24.941J / 6.543J / 9.587J / HST.727J The Lexicon and Its Features
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THE LEXICON AND ITS FEATURES
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Lecture 3 *09/23/04*

CONSONANTS AND THEIR FEATURES

Sonorant Consonants

Nasal

Figure 9.1 Midsagittal sections through the vocal tract during the production of nasal consonants produced by closing the lips (left) and raising the tongue tip to the alveolar ridge (right). For the labial consonant, the context is "Mets tes beaux habits," and for the alveolar consonant the context is "Une réponse ...." (Adapted from Bothorel et al., 1986.)

Source: Stevens, K. N. *Acoustic Phonetics*. MIT Press, 1998.
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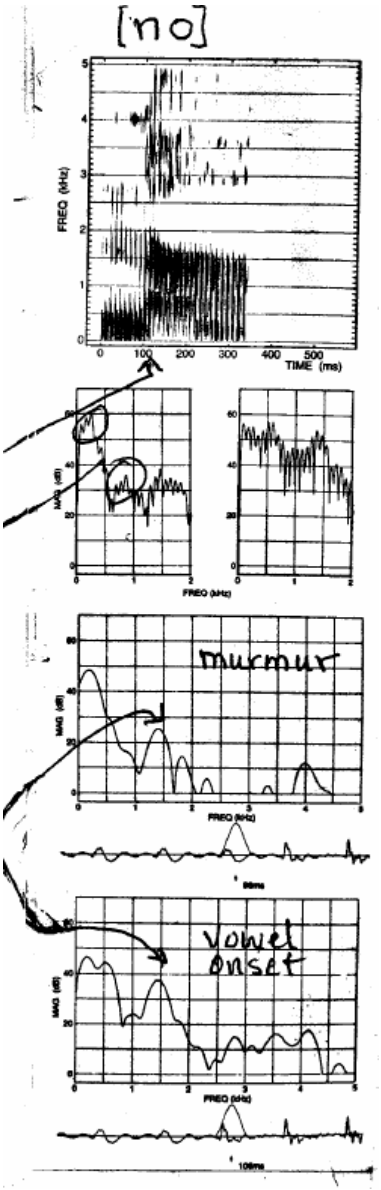
- abrupt change: a defining attribute for [+consonant]
- peak at low frequency and at ~900 Hz (nasal cavity resonance): defining attribute for [+nasal]



- jump in amplitude of F2 peak --- frequency depends on place of articulation: lips, tongue blade, tongue body

Source: Stevens, K. N. *Acoustic Phonetics*. MIT Press, 1998.
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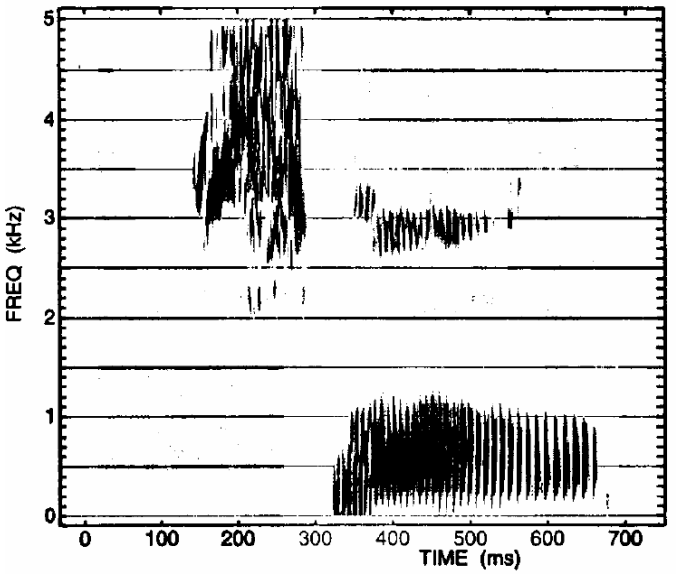
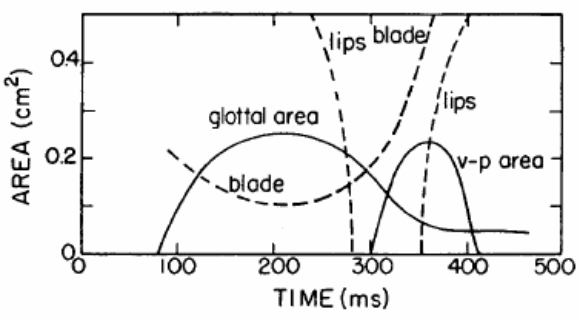
Some influences of gestural overlap for nasals:

1. Voiceless obstruent followed by nasal
   e.g. small





lowering of soft palate inhibited by pressure increase during [s]

Other examples:
acme, top notch, etc.

