, [+/-round] is contrastive for [-low] [-back] vowels

2. Place of articulation (near/against what do you place your articulators?)

• Velar (dorsal sounds) – contrast: velar vs. uvular

• Palatal (-anterior coronal sounds)

• Alveolar (+anterior coronal sounds) – contrast: palatal vs. alveolar

• Interdental (+anterior coronal sounds) ∂, O

• Labio-dental (labial, -round sounds) f, v

• Labial b, p, m

3. Manner of articulation

a. • **Consonantal** (vs. vocalic) stops (nasal and non-), fricatives, glides

• +Sonorant resonance in vocal track possible = vowels, glides, nasal stops, vowels, liquids

• -sonorant (obstruents) non-nasal stops and fricatives

b. • **+/-continuant**

+continuant vowels, glides, laterals, fricatives -continuant stops

c • **"affricates**"

stop followed by fricative acting as one segment: **ts (c), dz (j)**

3. .**Acoustic correlates of articulation**

• Glottal pulses (or, if spread glottis, noise) from vocal cords drive the acoustics of the vocal track.

• The *fundamental frequency* of the glottal pulses corresponds to the pitch of the voice.

• The vocal tract acts as a filter over the harmonics of the *fundamental frequency*

• The *tongue* separates the vocal track into two main, connected resonating chambers.

  • Tongue height mainly changes the volume of the back chamber – low vowels have a smaller back chamber and thus a higher resonant frequency for this chamber, which corresponds to the first "formant" or enhanced frequency band of the speech spectrum.

  • The front or back position of the tongue [+/-back], changes mostly the size of the upper resonating chamber of the vocal track. Back position increases the size of this chamber and lowers the frequency of the second formant or frequency band in the speech spectrum.

• The perceptual system is particularly tuned to the frequency of the formants, i.e., the pattern of enhanced harmonics of the pitch of the voice.

  • Perception of the formants is perception of the changing shape of the vocal apparatus as it articulates speech.

  • That is, the perceptual system is hearing the movements of the articulators and classifying speech sounds according to these movements.

6. Cross-linguistic phonetic differences:
These differences include those features (articulators, manners and places of articulation) the language chooses and the way in which that language combines these features into the sounds of the language.

Some examples:

1. French but not English uses nasality on vowels contrastively.
2. French but not English uses rounding on [-low] [-back] vowels contrastively,
3. In Chinese and other *tone* languages, differences in the pitch of vowels (in the fundamental frequency of the vowels) is **contrastive.**
4. Linguistic *tone* does not involve absolute pitch-- or else children could not speak the same words as adults.
5. Rather, tone is determined relative to the average pitch of each speaker.
6. And, pitch changes are linguistically relevant in Chinese but not in English (or at least not in the same way in English).

7.**Phonotactics (for sound-touching): possible combinations of sounds in a language**

More precisely, **phonotactics** refers to the generalizations about the distribution of phonetic features in a language.

These generalizations include which features a language uses from the universally available set and which features co-occur to create *phonemes* and which features co-occur across timing slots (across phonemes).

a. For example, *dipthongs* (vowel glide combinations) [aw] occur in limited environments.
b. [aw] is allowed before coronal sounds and word boundary: *out, loud, town, house, rouse, fowl, hour.*

c. [aw] does not occur before labials, palatals, and velars followed by a word boundary: **oub, *oum, *oup, *ouk, *oug, *oung, *oush* (cf. Bausch, foreign name).

d. Consider, aspiration of voiceless stops in English:

Top	stop
Pat	spat
Cat	scat
Photograph	
Photography	

What is the phonotactic generalization?

➜C^h at the beginning of stressed syllables

Elsewhere, unaspirated

$$\begin{bmatrix} -\text{cont} \\ -\text{voice} \end{bmatrix} \text{ is } [+\text{spread glottis}] \; / \; [_{\Sigma}\underline{\quad\quad} \; [+\text{stress}]$$

Complementary Distribution

- Aspirated and unaspirated voiceless stops in English never occur in the same environment.
- Thus, aspiration is not *contrastive* on voiceless stops in English
- Aspirated and unaspirated voiceless stops in English are in **complementary distribution:** aspirated stops at the beginning of stressed syllables; unaspirated voiceless stops elsewhere.