24.961 Phonetics-2 Consonants
Oct. 6, 2010

Acoustic Reflexes of Consonants

1. stops: gap with possible voice bar; place distinctions cued by properties of the burst and the formant transitions from adjacent vowels and sonorant consonants [fig. 8.7]

- burst: frequency t > k > p (cf. length of cavity)
- transitions: depend on vowel
    - labial: F2 and F3 point down for front vowel like [æ]
    - dental: F2 level or rising depending on vowel and F3 is level
    - velar: F2 is up but F3 is down--aka "velar pinch"

2. fricatives: aperiodic noise

- f and θ have less energy than s and ʃ and is concentrated in lower regions [8.9]
- θ has higher F2 locus than f
- f and θ are most confusable pair in noise
- they fall together in some dialects: Cockney, AAE

AAE	GAE	
[θɪŋ]	[θɪŋ]	'thing'
[θɪŋk]	[θɪŋk]	'think'
[diz]	[ðiz]	'these'
[dæt]	[ðæt]	'that'
[bæf]	[bæθ]	'bath'
[wɪf], [wɪt]	[wɪθ]	'with'

[mʌnt], [mʌnf] [mʌnθ] 'month' (source: Green, Lisa. 2002. African American English. Cambridge U P

- s and ʃ have greater energy; for s most above 4000 Hz while for ʃ is lower (cf. lip rounding gesture as enhancement)

3. some phonological distributions elucidated by relative availability of cues

- for English word-initial consonant clusters stops must be followed by sonorant consonant: *play, pray* but *<p>syche*
  sp, st, sk have most noisy (salient) fricative
- word-final stops more likely to be released after s: *lip* vs. *lisp*
- metathesis: *ask* -> *aks; crisp* > *crips* (Singapore English)

- brings stop next to vowel where formant cues available
- in Chinese substratum language final stops are not released

4. nasals
   - since air passes into nasal cavity, another set of formants appears: F at c. 250Hz and the absence of a formant til. c 2000 Hz.
   - in many languages strong coarticulation with preceding vowel
   - place distinctions weaker--cf. common nasal assimilation
   - strong discontinuity with vowel

5. laterals and glides
   - formant structure: l has peaks at 250, 1100, 2400 [8.11]
   - r: lowering of F3 from adjacent vowel [9.12] ("The deer heard the bear roar")
   - glides [w] and [j] have low and high F2 and F3, respectively as with cognate vowels

6. Airstream Mechanisms and Phonation Types
   - pulmonic egressive: plosives p,t,k; b,d,g
   - glottalic egressive: ejectives p', t', k' (vocal folds compressed and larynx raised)
     Lakota *p'o* 'foggy' vs. *t'uʃə* 'at all costs' vs. *k'u* 'to give'
   - glottalic ingressive: implosives ɓ, ɗ, ɠ (vocal folds compressed and larynx lowered)
     Sindhi: *ɓani* 'field' vs. *banu* 'forest'
   - velaric ingressive: clicks dental | alveolar ! lateral || bilabial ʘ
     Xhosa: ukuk|ola 'to grind', ukuk!oɓa 'to break stones', uk||olo 'peace'
     ukuk|ʰola 'to pick up'

7. States of the Glottis: controlled by arytenoid cartilages [6.4]

   - voiced: vocal folds together and vibrating
   - voiceless: vocal folds separated and not vibrating
   - breathy voice/murmur-1: [ɦ] *ahead* vocal folds separated but held loosely to vibrate
   - breathy voice/murmur-2: vocal folds vibrating in anterior region of glottis but separated in posterior region between arytenoids so air escapes
   - creaky voice: arytenoids closed tight while anterior portion vibrates
   - both breathy and creaky are secondary manuevers to obtain low tone (cf. Mandarin tone 3)

8. Aspiration and Voice Onset Time (VOT)

   - the interval between release of oral closure of stop and onset of voicing for vowel: 6.5
   - length of VOT a function of degree of glottal opening timed with release of oral closure

- large interval: aspirated t^h Sindhi *pʰaɲu* 'snake hood'
- small interval: unaspirated voiceless t Sindhi *panu* 'leaf'
- closure voicing: negative VOT voiced d Sindhi *banu* 'forst'
- length of VOT a function of degree of glottal opening timed with release of oral closure

9. VOT (voice onset time) is one phonetic variable that has been extensively studied cross-linguistically starting with Lisker & Abramson (1964)

correlates of p vs. b contrast in AE:

- voicing
- aspiration ≈ VOT
- fortis vs. lenis (too vague)

