LING 576 Acoustic Phonetics
Spring 2009
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Topic number 9: Spectrogram Reading 2 - Place of Articulation
3-12-09

Reading:
Ladefoged, Peter. 2001. Vowels and consonants: An introduction to the sounds of language. Malden, Massachusetts and Oxford: Blackwell. Read Chapter 6.
Everett, Caleb. 2008. Locus equation analysis as a tool for linguistic fieldwork. Language Documentation & Conservation 2: 185-211. http://scholarspace.manoa.hawaii.edu/handle/10125/4351.

1. Overview

Acoustic cues to place of articulation in consonants subdivide into several types:

- Segment-internal cues (formants)
- Release bursts
- Formant transitions

2. Segment-internal cues

Sonorant sounds (nasals, approximants, laterals) have identifiable formants which correlate with place of articulation.

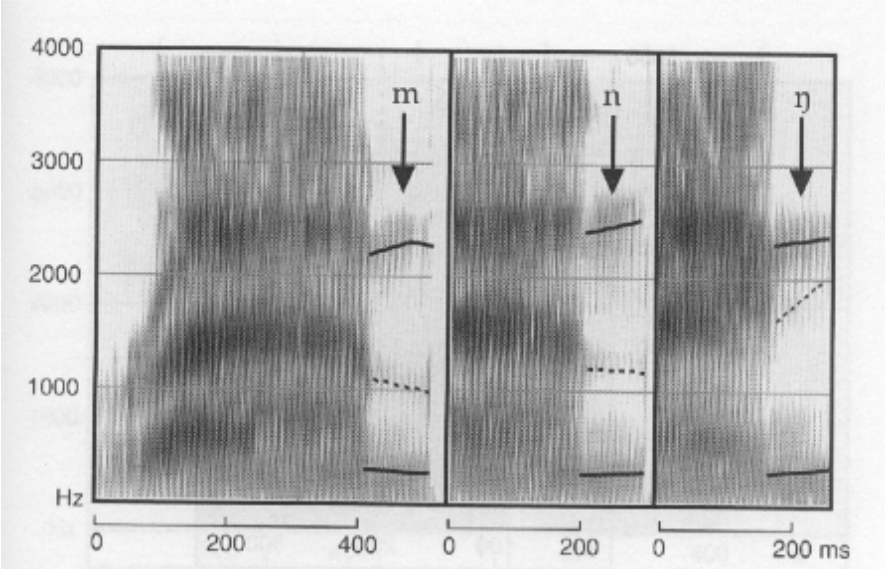


Figure 6.6 The nasals at the ends of the words *ram, ran, rang*. Only the ends of the last two words are shown.

-- from Ladefoged (2003:145)

Fricatives have aperiodic noise distributed over a wide range of frequencies.

Different fricatives typically have different frequency regions where the heaviest concentration of energy occurs.

- [f], [θ] (and their voiced counterparts) are very diffuse, with low intensity energy distributed over a large frequency range.
- [s] has comparatively little energy below about 5,000 Hz, and substantial energy at higher frequencies.
- [ʃ] has a lower spectral "center of gravity" (more energy at lower frequencies) than [s].

What is expected for [x]?

