THE RELATION BETWEEN COGNITION AND SPEECH MOTOR CONTROL IN HEALTHY AGING

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Dr. Dirk den Ouden

From a background in formal phonology and syntax, Dirk den Ouden investigates how the brain supports language functions in healthy and aphasic speakers. One goal of his research is to improve treatment outcomes through a neurophysiological approach to stroke-induced deficits (cortical stimulation), in combination with behavioral language training. He maintains an interest in linguistic theory, as well as in neural correlates of lexical representation/access and sentence production.

Research Premise

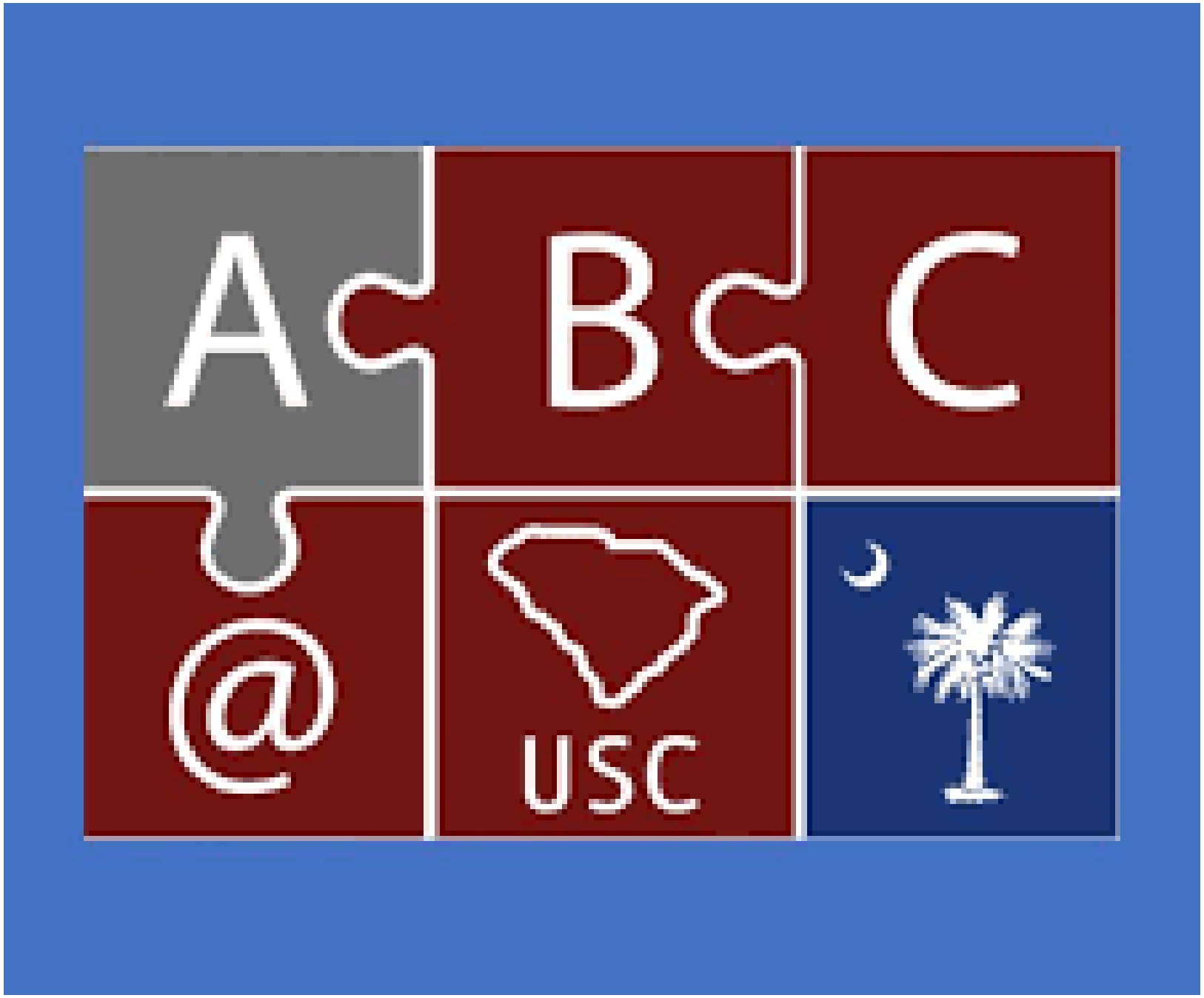
Using both vowel dispersion analysis and results from cognitive tests in areas such as memory, attention, and inhibition, we hope to find a relation between normal age-related cognitive decline and speech motor control, while taking age into account. If a correlation exists, is there a way to use indirect measures of cognition to determine early cognitive loss in healthy adults?

