Lab 4: Spectrographic Analysis of Fricatives

Introduction

Fricatives are produced by articulations that direct air flow through constrictions and/or onto obstacles causing turbulence. Turbulence provides a random, noise-like signal with a fairly flat spectrum in the normal range of speech frequencies. This noise is then shaped by cavity resonances adjoining the point of constriction; most significantly by any anterior cavity. In general, the further forward in the mouth the constriction occurs, the smaller the anterior cavity and the higher the frequency of the main spectral peak for the fricative. However the most front articulations also have the most heavily damped resonant cavities.

In this lab we shall look at the spectral and spectrographic properties of some common fricatives.

Scientific Objectives

- to investigate the main spectral properties of fricatives and relate these to their articulation.

Learning Objectives

- to become familiar with the visual form of fricatives on a spectrogram.
- to understand the relationship between a spectrographic picture and a spectral cross-section, and the advantages and disadvantages of each.
- to compare normal fricative production with one disordered production.
- to become more familiar with the dynamic characteristics of the spectrographic patterning of speech.

Method

You will be given a ready-prepared print containing both wide-band and narrow-band spectrogram of your production of the sentence:

'The hero shipped sixty thin fishes'

You can use the Esection program on the laboratory computers to print spectral cross-sections through the different fricatives (http://www.phon.ucl.ac.uk/resource/sfs/). You should ensure the recording has been captured at a high sampling rate to display frequencies up to 16000Hz. Also reduce the number of coefficients used for filter analysis in Esection to ten.

Observations

1. Annotate your spectrogram using a *broad phonetic* transcription. Pay particular attention to voicing.

2. Your utterance has been acquired onto the laboratory PCs. Print out spectral cross-sections for /h, ʃ, s, θ, f/. Make sure you properly title each print. Try and find evidence to confirm the main predictions that the main spectral peak becomes higher in frequency and greater in bandwidth as the articulation becomes more fronted.

3. Compare cross-sections for the t-burst in 'sixty' and of the final /z/ in 'fishes' with the cross-sections for the other fricatives. Which similarities and differences might you expect, and which can you find?

4. Record /ɑːsɑː , ɑːzɑː / and look for pulsed turbulence. What causes this?

5. Display a wide-band spectrogram for the "Sean's snowman" sentence by Tim. Compare the fricatives in the spectrogram and in the spectral cross-sections with your own. What differences can you observe? What does this tell us about Tim's articulation?

Concluding Remarks

What other aspects of the spectrographic pattern can be seen that might allow a listener to differentiate between fricatives? (Hint: look at the edges of adjacent vowels)

Discuss the statement: “If /h/ is just a vowel with turbulent noise excitation, then varieties of [h] should be as distinct as varieties of vowels”.

Reflections

1. Think of some other situations when turbulence generates an audible noise.
2. Why does the spectrum of turbulence have energy at every frequency?
3. Think of two ways in which losing your two front teeth will affect fricative production.
4. How and why does lip-rounding affect fricative quality?
5. Do you think whispered speech has intonation?
6. What is meant by “coarticulation”? Think of some other examples.