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HS361/NE360
Lab 9: Due 11-21-13

Abstract:

The purpose of this lab is to work with and learn the TRACE model of speech perception. A simple simulation is run, and TRACE's ability to detect components of human speech is tested. The test will then be used to consider how the model is designed, and what its strengths and weaknesses are. The response probabilities will be evaluated, along with inhibitory interactions within layers and parameters in the Luce Choice Rule.

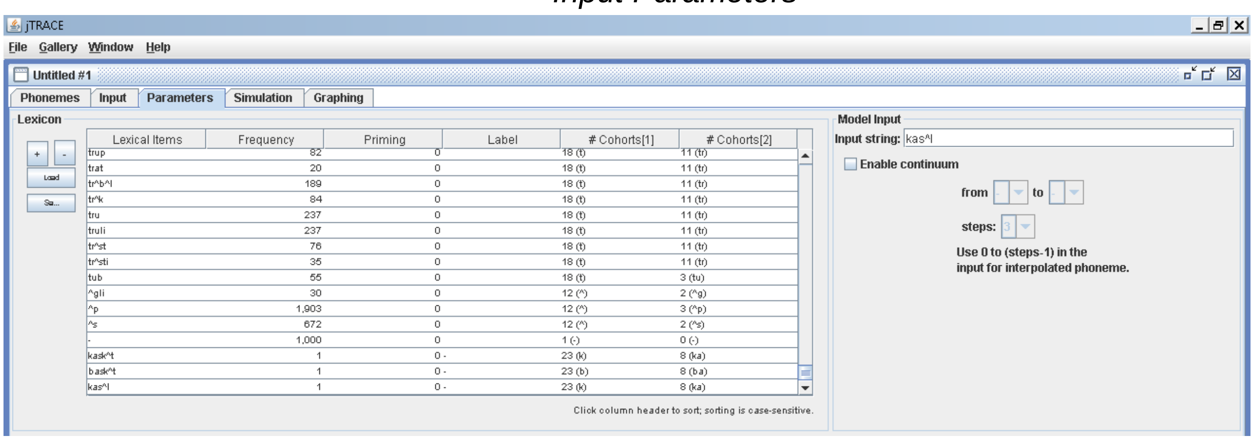
Results:

In part one of the lab we learned about the research that the results of which are the basis of jTRACE. In a study, participants were shown for images (a beetle, a beaker, a speaker, and a carriage). The researcher then said the name of one of the images, and measured which image the subject attended to. The result was that if the spoken word was a cohort of one of the others, the subject attended to both until there was evidence enough that specified the target word. Subjects also tended to attend to words that rhymed with the target word, but this effect tapered with time.

In part 1.1 of the lab we set up a jTRACE model with the inputs castle (kas^l), basket (bask^t), and casket (kask^t), all with the frequency of 1.