2. nasal following a reduced vowel
   e.g., sudden lesson

3. nasal preceding a glide
   e.g., "I'm done with it"

4. nasal spreading: win those

I can't go up to Sweden

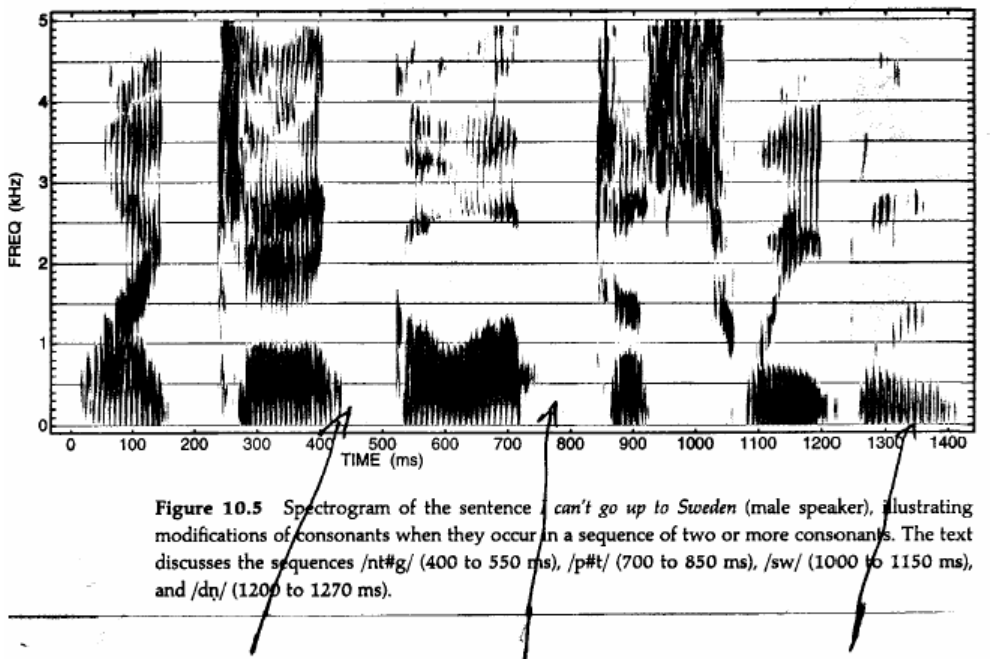


Figure 10.5 Spectrogram of the sentence *I can't go up to Sweden* (male speaker), illustrating modifications of consonants when they occur in a sequence of two or more consonants. The text discusses the sequences /nt#g/ (400 to 550 ms), /p#t/ (700 to 850 ms), /sw/ (1000 to 1150 ms), and /dn̩/ (1200 to 1270 ms).

no nasal murmur

no release of [p]

syllabic nasal

Source: Stevens, K. N. *Acoustic Phonetics*. MIT Press, 1998.
Courtesy of MIT Press. Used with permission.

Liquids

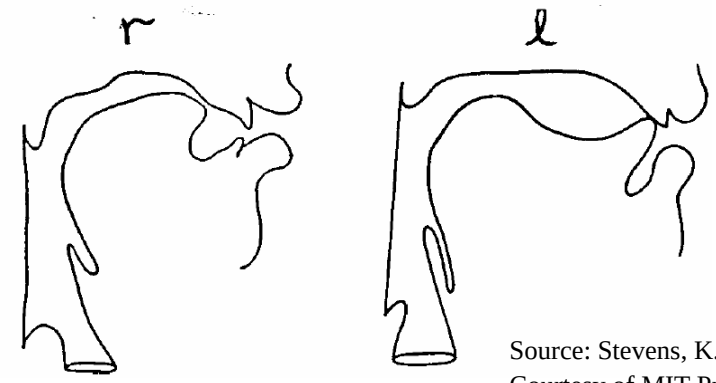


Figure 9.34 Midsagittal sections of the vocal tract for the liquid consonants /r/ (left) and /l/ (right). The midsagittal sections do not reflect the fact that in each case there is an acoustic path around the lateral edges of the tongue blade. The representation of /l/ is adapted from Narayanan et al. (1995b).

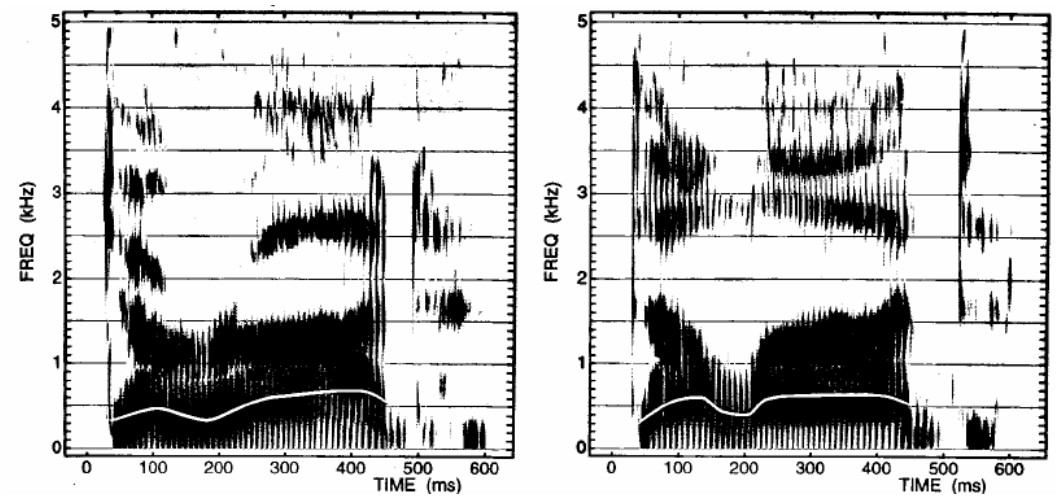


Figure 9.35 Spectrograms of the utterances /dəˈrɑd/ (left) and /dəˈlɑd/ (right) produced by a male speaker. The time course of the first-formant frequency during the liquid consonant is overlaid on the spectrogram.

