LING 151 Lab: Tone

November 5th, 2008

1 Working with Pitch in Praat

- All of the sound files that you will need today can be found at `http://people.ucsc.edu/~kaplanas/labs`.
- Usually, when analyzing speech sounds, we look at spectral properties such as formants more than we look at the fundamental frequency (F_0). One major exception, of course, is the study of phonemic tone contrasts – today's topic.
- Working with F_0 in Praat can be tricky. To illustrate some of the problems that can arise, download the file `f0_and_formants` that we looked at on October 22nd.
- Turn off everything on the spectrogram except the pitch track. Go to `Pitch` → `Pitch settings...` and set the pitch range from 100 Hz to 300 Hz. The pitch range tells Praat what values of F_0 to look for when analyzing the sound file and creating a pitch track. What do the pitch tracks suggest about the relative pitch of the four vowels in this recording? Is this right?
- Change the pitch range to 100 – 500 Hz. Now what do the pitch tracks suggest? Does this seem right?
- Change the pitch range to 200 – 500 Hz. What happens to the pitch tracks of the first and third vowels? Why do you think this is happening?
- Experiment with other pitch ranges to see how they affect the pitch tracks. As you look at different recordings today, you will need to reset the pitch range frequently in order to get accurate results. Telltale signs that the pitch range needs to be reset include
  - large jumps in the pitch track that don't correspond to changes in pitch in the recording, especially at the top or bottom of the pitch range,
  - a section of the sound that is clearly periodic but for which Praat doesn't find any pitch, and

Figure 1: Tone contours in two-syllable words in Ibibio

Contour	Recording
HH	
H$\widehat{\text{HL}}$	
HL	
LH	
L$\widehat{\text{HL}}$	
LL	

  - more generally, any place where what you hear in the recording differs wildly from what the pitch track suggests.

- Remember, Praat is not infallible. Although it seems to do well for the files we're going to look at today, this may not always be the case!

2 Tone in Ibibio

- There are six recordings of bisyllabic words from Ibibio on the website. Download them and listen to them.
- These words are (near-)minimal pairs representing six different tone contours. The six contours are listed in figure 1.

  $\Rightarrow$ H represents a high tone, L a low tone, and $\widehat{\text{HL}}$ a falling tone.

- The recordings are labelled A – F. Just listening to the recordings (not looking at the pitch tracks), try to figure out which recording has which contour. Fill in your answers in figure 1.
- Now look at the pitch tracks. Do your answers change at all?

3 Tone in Mandarin

3.1 Description of the Four Tones

- Mandarin Chinese has four lexical tones: high level, high-rising, falling-rising, and high-falling.
- One traditional way of analyzing tones involves assigning numbers to five evenly spaced reference points in the F_0 range and identifying each tone with a point or series of points.

Figure 2: Mandarin tones, with tone letters (1 (lowest) – 5 (highest))

Tone	Description	Tone Letters
1	high level	55
2	high-rising	35
3	falling-rising	214
4	high-falling	41

Figure 3: Example of how to calculate five evenly spaced reference points in an F_0 range

Reference Point	Frequency (Hz)
5 (maximum)	300
4	250
3	200
2	150
1 (minimum)	100

- Figure 2 shows the traditional results of this technique applied to the Mandarin tones.
- Today's materials include recordings of the four tones (`mandarin_tone1.wav`, etc.). Save these four recordings and look at their pitch tracks.
- Investigate whether the tones in these recordings conform to the analysis in figure 2. There are at least two ways to divide the pitch space, linear and exponential; today, you will use the linear method.

    1. Find the highest and lowest frequencies reached by the speaker across all four recordings. Use this range to define the F_0 space.
    2. Identify five evenly spaced points in this space, with 1 as the lowest frequency you found and 5 as the highest frequency. To find point 3, for example, you would find the midpoint between the highest and lowest frequencies; to find point 2, you would find the midpoint between points 1 and 3. Fill in the results in figure 4. Figure 3 gives an example of how the five reference points would be calculated if the speaker's range were 100 Hz – 300 Hz.
    3. Next, measure the relevent points in the four recorded tones to see whether they correspond to the reference points you found in the way predicted by figure 2. For example, is the frequency of the beginning of tone 1 close to reference point 5? Is the end of tone 3 close to reference point 4? Record your findings in the third column in figure 4.

Figure 4: Analysis of one speaker's production of Mandarin tones in a five-point tone-letter analysis

Reference Point	Frequency (Hz)	Realizations in Recordings	Mean Realization
5 (maximum)			
4			
3			
2			
1 (minimum)			

4. Some reference points are traditionally assigned to more than one tone; for example, both tone 3 and tone 4 reach level 1 at some point. For these reference points, find the means of the 'actual' frequency realizations you found in the recordings. Record these means in the last column in figure 4.

- How closely do the tones in these recordings match their traditional descriptions?

3.2 Downdrift

- The file `downdrift.wav` contains a sentence spoken in Mandarin. Listen to it and look at the pitch track.
- The transcription of the sentence (using the pinyin system) and its translation are as follows:

  (1) Niúròu, zhūròu, jī, yā, wǒ dōu xǐ huān.
  Beef, pork, chicken, duck, I like them all.

  ⇒ For today, all you need to worry about are the tones. Tone 1 is represented with a macron (ā), tone 2 with an accute accent (á), tone 3 with a hačekˇ (ǎ), and tone 4 with a grave accent (à).

- This sentence contains several words with a high tone (tone 1). On the spectrogram (using the pitch track to help you), locate the high tones in the words *zhūròu*, *jī*, and *yā*. Do all of these realizations of tone 1 have the same pitch?
- What seems to be happening to the pitch of the utterance as the sentence goes on?
- Locate the high tone in the word *dōu*. What has happened here?

3.3 Drawing Pitch Contours

- Using Praat, it's possible to output a spectrogram you're working with as a separate file (one, for example, that you can include in a paper). It's also possible to include things like formants and pitch tracks on the spectrogram. Today, we'll see an example of this with the spectrogram from the file `downdrift.wav`.

- Open the edit window for this file. Recall that the first step towards saving any images in Praat involves sending them to the Praat picture window. To do this with the spectrogram, go to `Spectrum` → `Paint visible spectrogram...`.

- No matter what is showing on your spectrogram at the moment (formants, pitch track, etc.), only the bare spectrogram itself will appear in the picture window. To include other elements in your picture, you need to add them separately.

- To add the pitch track to your spectrogram, go to `Pitch` → `Draw visible pitch contour...`.

- As we saw with the vowel charts last week, you can save this file by going to `File` → `Write to EPS file...`. You can also print directly from the Praat picture window by going to `File` → `Print...`.