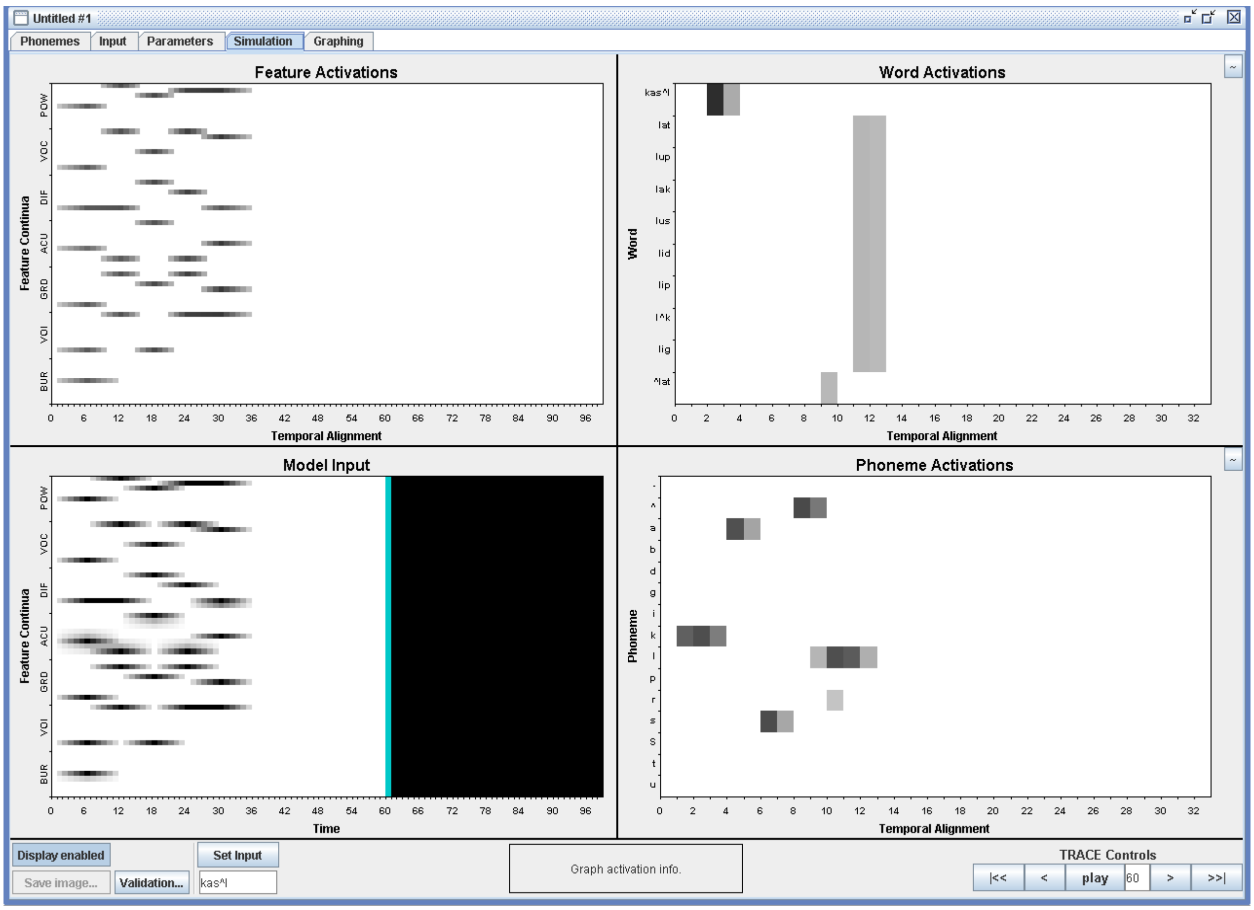
- Word frequency is part of the basic operation of the TRACE model. Word frequency alters the resting activation of a node (word), so increasing the frequency of a word increases the