Thesis Statement

I hypothesize a correlation between larger dispersion (variance) between attempted vowel formants of the same target word and lower scores on the cognitive assessments, and that these associations will be modified by age.

Methodology Overview

- Data collection
- Data transcription
- Formant extraction
- Data merging
- Vowel chart creation
- Visual check
- Re-transcription, extraction, and merging
- Statistical analysis



Data collection

Participant data was collected through the recruitment process of the Aging Brain Cohort.

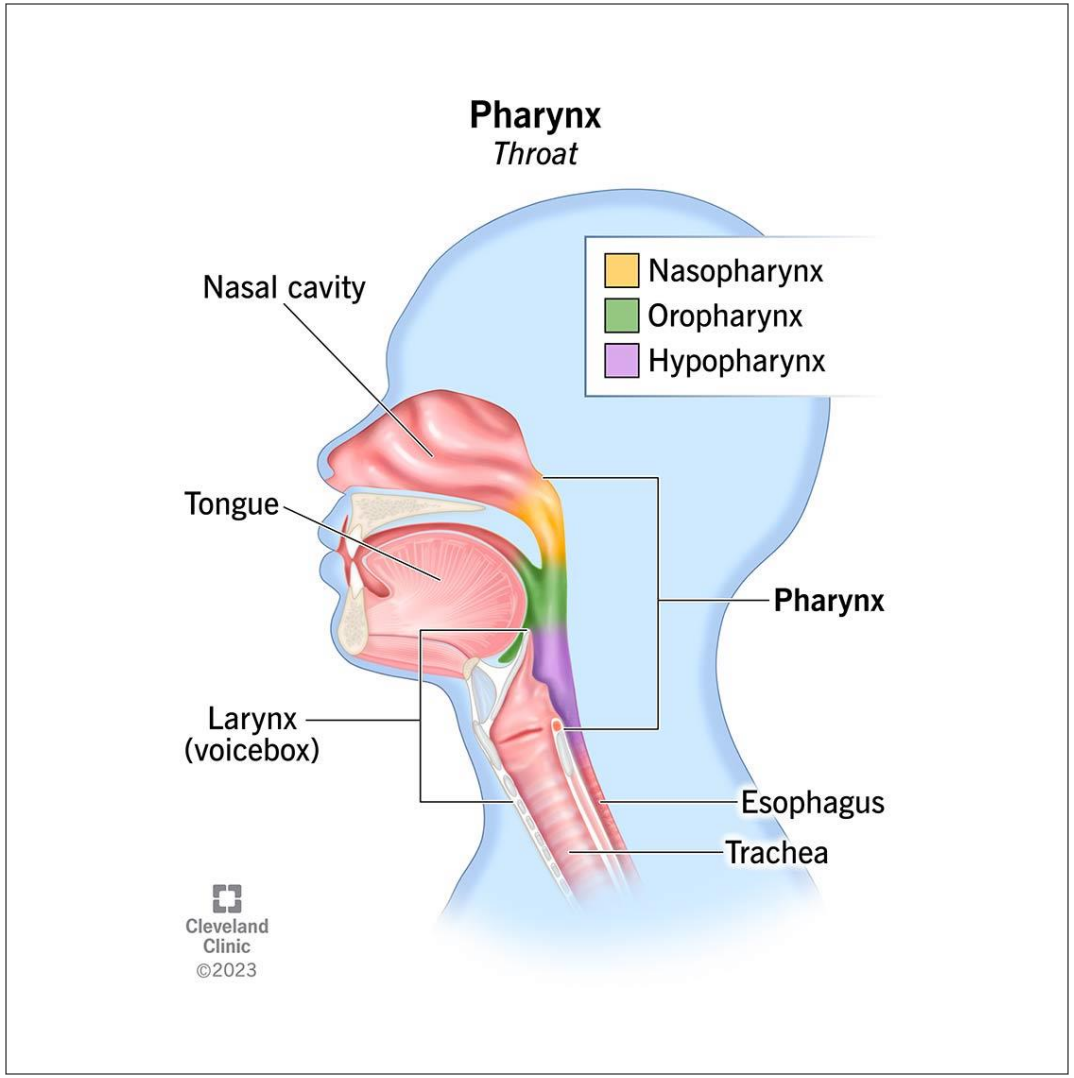
The Aging Brain Cohort is a longitudinal and cross-sectional study of aging.