In prevocalic position, /ℓ/ usually shows a discontinuity, typical of a consonant. In postvocalic position, often discontinuity not visible.
Discontinuity not seen in American English /r/

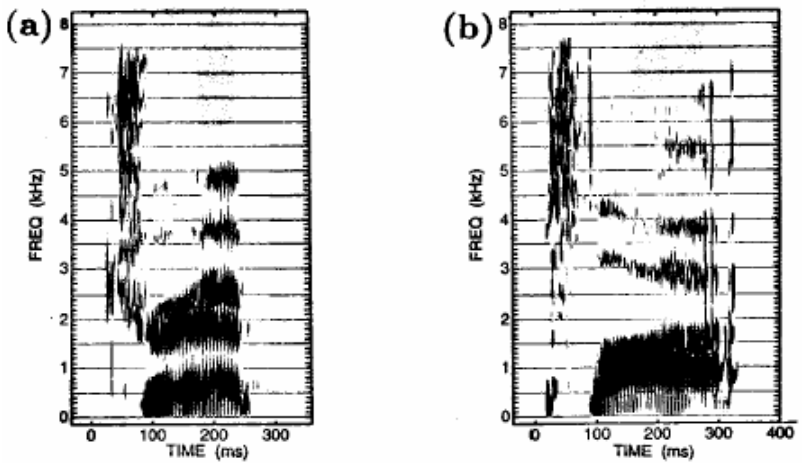
/ℓ/: high F3

/r/: low F3 (front cavity resonance)

Both have backed tongue body: enhancing gesture?

Some contextual variants due to gestural overlap

clusters: drip plot

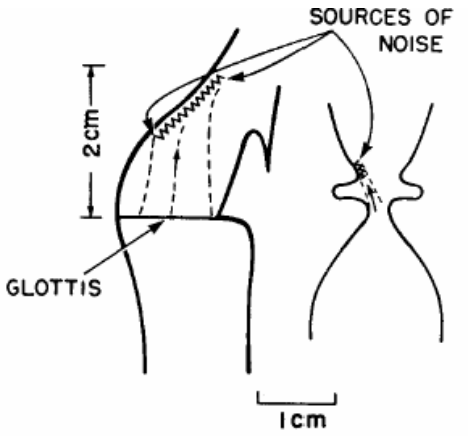


Sometimes no tongue blade closure for / ℓ /

e.g. ball game
Elmer

Also / ℓ / and /r/ can be syllabic

[h] [+spread glottis]



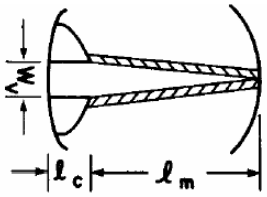
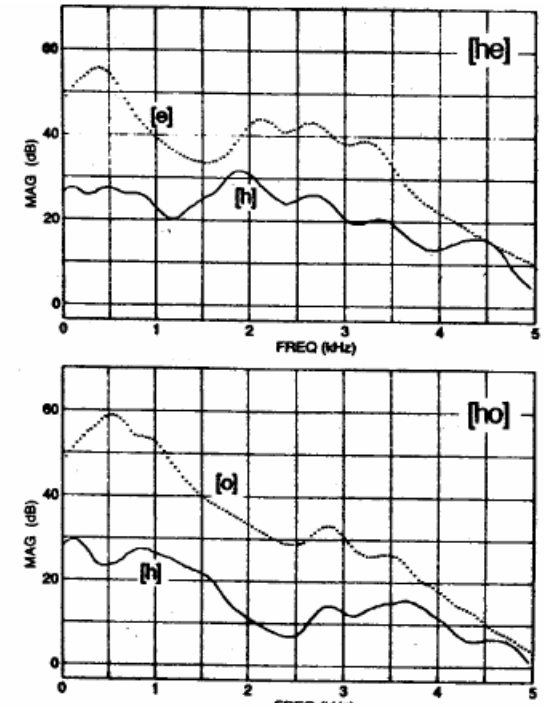


Figure 8.33 Schematization of glottal opening for an abducted glottal configuration. The glottal width at the level of the arytenoid cartilages is w_v; ℓ_m and ℓ_c are the lengths of the membranous and cartilaginous portions of the glottis.

Figure 8.38 Schematized views of the laryngeal region in the sagittal plane (left) and in coronal section (right), indicating how airflow through the glottis might impinge on the surface of the epiglottis (left) or on the ventricular folds (right) to produce turbulence noise that is represented as a source of sound pressure.



[h]

spectrum of noise and of

adjacent vowel

Source: Stevens, K. N. *Acoustic Phonetics*. MIT Press, 1998. Courtesy of MIT Press. Used with permission.