Input Parameters



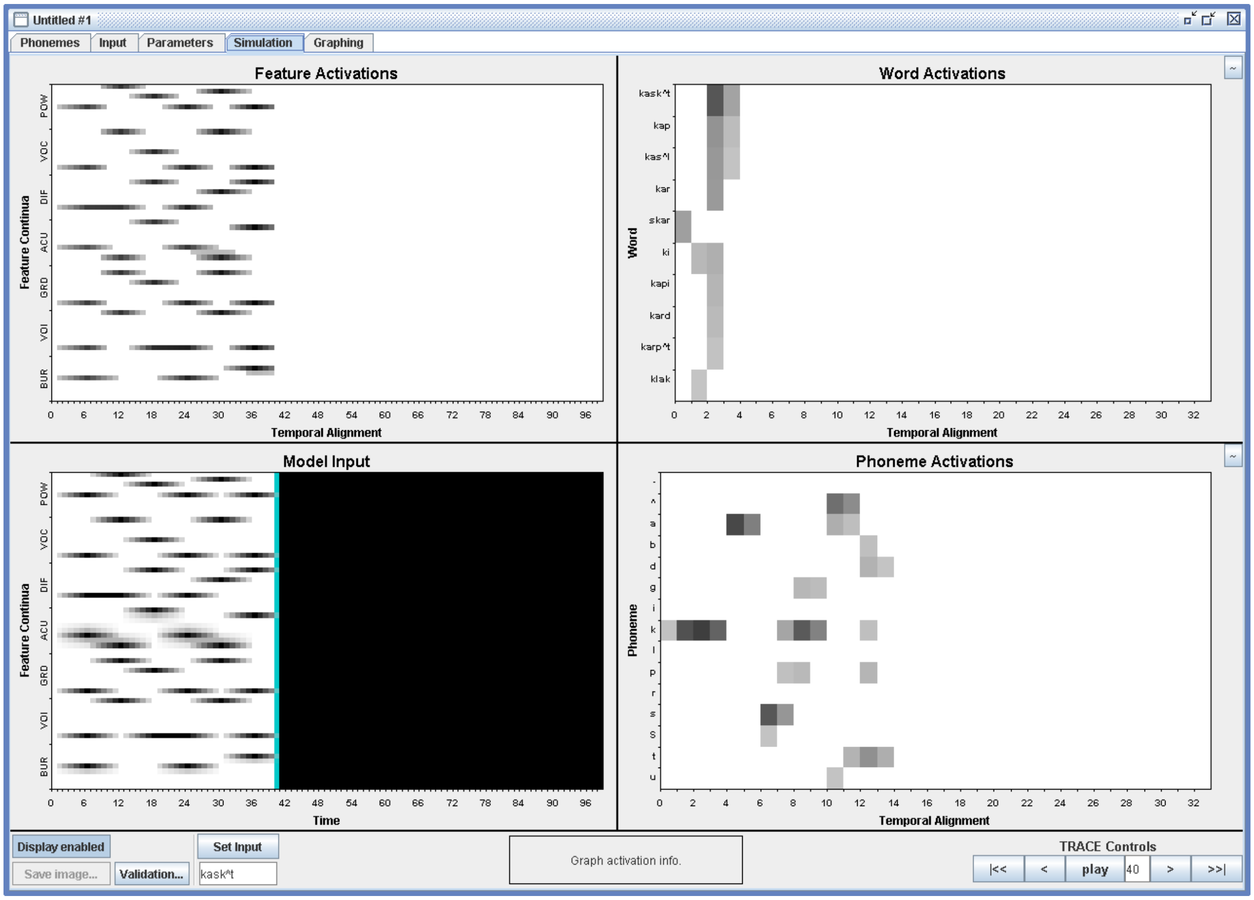
- The bottom left is a plot of the features being created and read into the model. The top left subplot is a plot of the features that the model is detecting. The bottom right subplot shows the phonemes that the model is detecting from the features detected from the input. The top right model shows the words that could be created by the phonemes. The darkness of the bands in the activation plots represent the likelihood of that event being true. In the phoneme activation plot the x-axis shows the time scale, and the y-axis shows possible phonemes that could be active. The phoneme activation will change as the model continues to "hear" the word because the bidirectional flow of excitation/inhibition between levels acts as a feedback loop that helps narrow down possible activity in lower levels.

Simulation of "casket"



- The reason that there are multiple words that could possibly be activated after 40 time steps is that the activation of a word is based on the possible mixtures of activated phonemes, which have not all been read into the model. Since the phoneme activation plot is not complete, it is giving a certain probability to several different possible words. When the time series is continued, to about 60 time steps, the possible activated words lessens, with just the intended one being the only likely candidate. This is because there is more data to rule out possible words.

