Hoole, Seminar Akustik

Exercise with Praat. Acoustic analysis of fricatives

After logging on to the matlab account:
```
cd akustikfort/fricatives
```

1. Preliminaries

Load all of these wav files:
afa, atha, asa, asha, aca, axa

(They contain labiodental, dental, alveolar, postalveolar, palatal and velar fricatives in the vowel context a_a)

In this order, open each sound in an edit window.
When you open the first edit window set the spectrogram display as follows:
```
Spectrum > Spectrogram settings > View range 0 10000, Window
length 0.005, Dynamic range 50
```
and
```
Spectrum > Advanced spectrogram settings > Pre-emphasis 0
```

Mark a stable portion of the fricative and extract this as new sound to praat's object list with
```
File > Extract sound selection (time from 0)
```
Rename the new object in Praat's object list, e.g afa ==> f, atha ==> th etc.
Close each edit window after you have extracted the fricative segment.

In addition to the original sounds you should now have the following 6 sounds in this order in the object list: f, th, s, sh, c, x.
Select these six sounds in the object list and choose
```
Combine sounds > Concatenate
```
A new sound named 'chain' will be added to the object list.
Open this sound in an edit window.
Listen to it.
Observing the spectrogram of this combined sound should give a good idea of how the fricative noise changes as the place of articulation moves from front to back.

One basic idea in fricative acoustics is that the frication noise moves towards lower frequencies as the place of articulation moves further back (because the length of the cavity in front of the main constriction becomes longer).
Do you observe any exceptions to this idea?

2. Quantitative measures of fricative spectra

Many measures of the acoustic properties of fricatives have been suggested, though none have become as well established as formants are for vowels.
Here we will use two typical measures that allow us to compare fricatives numerically.
We will use a short script, as this makes it easier to print out the values in a convenient form.

In the 'Praat' dropdown menu in the 'Praat objects' window choose 'Open Praat script', and then select file fricana_praatscript.txt.
Insert the label of the sound you want to analyze (e.g 'f') between the quotes in the first line, and press run.

You should see a printout like the following in praat's info window:
```
From left to right: intensity (dB), centre of gravity (Hz), dispersion(Hz)
f     58    5071  2366
```

This means that this sound has an intensity of 58dB, a centre of gravity of 5071Hz and a dispersion of 2366Hz.

The **centre of gravity** corresponds to the frequency that divides the spectrum into two halves such that the amount of energy in the top half (higher frequencies) is equal to that in the bottom half (lower frequencies). A sound with a lot of high-frequency energy will have a large value for centre of gravity.

  dispersion provides a measure of whether the energy is concentrated mainly in a small band around the centre of gravity or spread out over a wide range of frequencies (praat refers to this measure as 'standard deviation').

More background to these and other measures is given in the exercise on fricatives for the seminar "Akustik für Fortgeschrittene".

Edit and re-run the script to get the measures for all 6 fricatives.
Plot the values in the two charts 1) dispersion vs. centre of gravity 2) intensity vs. centre of gravity.

As you run the script you will notice that new spectrum objects appear in praat's object list (e.g Spectrum f, and Spectrum f_smooth).
Praat needs these spectrum objects in order to be able to calculate the centre of gravity and dispersion. In addition, we will use the 'smooth' versions to plot the spectra in the next part of the exercise.

3. Plotting the spectra

A convenient way of comparing fricative spectra is to plot them in different colours in praat's picture window.

First of all, in praat's picture window choose
```
Pen > Line width 2
```

For example, to compare s and sh:
In the object list choose Spectrum s_smooth, then
```
Draw > Draw > Minimum power -10, Maximum power 40 > OK
```
Then in the picture window change the color for the next plot with, for example
```
Pen > Red
```
Chose Spectrum sh_smooth in the object list, and repeat the draw commands.
Note: you may have to experiment with other settings for minimum power and maximum

power, but it is important to keep the same settings for all sounds plotted.