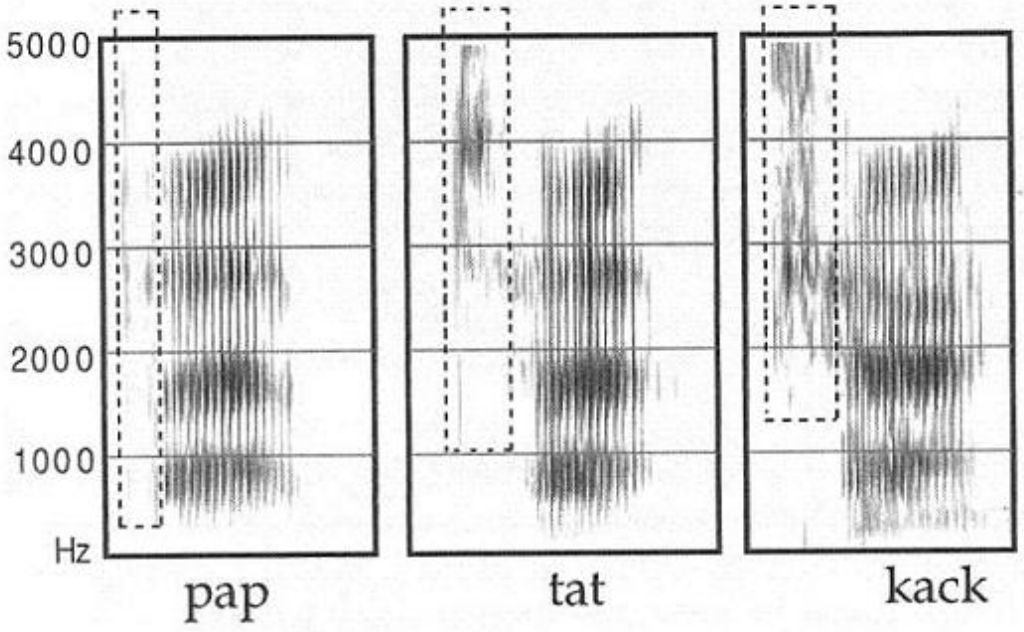
3. Release bursts

Release bursts are typical of voiced and voiceless stops.

They are only a few milliseconds in duration.

Like frication noise in fricatives, the frequency spectrum of release bursts varies with place of articulation.

- Labial stops have short, weak, diffuse bursts (energy over a large frequency range).
- Coronal stops have longer and more intense release bursts, with most of the energy at high frequencies (above about 3,000 Hz).
- Velar stops release bursts are typically the longest, with a typical energy concentration somewhat lower than for coronal consonants. Velar stops often have double bursts.



Spectrograms of voiceless stops in *pap, tat, kack* (as in *cackle*).

-- from Ladefoged (2001:51)

4. Formant transitions

Formant transitions are changes in formant values of vowels in the vicinity of a preceding or following consonant.

The trajectories of formant transitions depend on the place of articulation of the consonant involved.

Formant transitions are relevant to all types of supralaryngeal consonants (i.e., excluding laryngeals like [h]), not just stops.

However, they are particularly important for the perception of place of articulation in stop consonants.

The trajectory of VC or CV formant transitions will depend not only on the place of articulation of the consonant, but also on the target formant values of the vowel

Some general tendencies to note:

- F_2 tends toward 1700 Hz (or somewhat higher) near coronal (e.g. alveolar) consonants.
- F_2 and F_3 are both typically lowered near a labial consonant.
- Next to a velar consonant, F2 and F3 often come together ("velar pinch").

This may not happen in the case of high or mid front vowels however.

