Problem 9.1

Estimate a consonant confusion matrix for the visible (lip-reading) channel. Each of you should take turns being the caller; while one person is being the caller, all others should be the listeners. The caller's job is to read silently (with no voice, whisper, or air released) a list of randomly ordered nonsense phrases. The phrases should be read as nearly as possible in a normal reading style (not hyperarticulated). The listener's job is to try to determine which phrase was read. After each utterance, the listener should write down the utterance that she or he believes to have been produced.

Before you begin, each caller should randomly determine the sequence of phrases that he or she will produce. Making sure that none of the listeners are watching, throw a pair of dice, and look up the resulting phrase in table 1. Write down the phrase, and label it "phrase number 1." Repeat; label the second phrase "phrase number 2." Continue until each phrase in the table has appeared at least once. If some of the phrases appear more than once, that's OK. Number your phrases in the order generated by the dice.

Once each of you has generated a list of phrases, take turns being callers. Each caller should read through his or her phrases in order, making no sound while doing so. Before you read each phrase, signal its number with your fingers: number 1, number 2, etc. Listeners should write down each phrase number, and their best guess as to the phrase identity. If you have no idea what the caller said, then guess. Leave no blanks.

Once a caller is done, all listeners should give him or her a list of the words that they thought they saw for each phrase uttered. The talker should then score the phrases, and create an $18 \times 18$ confusion matrix.

Once all talkers are done scoring the response sheets, average your confusion matrices to create a group-average confusion matrix.

Problem 9.2

This problem can be done at home.

Use the group average confusion matrix to calculate the conditional entropy (the "equivocation") of the visual channel. Calculate also the entropy of the source, and the mutual information between called and perceived word strings.

Assume that the auditory channel would have zero errors (every phrase would be correctly perceived—this is not quite true, but almost). What would be the conditional entropy of the auditory channel? What would be the mutual information between called and perceived word strings?
Die 1 = 1 or 2
Die 2 Phrase
1 a bug
2 a pug
3 a dug
4 a tug
5 a kug
6 a gug

Die 1 = 3 or 4
Die 2 Phrase
1 a chug
2 a jug
3 a fug
4 a vug
5 a thug
6 a the-g

Die 1 = 5 or 6
Die 2 Phrase
1 a sug
2 a zug
3 a slug
4 a zhug
5 a mug
6 a mug

Table 1: Confusable consonant phrases. Choose the order of phrases randomly by throwing two six-sided dice, and selecting as shown in the table. For example, if the first die shows 4 and the second shows 2, write down “a jug.”