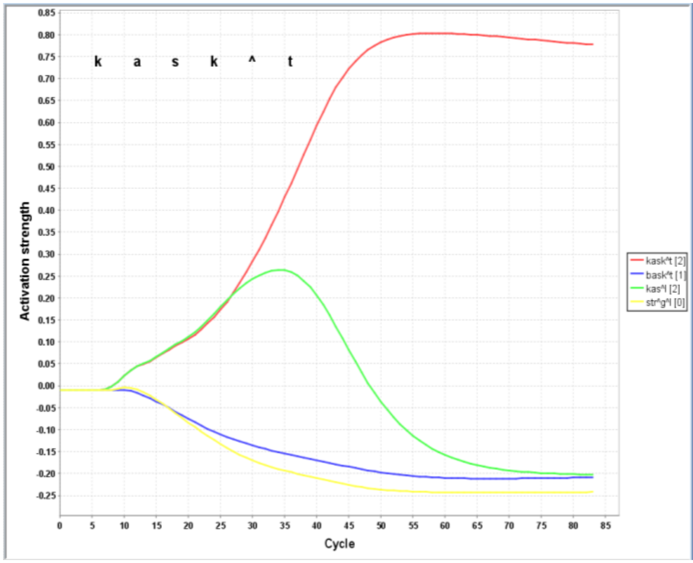
Shortened Simulation of "Casket"



In part 1.2 of the lab we analyze the results of the TRACE model in further detail.

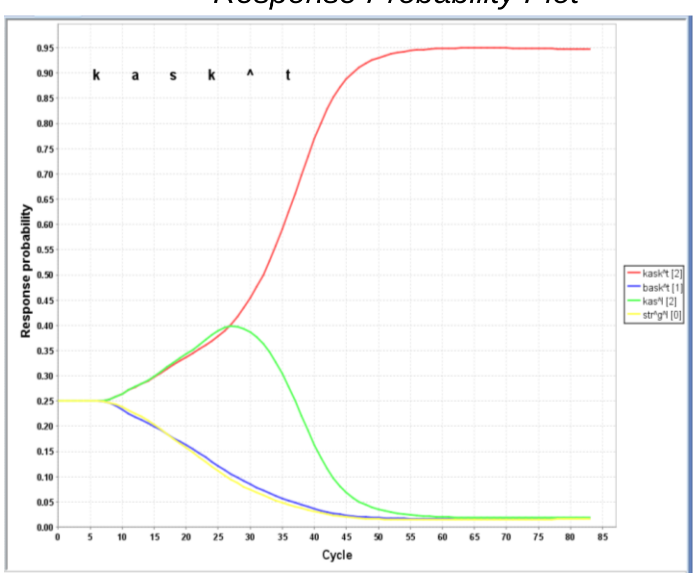
- The curve for "casket" grows quickly, and then levels off after it peaks. The curve for "castle" grows quickly along with "casket", but drops off after its activation strength hits about .25. The curves for "basket" and "struggle" both drop off quickly and level of at an activation strength of -.20 and -.25 respectively. The reason that "casket" and "castle" show the most activation is that for their first few phonemes, they sound the same. This causes similar onsets of activation strength between the two, and also explains the rapid offset of the activation strength for "casket". Since inter level communication is inhibitory, the activation of "casket" inhibits the activation of "castle", as well as "basket".