Figure 8.44 Examples of smoothed spectra sampled in /h/ (solid lines) and in the following vowel (dotted lines) for the utterances /he/ (male speaker) and /ho/ (female speaker) as indicated. Spectra were obtained by calculating a discrete Fourier transform (time window of 30 ms) and then smoothing this spectrum with a weighted frequency window of width about 400 Hz.

breathy voicing

vowel

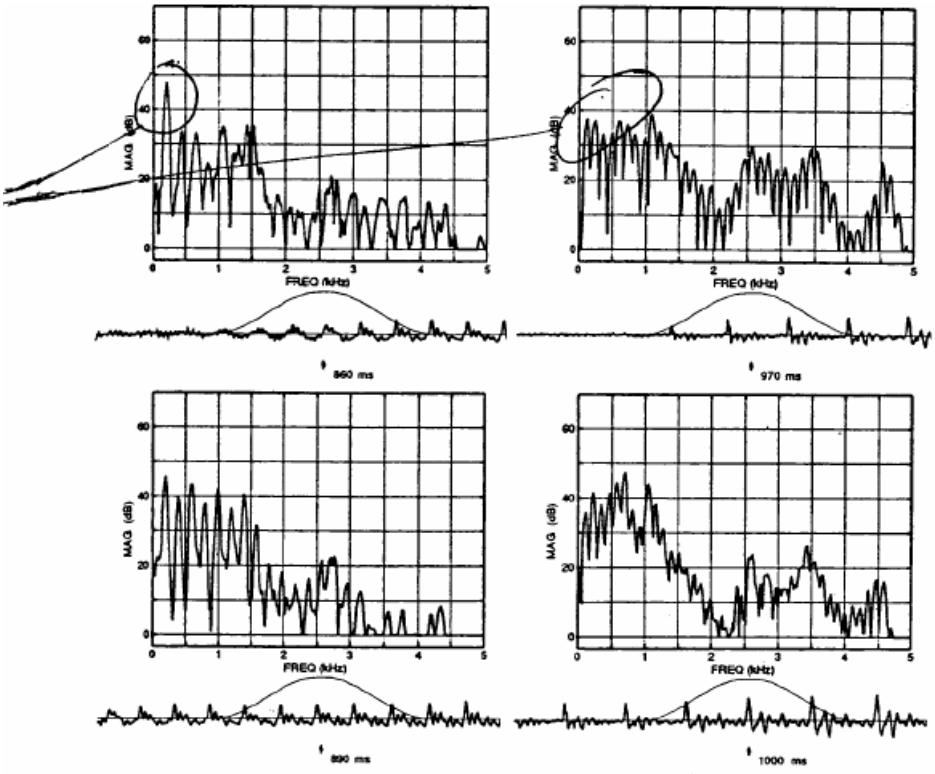


Figure 8.36 Spectra sampled near the onset of the vowel (upper panels) and about 30 ms later (lower panels) in the syllable /ha/ produced by two speakers: a female (left) and a male (right). Waveforms are shown below each spectrum, together with the time window over which the discrete Fourier transform is calculated.

Source: Stevens, K. N. *Acoustic Phonetics*. MIT Press, 1998. Courtesy of MIT Press. Used with permission.

Obstruent Consonants

For obstruents the features and their acoustic and articulatory correlates are more straightforward than for sonorants. The presence of a turbulence noise source produced near a vocal tract constriction is a defining acoustic attribute of [-sonorant].
A constriction that results in a substantial increase in intraoral pressure is a defining articulatory attribute.