My project will use a portion (N=172) of the data collected.

Participant data collected

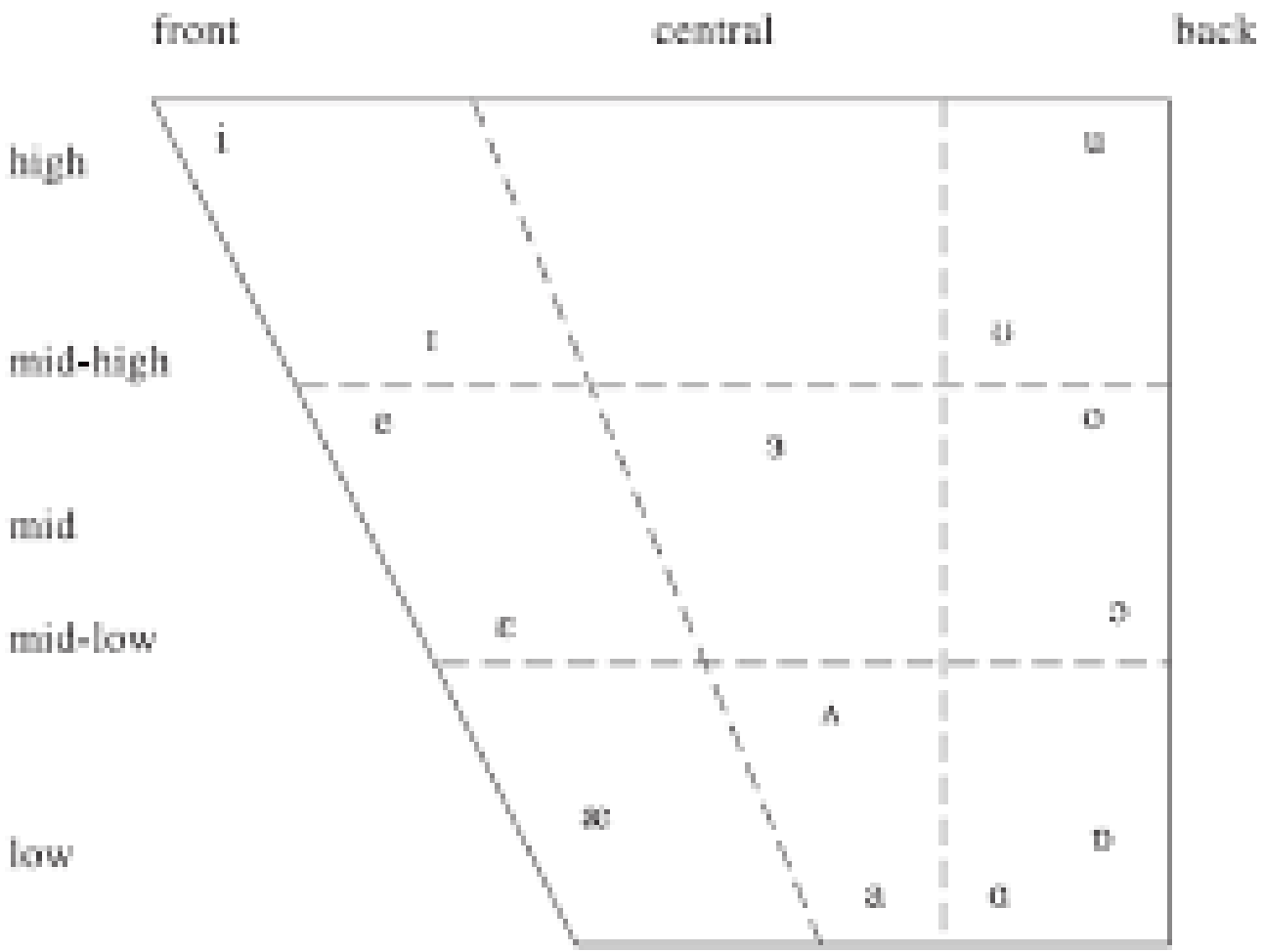
Montreal Cognitive Assessment: validated, highly-sensitive cognitive assessment tool used to assess short term memory, visuospatial abilities, executive functions, attention, concentration, working memory, language, and orientation to time and place.

