

( 20 points )

# (L) The Whole Spectrum (1/4)

## Background

The sounds of human speech (and indeed all sounds) travel through the air in waves, some of which your ear detects as sounds. These waves can be analyzed (by a mathematical technique called "Fourier analysis") into combinations of basic ("sinusoidal") waves whose most important properties are "frequency" and "amplitude." One sound may comprise many such basic waves, and a basic wave of the same frequency or amplitude may appear in many sounds. Linguists sometimes display this analysis on a diagram called a spectrogram: the resulting sine waves' frequencies are plotted vertically (with greater amplitude indicated by darker points) and the time horizontally.

## Data

A sequence of spectrograms produced using the computer software "Praat" is shown in the following pages. The first 12 are each labeled with an English word, which is shown in the spectrogram. The following words are given:

**sash, lamb, knee, sheesh, soup, pang, loose, (the letter) e, mice, ice, coo, shine**

The last four spectrograms each show one of the following eight words:

**louse, lass, lease, lice, pass, ash, sheep, lack**

## Problems

**L1.** What words are shown in the last four spectrograms? You may give up to two answers on each; if you give two, you will be given half credit if either of them is correct.

(13) \_\_\_\_\_ (14) \_\_\_\_\_ (15) \_\_\_\_\_ (16) \_\_\_\_\_

**L2.** For each of the three most significant sounds in "sash," mark an interval corresponding to the duration of that sound. You should mark each interval by a horizontal line drawn above the spectrogram over all parts of the spectrogram affected by that sound. If you make other markings on the spectrogram, clearly indicate where each of the three requested intervals starts and ends.

**L3.** Do the same for "lamb."



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L4. Explain your reasoning for G1.

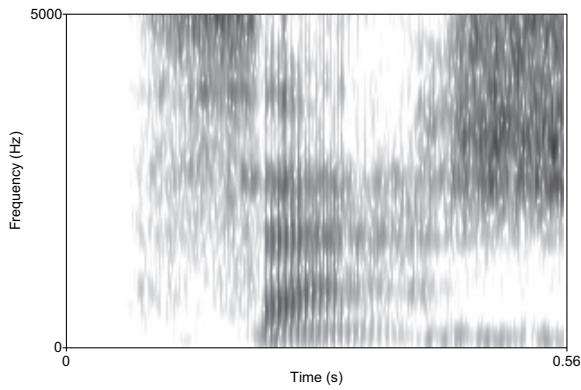
L5. Discuss the correspondence between the English spellings of the given 12 words and their spectrograms. In particular, some letters' sounds affect longer intervals in the spectrograms than others do. Which letters and sounds affect the longest intervals? Do adjacent sounds' affected intervals overlap, and if so, how? Are there any letters that correspond to no interval at all, and which letters? Conversely, are there any distinct sounds on the spectrograms that correspond to no English letters, and where are those sounds?



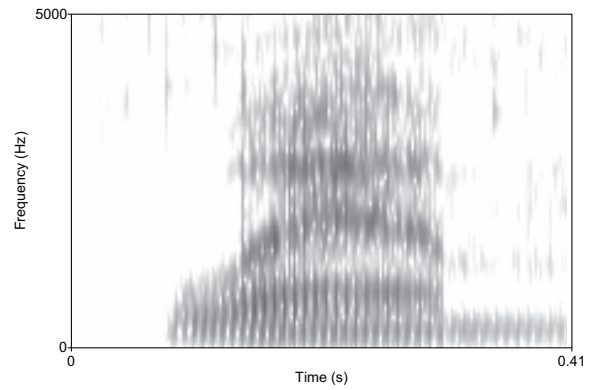
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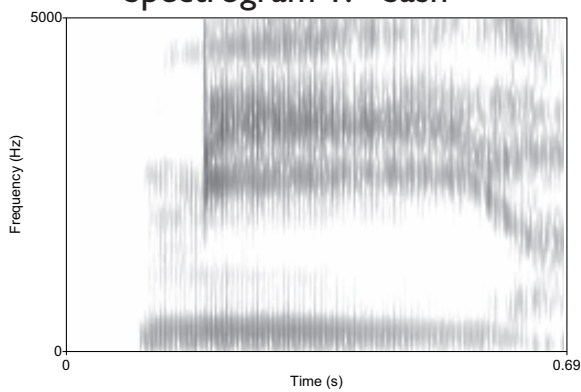
# (L) The Whole Spectrum (3/4)



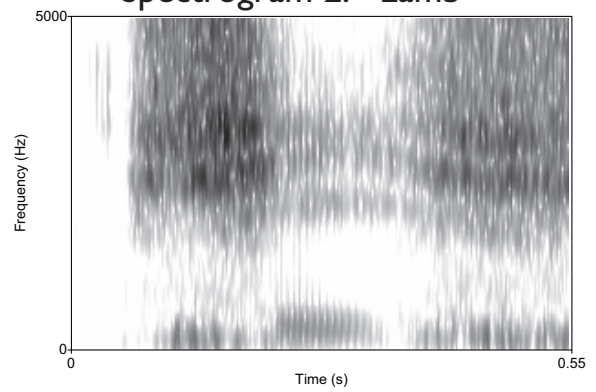
Spectrogram 1: "Sash"



