Chap 14
Perceptual and linguistic phonetics

1. Staging speech perception
2. Lack of invariance
3. Cues and cue trading
4. Categorical perception
5. Ease of articulation vs. perceptual distinctiveness

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The speech chain

Bottom up/ top down

Top-down Modulation
(internally-driven attention)

Perception

Bottom-up processing
(externally-driven attention)
Lack of invariance

• Each person produces different physical signals
• Much variance!
• A computer has a hard time decoding this
• Human listeners do not
• How do we explain this?

Lack of invariance - example

/u/ vs. /tʰu/

... /u/ F2 starts much higher here!

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Coarticulation

• **Anticipatory**
  (= “right to left”)
  
  /s u/  
  
  *lip-rounding affects /s*/

• **Perseverative**
  (= “left to right”)
  
  /s u/  
  
  */s/ frication carries over onto /s*/
Anticipatory coarticulation

• Index of speech planning
• Language dependent
• For instance, lip rounding in English extends roughly 250 msec (~ 1 syllable)
• In French, can extend up to ~ 6 syllables

“sinistr(e)structure”

LIP ROUNDDING ALREADY HERE!
Perseverative coarticulation

- Measure of biomechanical, inertial properties of speech
- An example is *tongue twisters*
- Contain sounds with many close features
- Left to right coarticulation causes speech errors
More coarticulation facts

• All people coarticulate in all speech!
• Lack of coarticulation (e.g., in poor speech synthesis) sounds “robot-like”
• Coarticulation mastered early by children
• Seems to break down in some disorders, including apraxia of speech (AOS)
More than one way to signal a phonetic feature....

Example:

• VOT and bursts can cue a stop consonant
• Redundancy!
• Cues can also trade off (see next slide)
• Allows for precise control of sounds
• Valuable tool for investigating perception

For samples in English, German, French and other languages: http://www.ims.uni-stuttgart.de/institut/mitarbeiter/moehler/synthspeech/
Cue trading in action


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Two types of perception

**Graded (usual)**

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Intensity of light
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**Categorical (Speech)**

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Light intensity
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Voice Onset Time (VOT)


60 msec
/da/ vs. /ta/ identification

/da/ vs. /ta/ discrimination

English VOT production

- Not uniform
- 2 categories

Figure 5-3. VOT productions of a single normal adult speaker of American English for words beginning with /d/ and /t/. (Figure adapted with permission from Blumstein, Cooper, Goodglass, Statlender, & Gottlieb, [1980]. Production Deficits in Aphasia: A Voice Onset-Time Analysis. Brain and Language, 9, 153-170. Copyright 1980 by Academic Press.)
VOT production breaks down in aphasic speech \((n=3/\text{group})\)
Ease of articulation vs. Perceptual distinctiveness

• Two properties which constrain language
• Tend to balance each other in an opposing fashion....
Ease of articulation

- **EXAMPLES**
- “soft_en” /t/ -> 0 (ellipsis)
- “in” + “possible” = “im_possible” (assimilation)
Q: What is “easier” to produce in speech?

EXAMPLES:

• Vowels easier than consonants
• CV syllables easier than heavy syllables (e.g., CVC) – see infant babbling
• Short vowels easier than long – evidence from language change (diachronic):

Longer vowels difficult to produce because of extra time and energy to expel air out of the lungs
Perceptual distinctiveness

• Vowel systems of world languages appear organized for maximal “listen-ability”

• Languages with small vowel inventories tend to “hug the periphery” and be spread out

• Languages with larger inventories tend to have additional features (e.g. length, nasalization) to ensure perceptual distinctiveness
Examples

• From UPSID (UCLA Phonetic Segmental Inventory Database) > 317 languages
• Range of 3 -15 vowel phonemes in inventory
• Most common: 5 vowel system with /a i u e o/
• Tellingly, no as “/i ɨ i e ɛ/” or “/u ʊ ɔ o a/” systems found....
Common 3- and 4-vowel patterns
Common 5–vowel patterns