Acivity Strength Plot



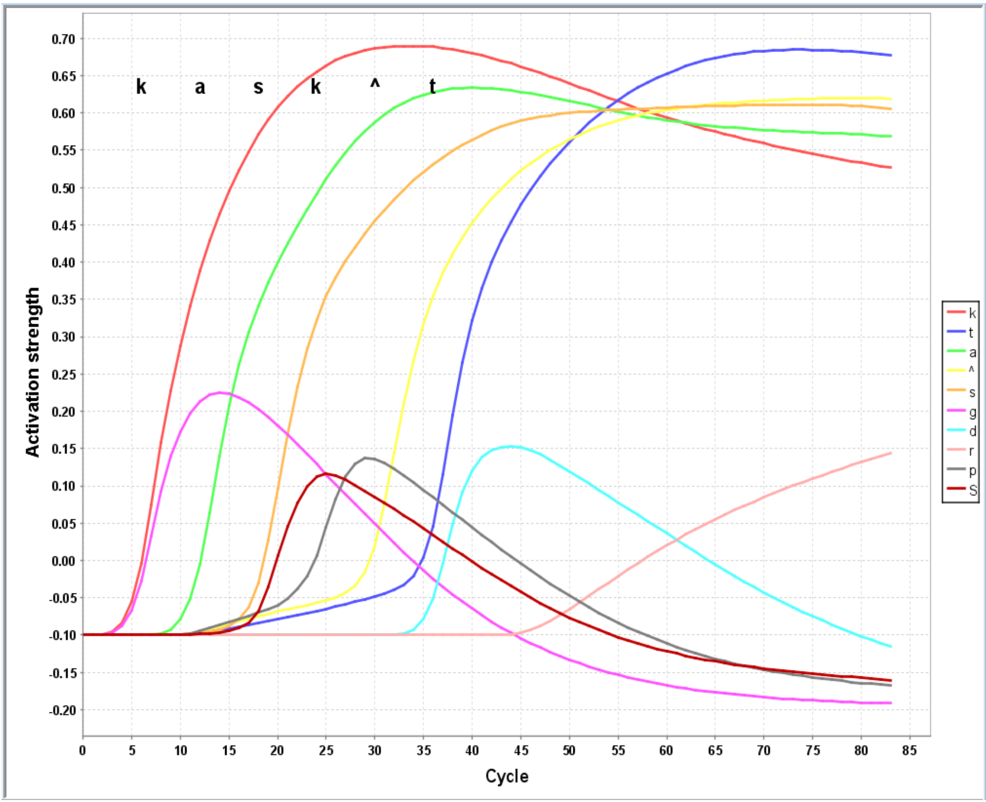
- Whereas the previous plot shows the activation strength of the different words, the new one shows the probability that a given word is the correct target. The property of the plots that change their appearance is that in the previous plot, the lines are not interdependent, whereas in the current plot the value of one line is dependent on the others. The plot still represents the Fixatoin experiment though. Words that have similar starting formants show similar response probabilities at first, until the formants split. The reason that it is necessary to convert from activation strength to response probability is to move from what models a physiological response, to what models a behavioral response.

Response Probability Plot



- As the input ("casket") is read into the model, the phonemes begin to activate as they are reached in the word. The progression goes /k/ /a/ /s/ /^/ /t/. There is not a second /k/ since it is already activated.

