

ACOUSTIC ANALYSIS OF SPEECH PRODUCTION (continued)

3. Acoustic properties in the production of fricatives

Fricatives:



Aperiodic sound waves: uneven shading across a wide frequency range.

Fricatives of different places of articulation are associated with differences in

- a. overall amplitude
- b. distribution of spectral peak.

e.g., [f] [v]: the front cavity is very short -- high frequency!

As the place of articulation moves backward in the oral cavity, the length of the front cavity increases -- the lowest resonance frequency decreases.

The source of the fricative sound is the *constriction*. The spectrum of the sound is determined by the resonant characteristics of the *constriction and the vocal tract anterior to the source* – consider the formula discussed earlier!

For example:

In [s], because of the narrowness of the constriction, the back cavity resonances are not heard; thus, there is little energy below 4000 Hz. The distance between the anterior edge of the constriction (source!) and the lips is about 2 cm (for a man). The air filled cavity in front of the noise source is a quarter-wave tube (closed at one end!).

$$f = \frac{34,400}{4 \times 2} = 4000 \text{ Hz}$$

Differences in the amount of acoustic energy present: darkness indicates amplitude, e.g., [f] is less loud than [s]

Study the Handout.
Study Fry, p.122, and Figure 48.

VOICED FRICATIVES: vertical striations on the spectrogram indicate glottal pulsing (=voicing).

Voiced fricatives have two sources of acoustic energy: vocal fold vibration (periodic), and the energy of the turbulent source noise (aperiodic). Voiced fricatives tend to have shorter noise segment duration!

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4. Acoustic properties in the production of affricates

Like STOPS, the affricates are produced with a period of complete obstruction of the vocal tract.

Like FRICATIVES, the affricates are associated with a period of frication. The frication interval for affricates tends to be shorter than for fricatives.

Affricates are characterized by a rapid build-up of acoustic noise energy (though not as rapid as for stops);

Difference in RISE TIME (= measure of time over which the amplitude reaches its maximum) between affricates and fricatives.

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5. Acoustic properties in the production of approximants

a. Glides [j] [w]

- distinct (= vowel like) formant pattern – [j] is similar to [i], [w] is similar to [u]

- for [w] the upper formants (F3, F4) are very weak due to the degree of oral closure;
- formant transitions: slow – “getting there” is a glide: momentary articulation! For example, from a nasal transition is about 25 msec, for glides, the transition may take 100 msec;
- [aja] – the first formant of [a] moves down because the mouth constricts, the second moves up, because of the resonance of the narrowed front cavity
- [w] has two places of articulation!

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Compare the acoustic patterns of the alveolar voiced stop, the alveolar voiced fricative and the palatal stop: Pickett, p. 119, Figure 7.4:

[d] and [z]: formant frequency transitions are similar, but: for [z] there is a continuous strong turbulent sound at between 4000 and 5000 Hz; for [d] there is complete silence.

[j] : longest formant transition; [d] short formant transition

Explain: Study Pickett, pp.118-121.

b. Liquids: [l] [ɭ]

- distinct (= vowel like) formant pattern
- the upper formants (F3, F4) are very weak due to the degree of oral closure
- differences in tongue-tip configuration and position create the distinctions between [l] and [ɭ]; the acoustic results of tongue tip adjustment are reflected in F2, but most obviously in F3
- for [ɭ], F3 plunges *below* the F3 frequencies of the vowels, while for [l] it does not depart from them significantly
- transition of F1, F2 and F3 of [ɭ] is slow, although not as slow as for the glides; [l] has abrupt F1 transition

- differences between dark (velarized) and clear [ɫ] – F1 and F2 formant frequencies are comparable to back vowel formant frequencies for the dark [ɫ] and to front vowel formant frequencies for the clear [l].

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Some phoneticians refer to these sounds as *glides*: justification in Pickett, p. 108.



liquid is an auditory term, not related to articulation; based on their transition speed, they should be referred to as *glides*.

Study the Handout. Study Pickett, p. 109, Figure 6.4, and pp. 108-110.

Study Pickett, Chs. 6-9;
Important: Summary Tables 7.1 (p. 120) and 9.1 (p. 140)