Fricatives

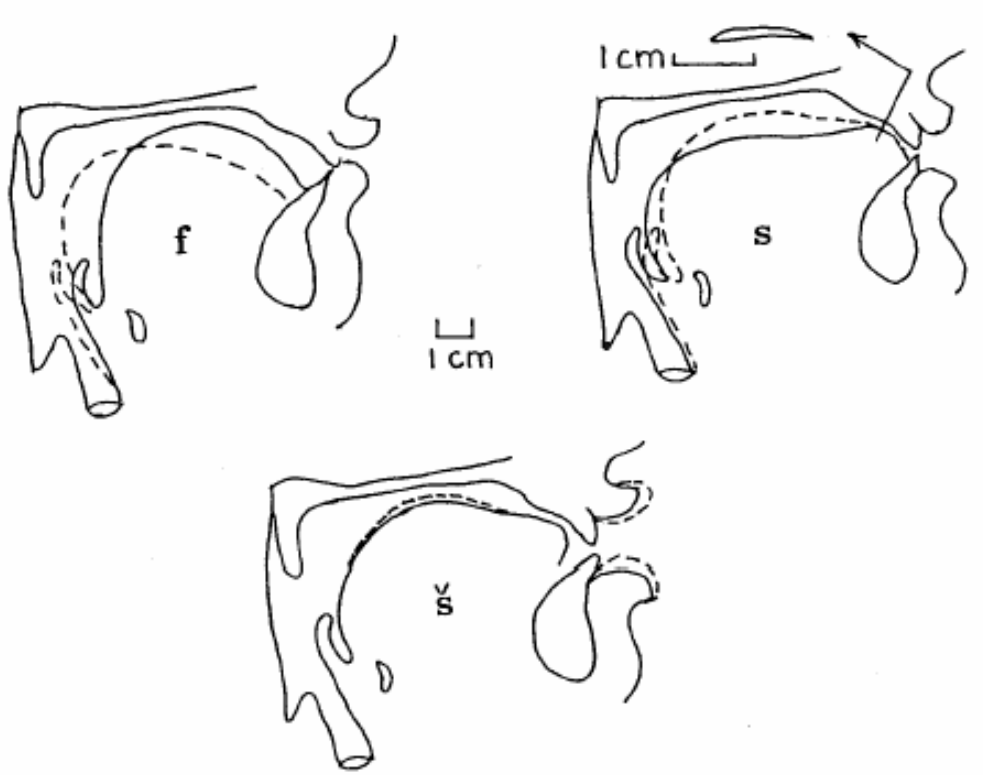
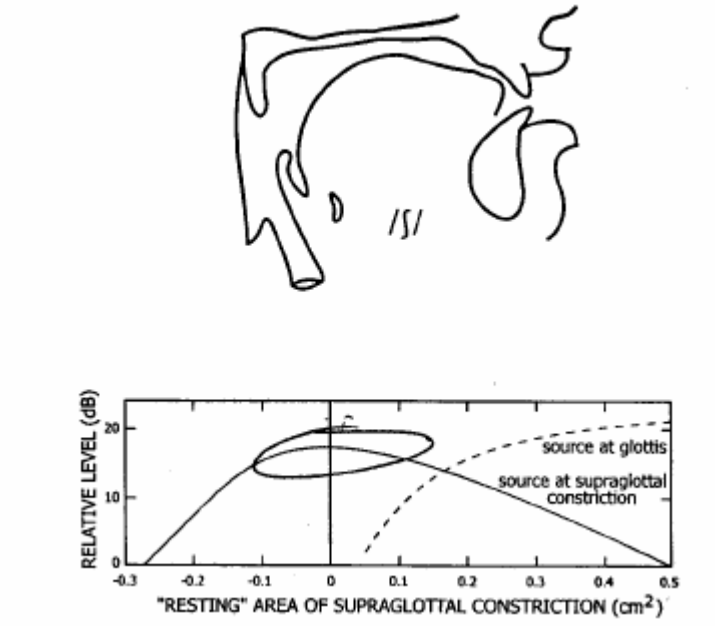


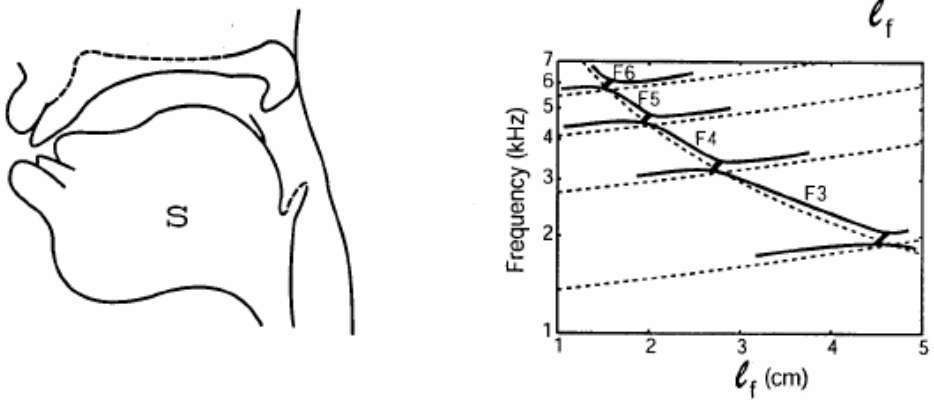
Figure 8.1 Midsagittal sections obtained from cineradiographs during the production of the three fricative consonants /f/, /s/, and /š/, as indicated. The subject is an adult female speaker of French. The approximate scale is given between the /f/ and /s/ configurations. In the case of the /s/ configuration, an estimate of the cross-sectional shape at the constriction is given. (This shape is drawn with an enlarged scale, as shown.) For each panel, two midsagittal sections for the tongue (and, in the case of /š/, for the lips) are shown, representing the fricative in two different phonetic environments. For /f/, the following vowel contexts are the high front rounded vowel /y/ (solid line) and /ɔ/ (dashed line); for /s/, /a/ (solid line) and /i/ (dashed line); and for /š/, /a/ (solid line) and /u/ (dashed line). (After Bothorel et al., 1986.)

•partial closure of the airway: [+continuant]