Formant Activity Strength

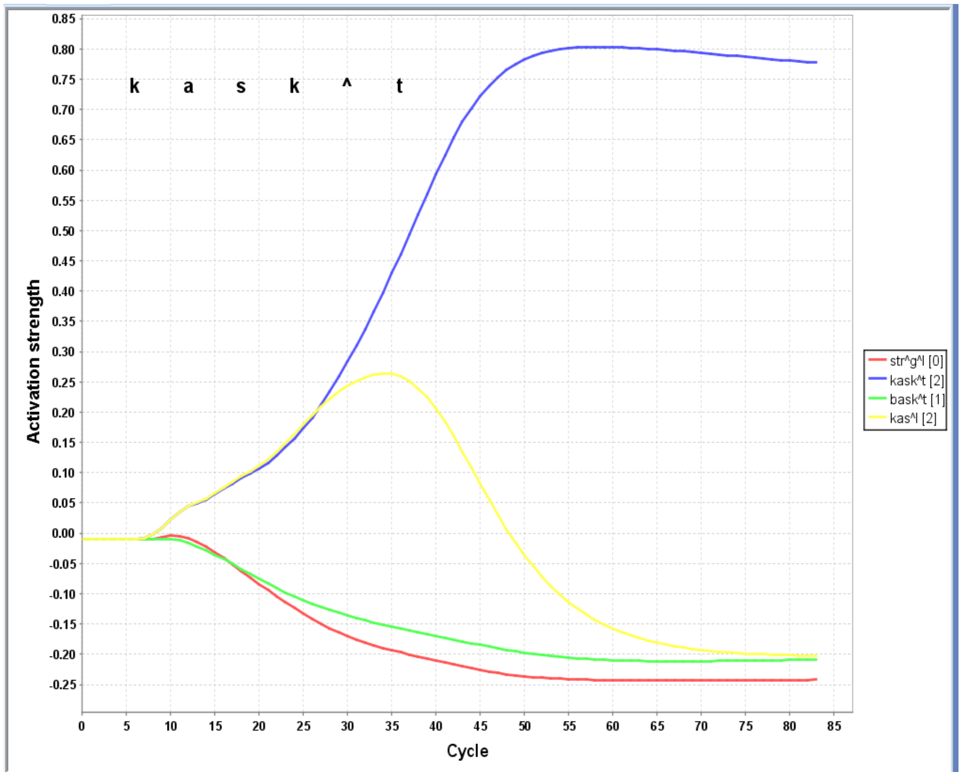


- The /k/ and /g/ phoneme sound similar, which leads to the similar activation strengths early on. What causes the split would be the inhibitory communication within levels, where k and g will inhibit each other.

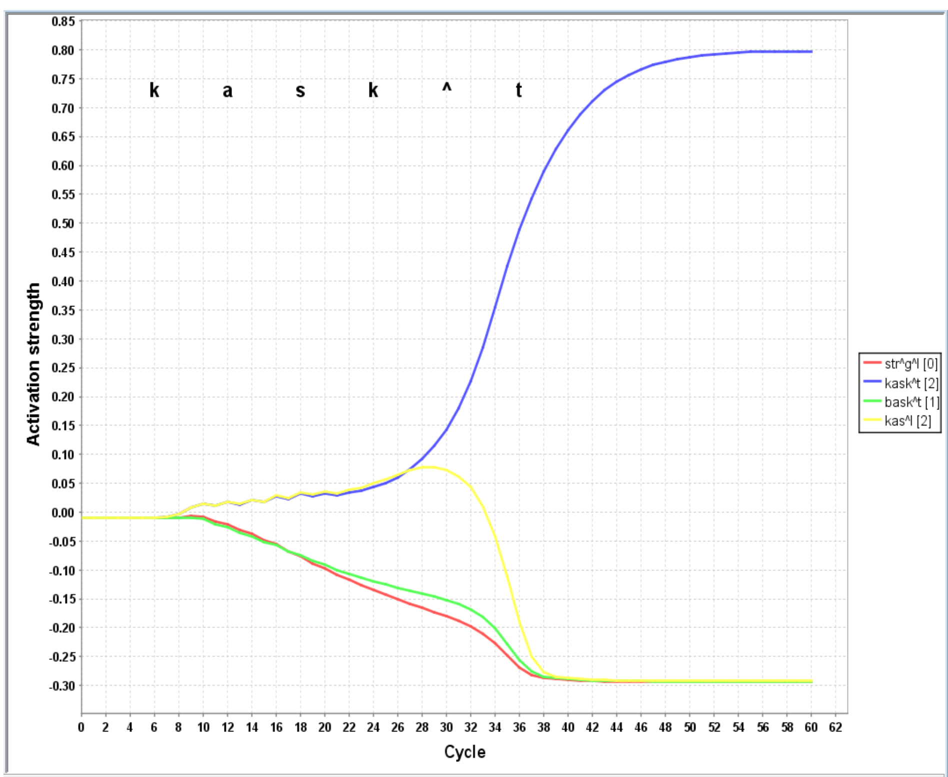
In part 2 of the lab we experimented with the TRACE model by modifying the parameters, and looking at the results in the plots. In part 2.1 we looked at the impact of modifying the strength of the inhibition within the word layer.