10. study of word initial stops in c. 10 languages

	b	p	p^h
dutch	-82	17	
spanish	-118	14	
hungarian	-78	16	
tamil	-71	21	
cantonese		19	79
american english		9	69
e. armenian	-104	16	78
thai	-77	14	72
hindi	-77	14	72

- languages fall into three groups: b vs. p, p vs. ph, b vs. p vs. ph
- no lg has maximal dispersion: b vs. ph
- velar has longest VOT lag

11. Keyser & Stevens (2006)

- basic contrast is [±voice]
- other phonetic properties like aspiration and duration may be added to enhance the basic contrast
- in some cases the basic contrast may be weakened or even eliminated

	initial:	p^hin	bin	weak voicing
sC:	spin		no contrast	
	final:	tap	tab	vowel length

- controversy in current literature on Germanic languages (English, German, Dutch, Icelandic) as to which feature is basic and which is enhancing

12. languages and dialects can differ in enhancing features for same underlying phonological contrast

- In Southern British English vowel duration enhances /i/ vs. /ɪ/ contrast of heed vs. hid while in Scottish English it does not (Escudero & Boersma 2002)
- In Canadian English vowel duration enhances /ɛ/ vs /æ/ contrast while in Canadian French it does not (Escudero 2009)

13. enhancing features can become primary distinction and original contrastive feature is lost: Evolution of vowels from Latin to Romance (Rohlfs 1949)

Stage 1: contrast of [±long] with no difference in quality (cf. Japanese)

i	u	i:	u:
e	o	e:	o:
	a		a:

Stage 2: [±long] contrast enhanced by [±peripheral] (aka tense-lax) at least for [-low]

Cf. Arabic, English, Cantonese?

ɪ	ʊ	i:	u:
ɛ	ɔ	e:	o:
	a		a:

Stage 3: [±peripheral] is reinterpreted as contrastive feature

Loss of contrast in low vowels

i				u
	ɪ		ʊ	
e				o
	ɛ		ɔ	
		a		

Stage 4: four way height contrast eliminated by merger of /ɪ, ʊ/ with either /i,u/ (Southern Italian) or /e,o/ (Northern Italian) and diphthongization of /ɛ,ɔ/

i		u
e		o
iɛ		uɔ
	a	

Latin	N. Ital.	S. Ital	
nive	neve	nivi	‘snow’
cruce	croce	kruci	‘cross’
pede	piede		‘foot’
locus	luogo		‘place’
canis	cane		‘dog’
ni:dus	nido		‘nest’
u:va	uva		‘grape’
ste:lla	stella		‘star’
so:lus	sole		‘sun’
stra:ta	strada		‘street’

14. Enhancing feature becomes basis of loanword adaptation

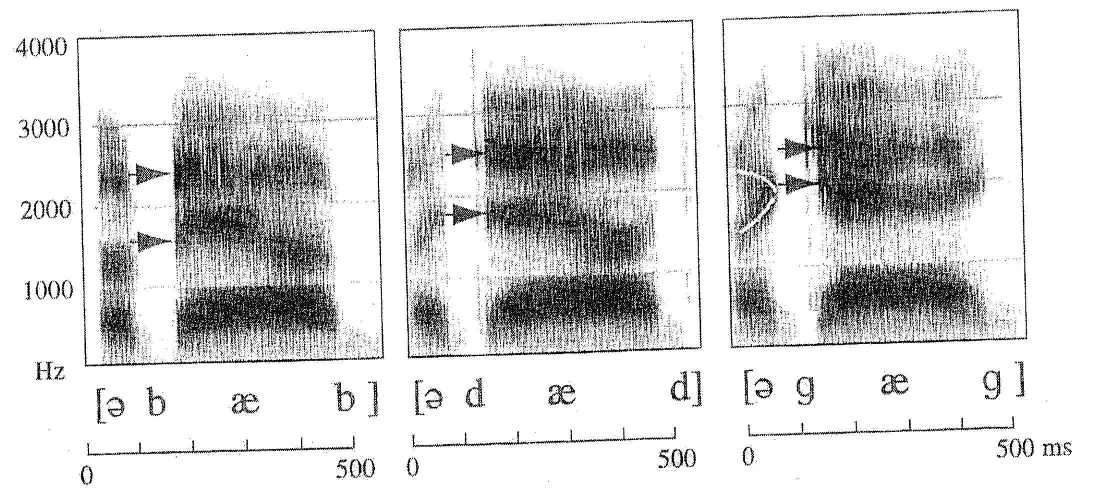
Mandarin [±back] enhances coronal vs. dorsal nasal coda contrast

/An/ ->	[an]
/Aŋ/ ->	[ɑŋ]

loanwords adapted on basis of enhancing feature

[æn]chovy	an.hou
C[ɑŋ]go	gɑŋ.guo
m[ɑn]soon	mɑŋ.un
t[æŋ]k	tan.ke

FIGURE 8.7 A spectrogram of the words *a bab, a dad, a gag*.