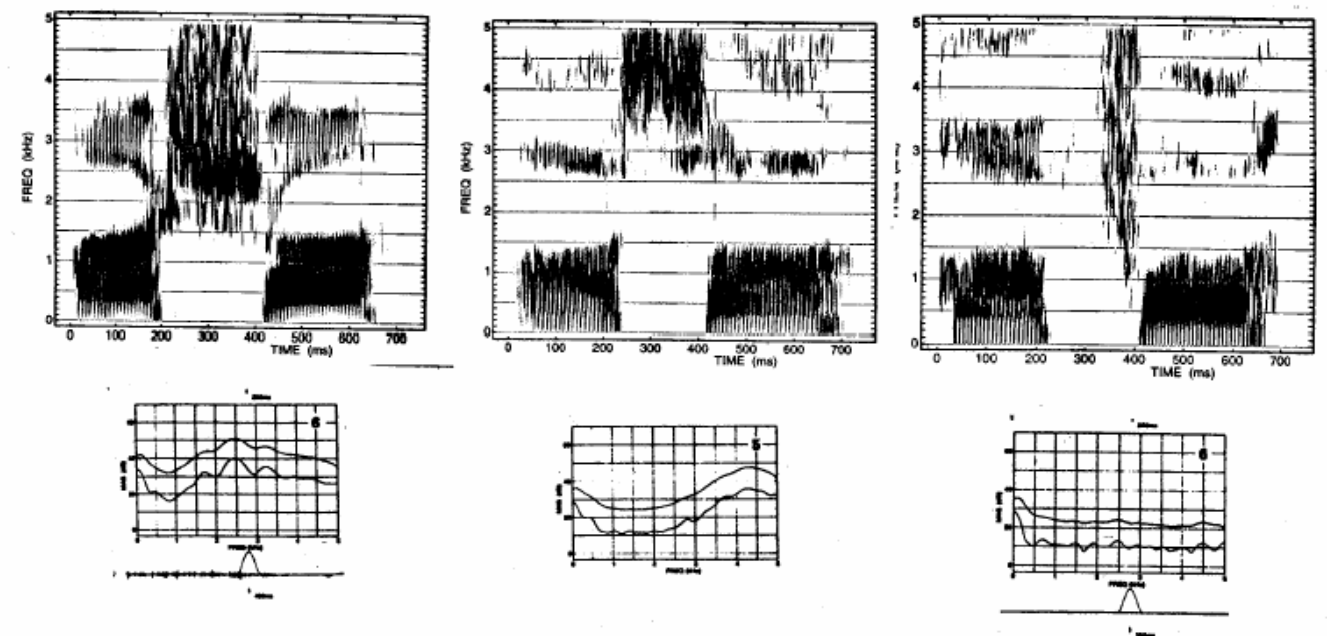
A broad maximum in amplitude occurs over a range of constriction sizes

The feature [anterior]



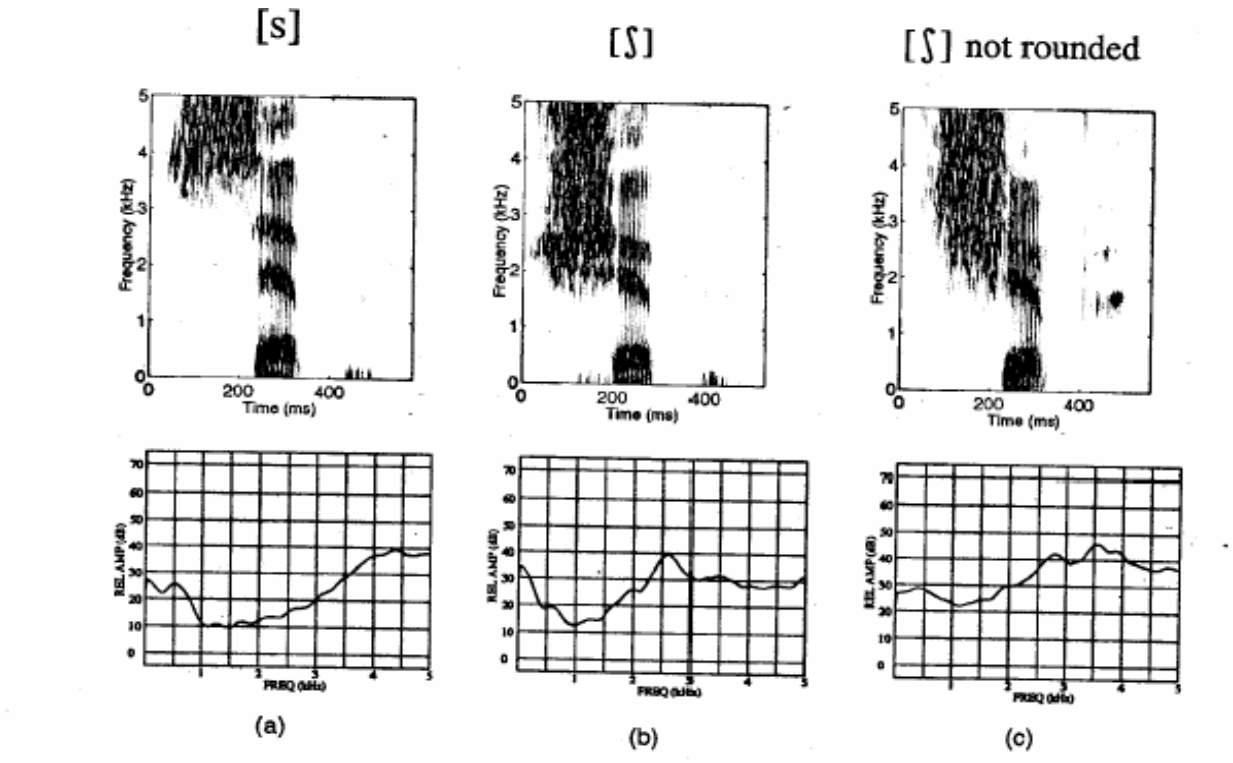
As front cavity length increases its formant affiliation jumps from F5 --- F4 -- F3 in a stepwise manner

[ʃ] [s] [f]



Some enhancing gestures for fricatives:

Rounding for [ʃ] in English



Another enhancement (and overlap) example:

For nonstrident [θ] and [ð] a flattened tongue blade placement to avoid airstream impinging on an obstacle (teeth). This tongue blade shaping seems to involve a more backed tongue body position and hence a F2 transition different from an alveolar, which has a more fronted tongue body position as an enhancing gesture. Thus in a sequence like win those nasalization spreads into [ð] but the F2 transition out of [ð] contains cues for this [+anterior, -strident] segment. (Manuel 1995, J. Phonetics).