Gross motor skill assessments: 4-meter walk, grip strength, pegboard test

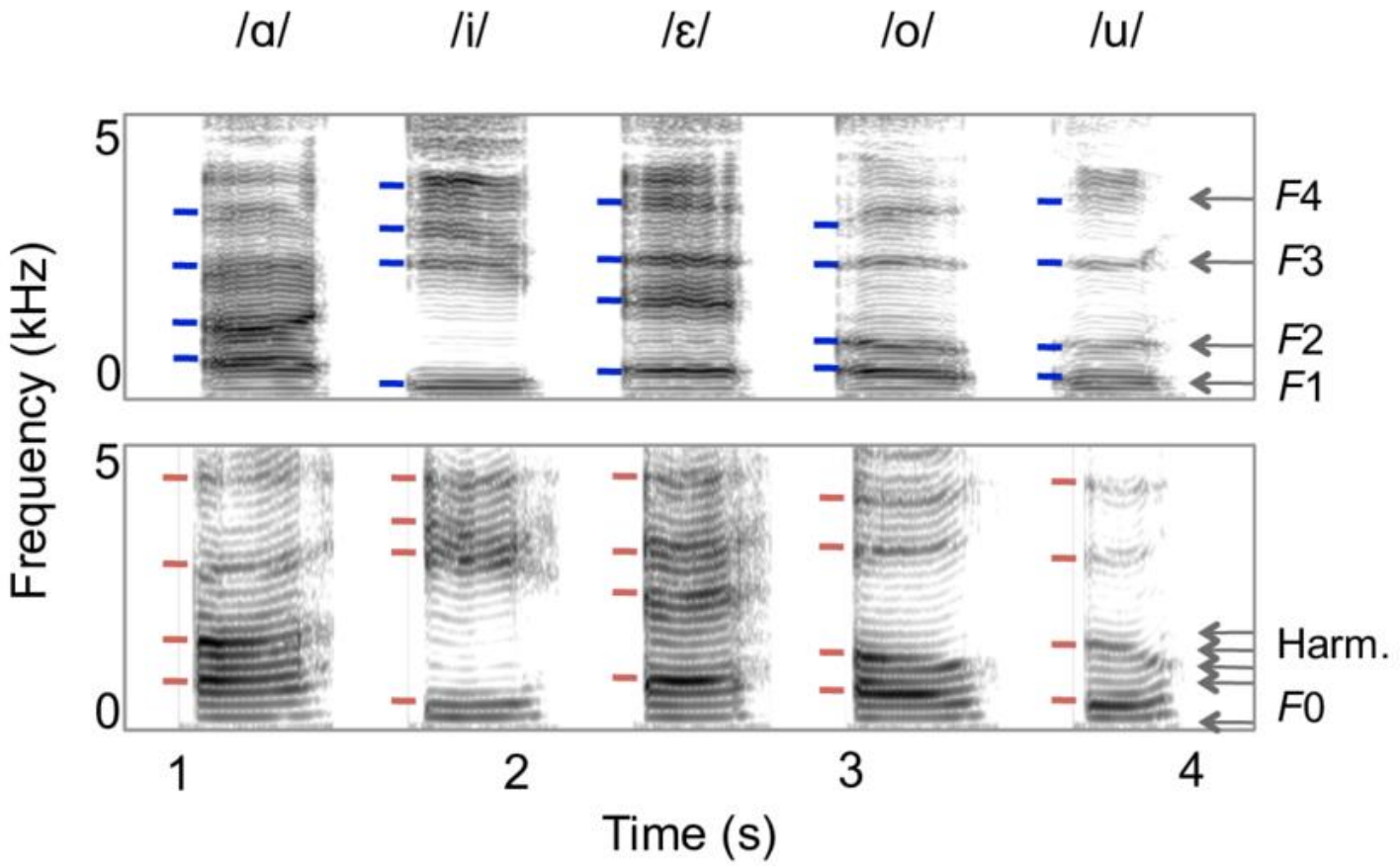