Then experiment with other combinations of fricatives. To get rid of the current plot choose `Edit > Erase all` in the picture window

4. Final questions

Which measures seem to be most useful for distinguishing between the fricatives?
Is the intensity measure useful?
What is a possible problem with using intensity in practice?
Are there any differences between the fricative spectra that are not well captured by centre of gravity and dispersion?

One point for further investigation (if time):
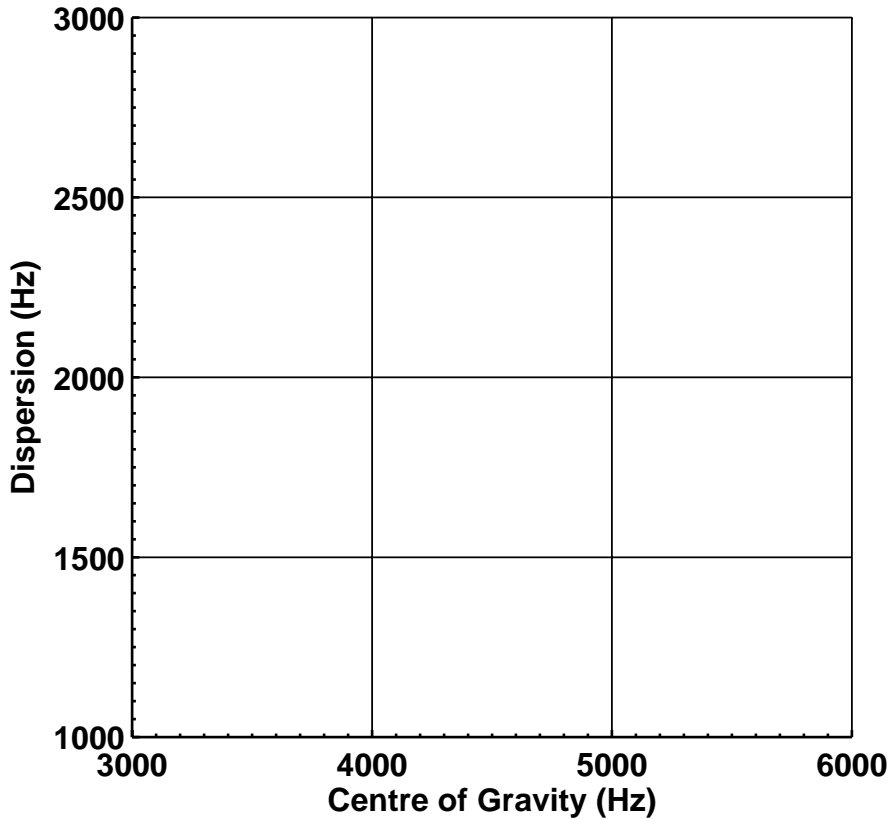The differences between labioidental and dental (f and th) probably do not look very large.
One aspect we have neglected here is the formant transitions from vowel to fricative.
Go back to the original sounds (e.g afa and atha) and compare the formant movements from vowel to fricative (and from fricative to vowel).

```
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```
For reference: The praat script

```
mysound$="f"
select Sound 'mysound$'
To Spectrum... yes
Cepstral smoothing... 200
Rename... 'mysound$'_smooth
select Spectrum 'mysound$'
cog = Get centre of gravity... 2
std = Get standard deviation... 2
select Sound 'mysound$'
intensity = Get intensity (dB)
cog=round(cog)
std=round(std)
intensity=round(intensity)
printline From left to right: intensity (dB), centre of gravity (Hz),
dispersion(Hz)
printline 'mysound$''tab$''intensity''tab$''cog''tab$''std'
```

Fricative analysis (1) — Centre of Gravity (Hz) vs Dispersion (Hz)

Fricative analysis (2) — Centre of Gravity (Hz) vs Intensity (dB)