- The effects of changing this parameter is that the onset/offset of the words take much longer, and there is a much smaller and less dramatic period in which the cohorts have lines similar to each other. The reason for these effects is when the inhibition is increased, it causes the lines to bunch together in the middle. This is because each line has a stronger pull on the others, drawing them together. This ends when one line gains a significant boost in its activation, which propels it away from the others.

Original Plot



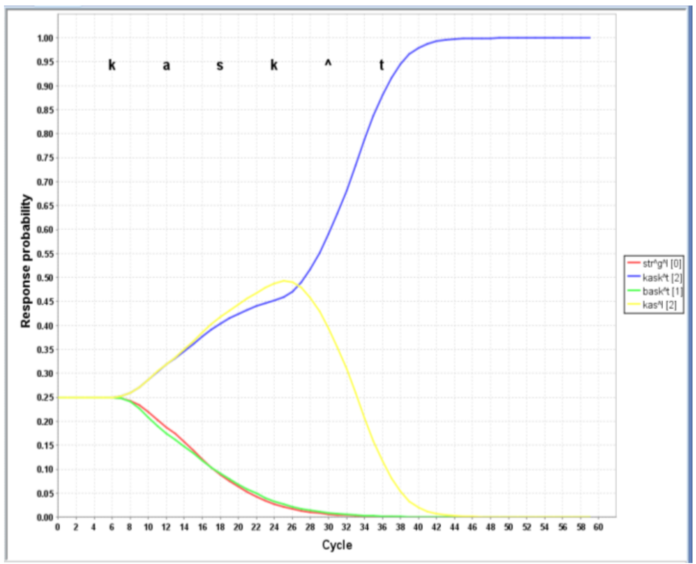
Plot With Altered Parameters



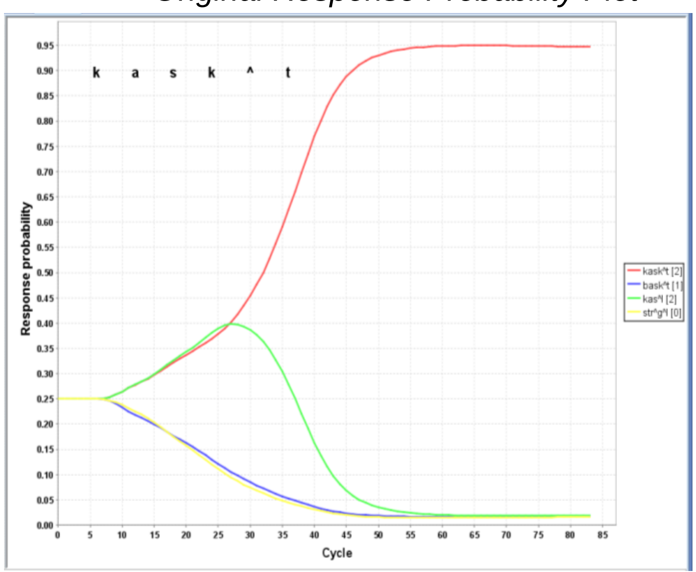
In part 2.2 of the lab we looked at the effects of altering the value of k in in Luce Choice.

- When altering the k value, the effect is that the cohort words share a longer period of common probability, similar to increasing the cross-inhibition in the word layer. The reason for this is that when the k value is increased it increases the denominator in the equation for the Luce Choice rule, which drags out the period of similar probability.

Altered "k" Value Plot



Original Response Probability Plot



Conclusion:

The purpose of the lab was to gain a familiarity with the Trace model of speech perception. In the lab we looked at the framework of the software, by creating probabilistic models of what word is being said, and we looked at the graphs that it could create to represent how words are determined over time. We then further investigated the software by manipulating the parameters to better understand how its algorithms function.