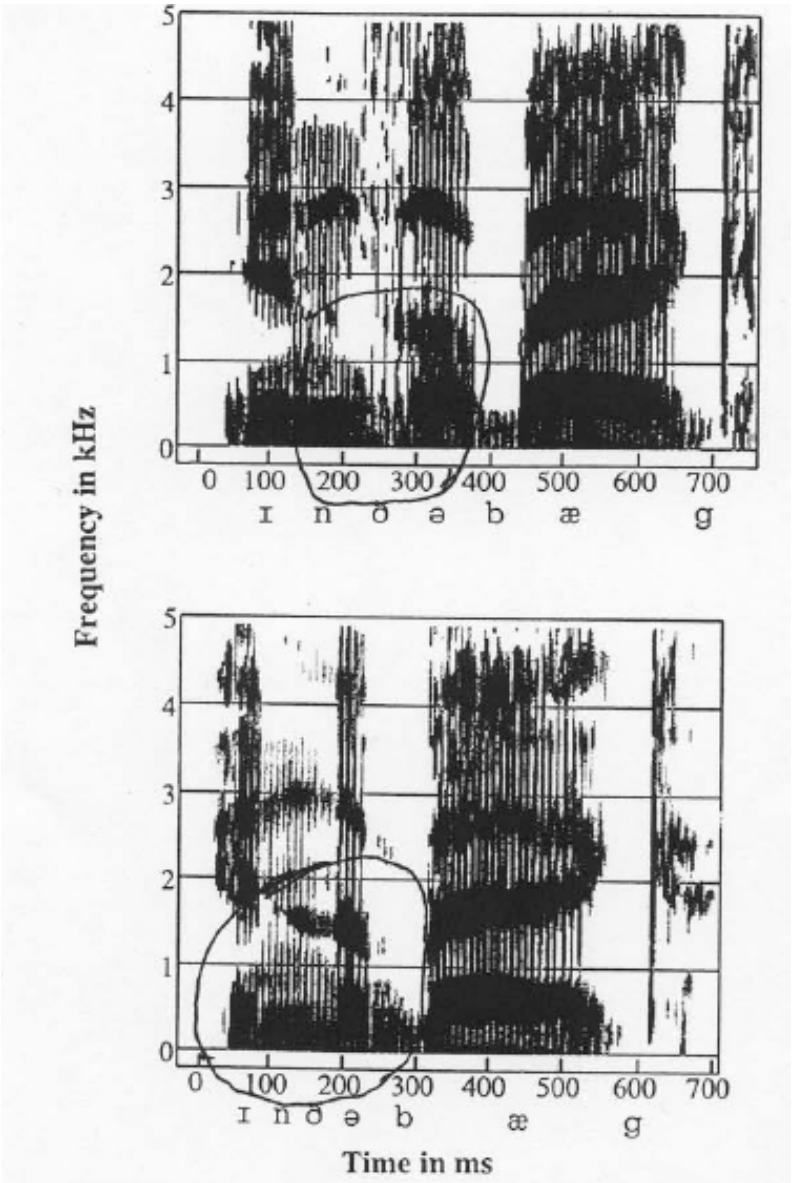
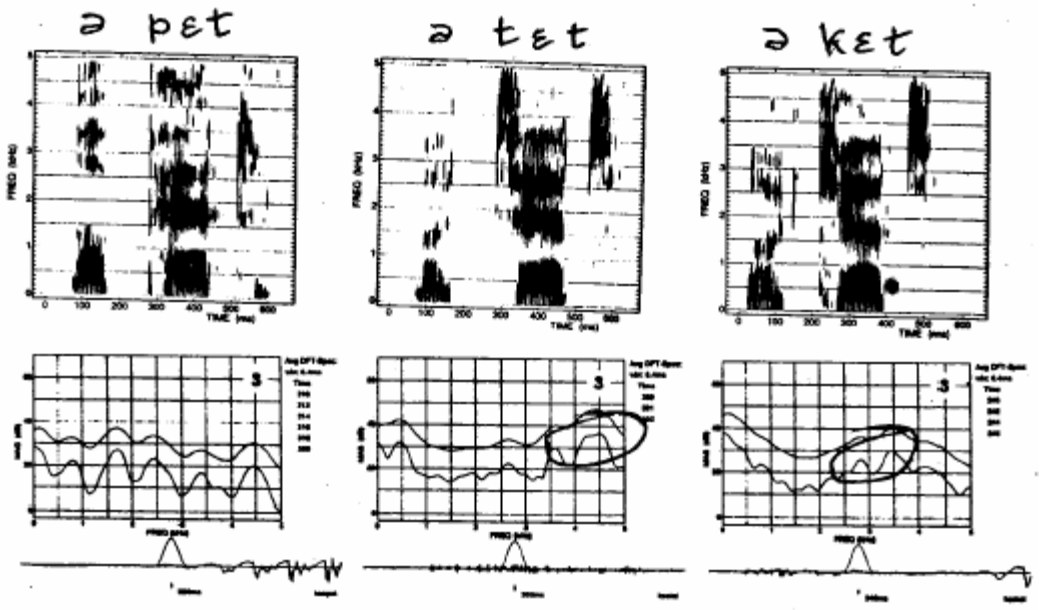