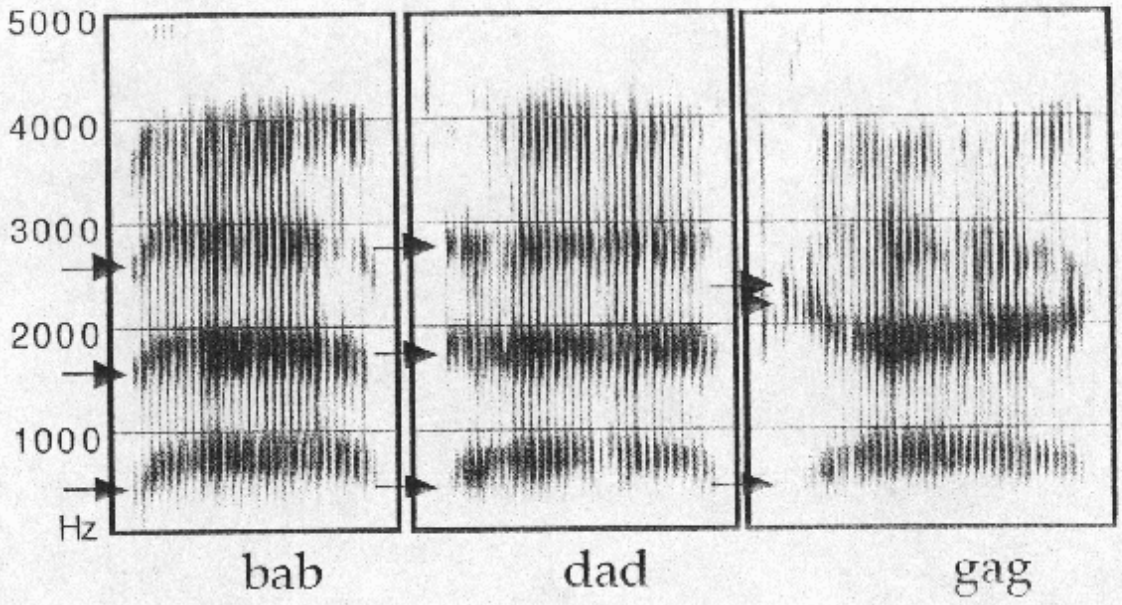


Figure 6.1 Spectrograms of stops in *bab, dad, gag*. The arrows mark the origins of the first three formants.

-- from Ladefoged (2001:49)

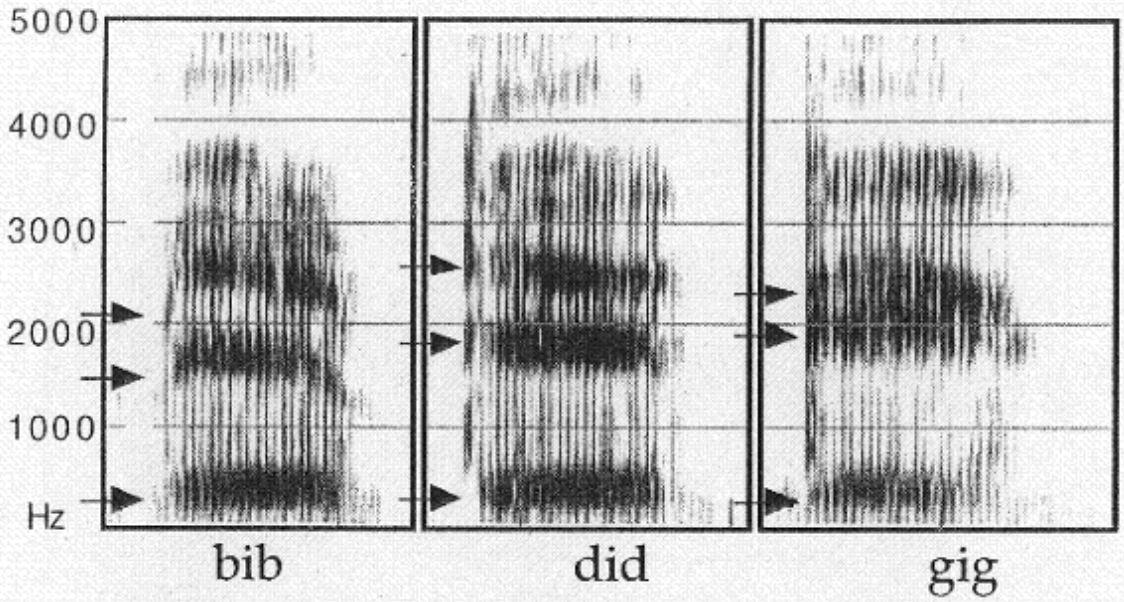


Figure 6.2 Spectrograms of stops in *bib, did, gig*. The arrows mark the origins of the first three formants.

-- from Ladefoged (2001:50)

Formant transitions out of a *voiceless* consonant are sometimes difficult to see in the spectrogram. (Why?)

Formant transitions and speech perception

It is interesting to note that much of the acoustic information speakers rely on to perceive place distinctions in consonants (especially stop consonants) is not actually contained in the consonant itself, but in the formant transitions in the following and preceding vowel.

Studies have shown that the formant transitions following a consonant ("CV transitions") are a more important perceptual cue than the formant transitions preceding a consonant ("VC transitions") (Steriade 2000 and references therein).

What implications might these facts have for neutralization of perceptually different contrasts in different syllable positions?

References

Ladefoged, Peter. 2001. Vowels and consonants: An introduction to the sounds of language. Malden, Massachusetts and Oxford: Blackwell. Read Chapter 6.

Ladefoged, Peter. 2003. Phonetic data analysis. Malden, Massachusetts and Oxford, England: Blackwell.

Steriade, Donca. 2000. Directional asymmetries in place assimilation: a perceptual account. MS, UCLA. (Available at http://www.linguistics.ucla.edu/people/steriade/papers/ICPHS2000.pdf.)