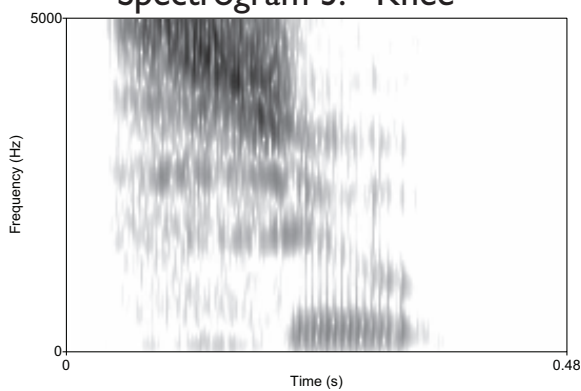
Spectrogram 2: "Lamb"



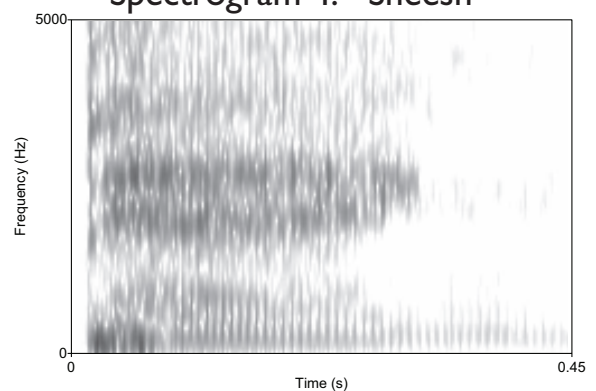
Spectrogram 3: "Knee"



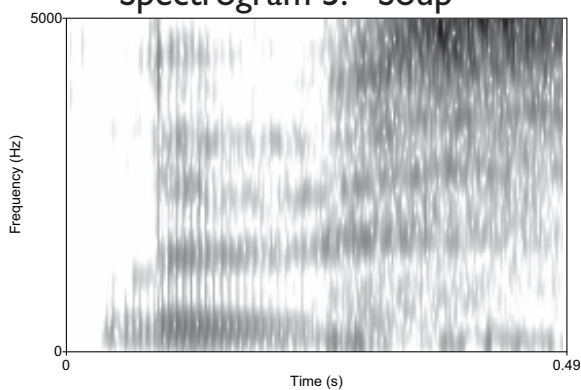
Spectrogram 4: "Sheesh"



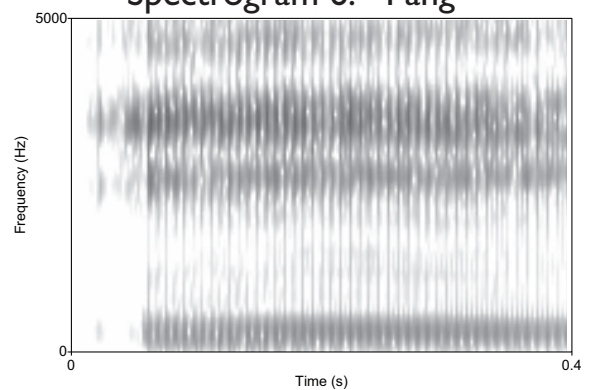
Spectrogram 5: "Soup"



Spectrogram 6: "Pang"



Spectrogram 7: "Loose"



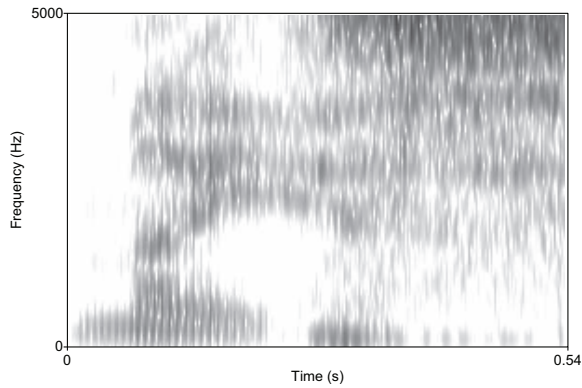
Spectrogram 8: (the letter) 'e'