8.9

FIGURE 8.9 A spectrogram of *fie, thigh, sigh, shy*. The frequency scale goes up to 8000 Hz in this figure. The arrows mark the onsets of the second formant transitions. Only the first word is shown in full. The second part of the diphthong has been deleted for the other words.

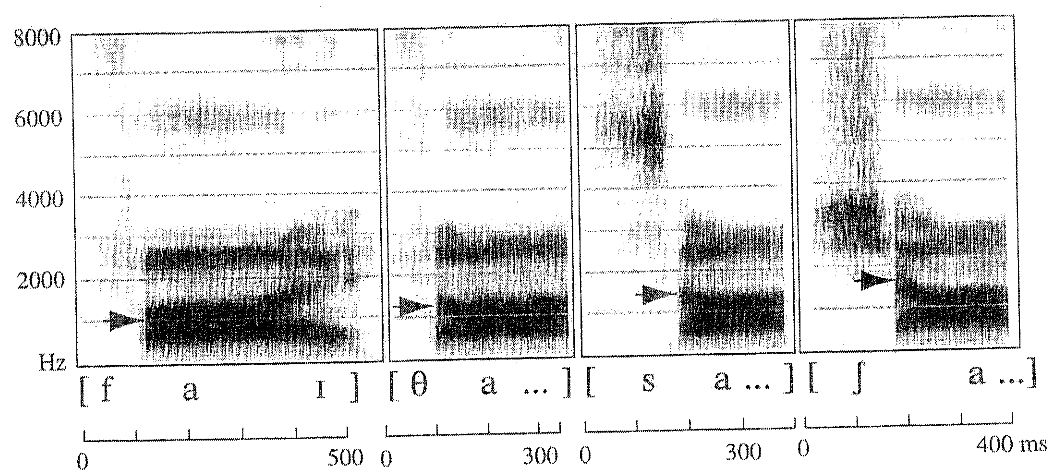


FIGURE 8.11 A spectrogram of *led, red, wed, yell.*

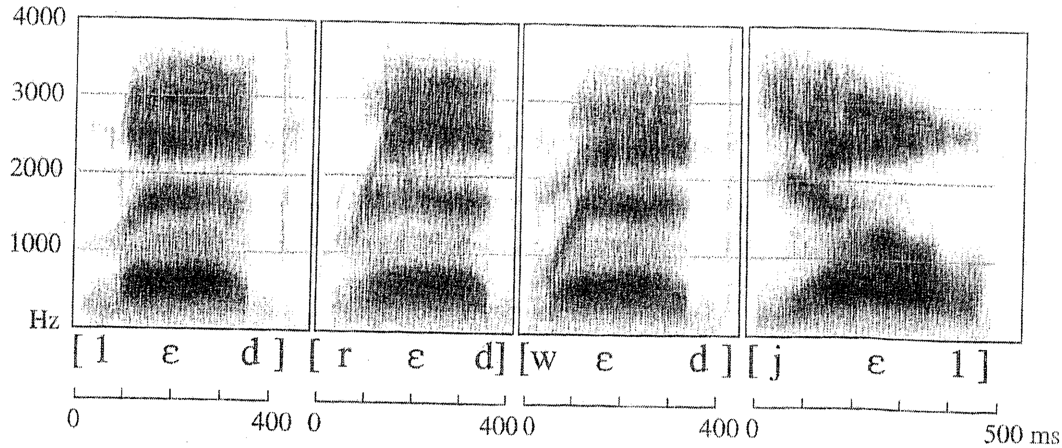


FIGURE 9.12 A spectrogram showing the lowering of the frequency of the third formant (and the second formant) during rhotacized sounds in a sentence in American English.