Figure 1. Spectrograms of very careful (upper figure) and casual (lower figure) productions of *in the bag*. In the casual production, the /ð/ is nasalized.

Stop Consonants

Figure 7.2 Midsagittal sections through the vocal tract during the production of stop consonants produced by closing the lips (left), raising the tongue tip to the alveolar ridge (middle), and raising the tongue body (right). Adult male speaker. (From Perkell, 1969.)



For p b no front cavity resonance
For t d front cavity resonance is F4 or F5
For k g front cavity resonance is F2 or F3
depending on backness of vowel
(in this example some excitation of F4 also)

These burst characteristics can be considered to be the defining acoustic correlates of the place features.

Enhancement gesture for alveolar stops t d:

Tongue body seems to be fronted and F2 transition is kept distinct from that of labials and velars.

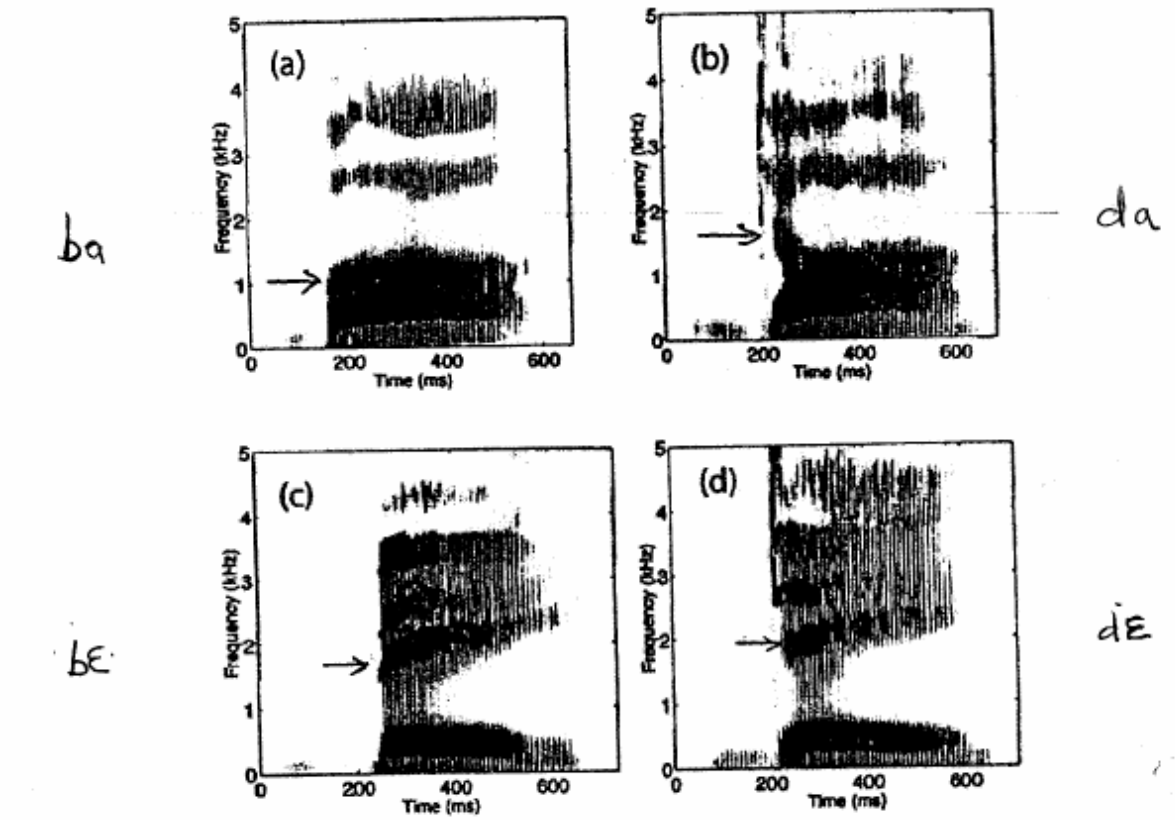


Figure Spectrograms of (a) /ba/, (b) /da/, (c) / bɛ/, (d) /dɛ/. These spectrograms illustrate the higher starting frequencies of the F2 and F3 transitions for the alveolar consonants relative to the labial consonants, indicating a more fronted tongue body position for the alveolars. The F2 starting frequency is less dependent on the following vowel for /d/ than for /b/.

Examples of gestural overlap:

top tag: no [p] release in sound
batman: sometimes no [t] closure, but enhancing gesture of tongue body fronting seems to remain
writer/rider