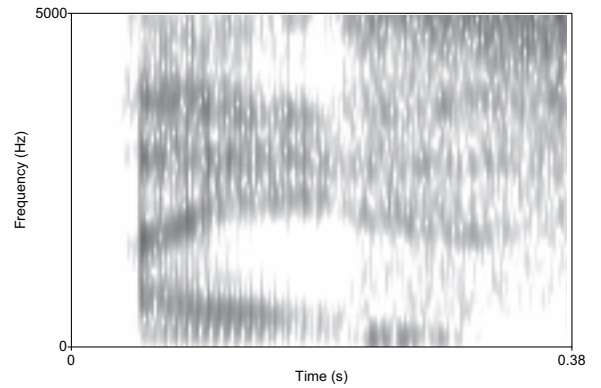
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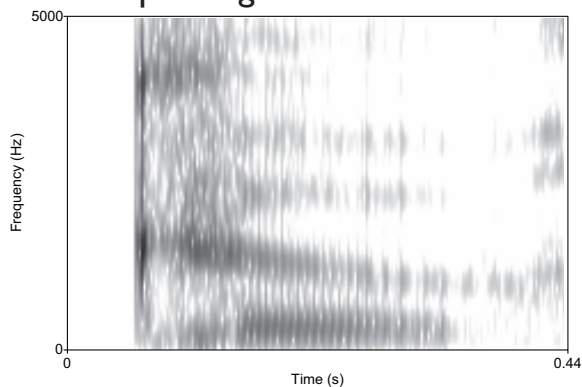
# (L) The Whole Spectrum (4/4)



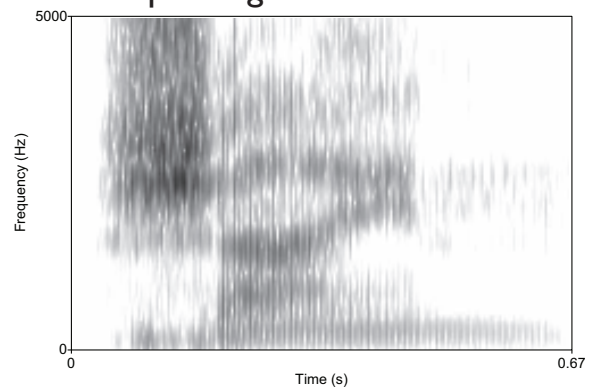
Spectrogram 9: "Mice"



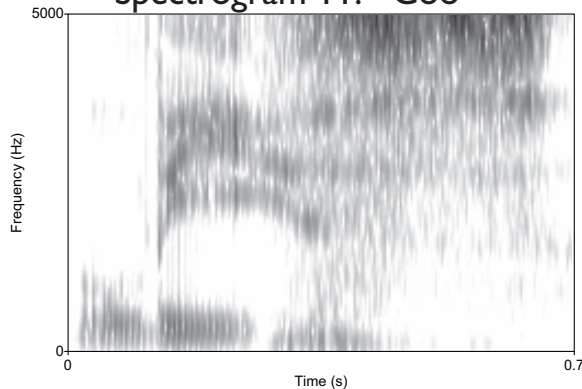
Spectrogram 10: "Ice"



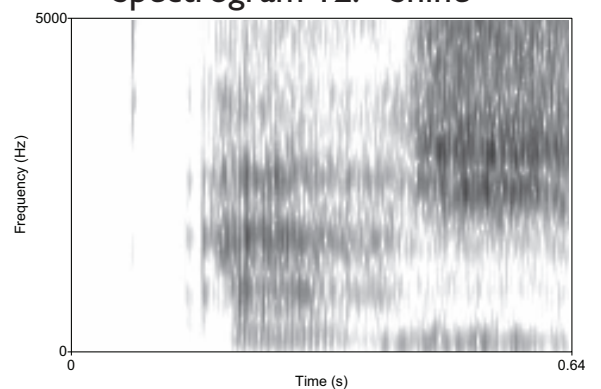
Spectrogram 11: "Coo"



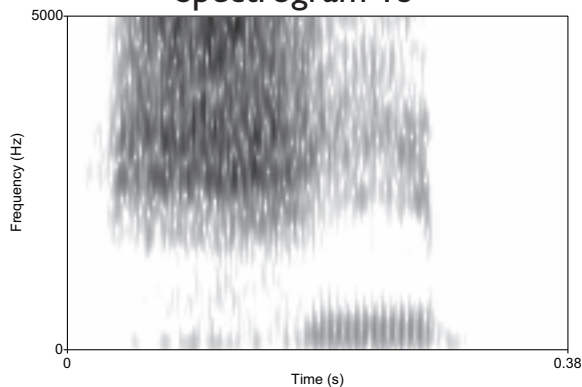
Spectrogram 12: "Shine"



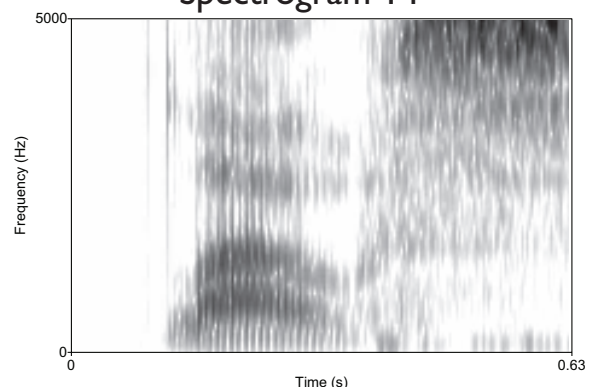
Spectrogram 13



Spectrogram 14



Spectrogram 15



Spectrogram 16