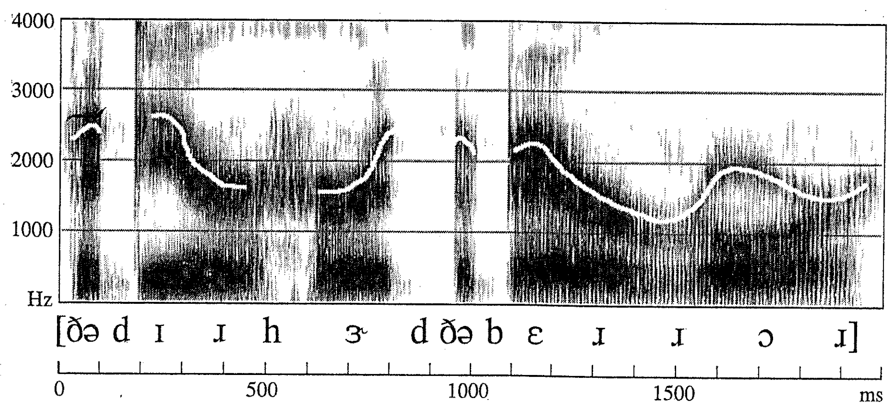


FIGURE 6.4 Four states of the glottis.

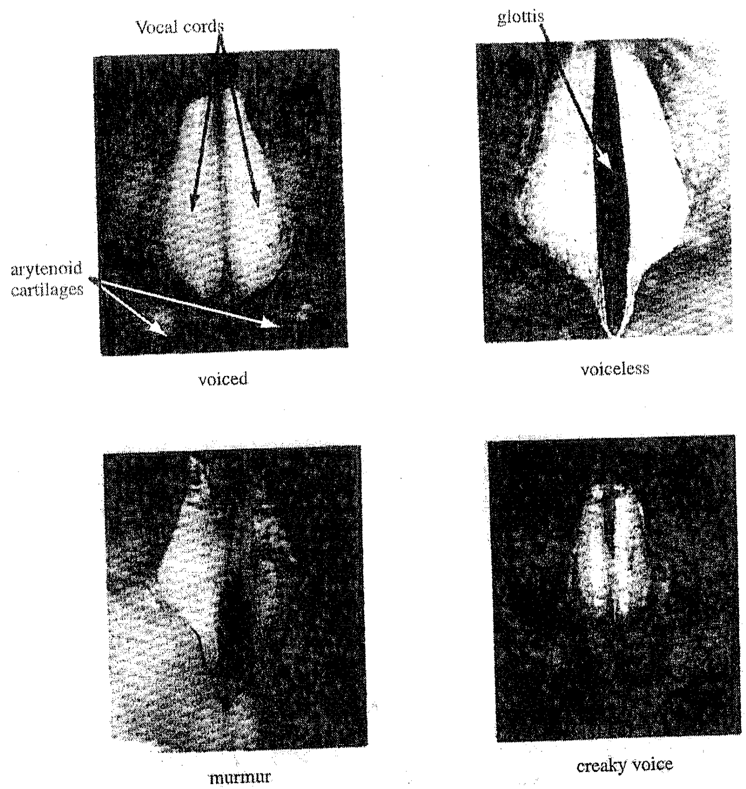
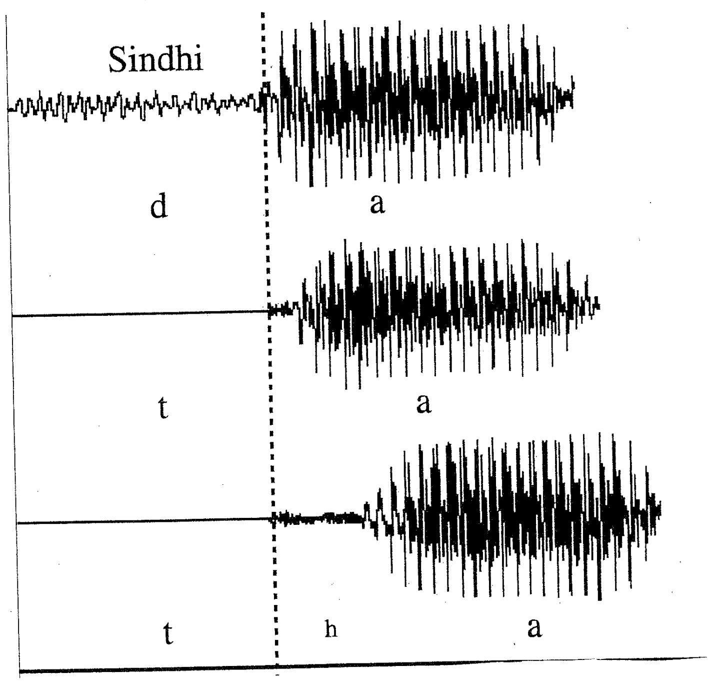


FIGURE 6.5 Waveforms showing stops with different degrees of voicing and aspiration.



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