Background information: vowel formants

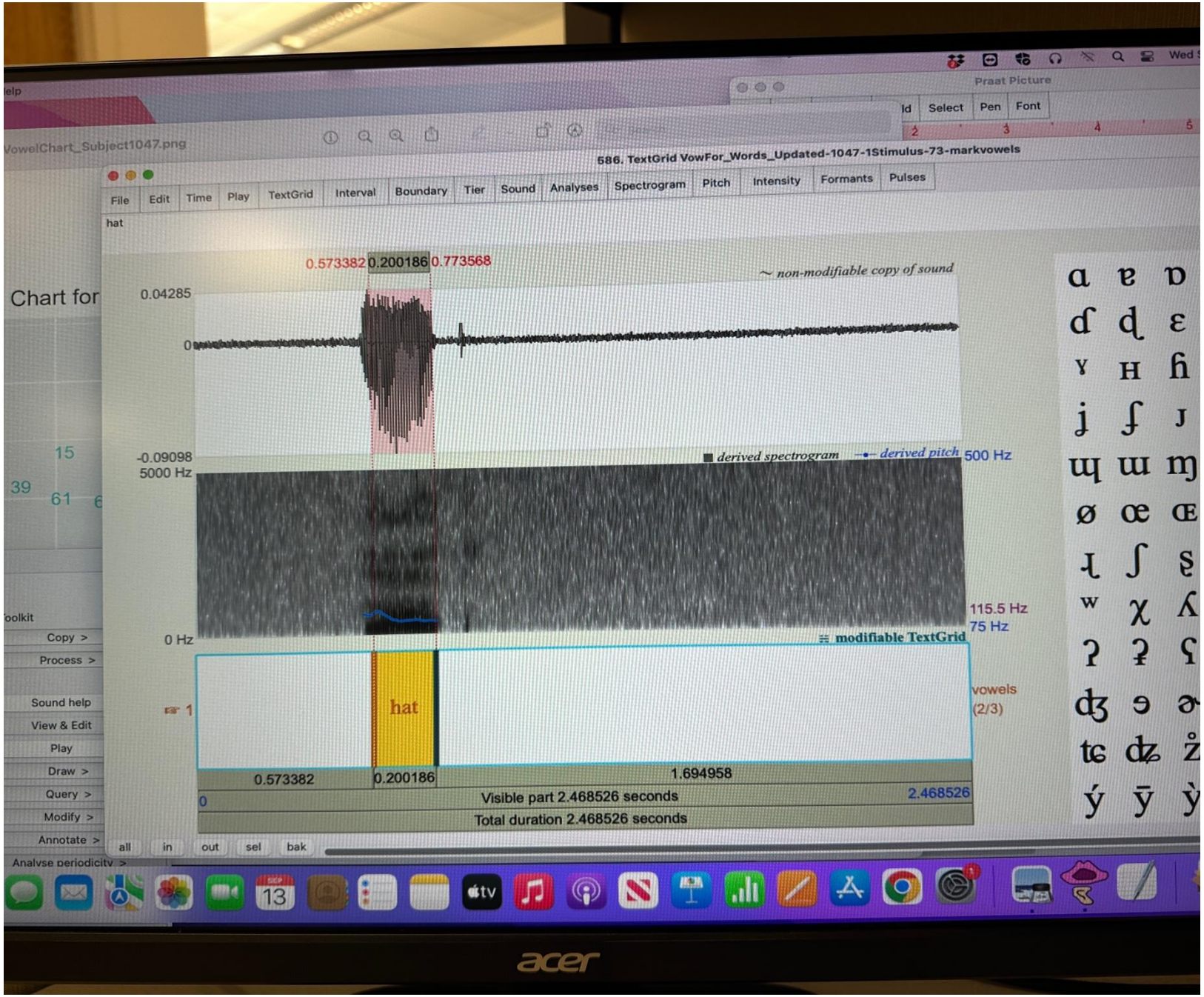
- Vowels in speech are produced by an open configuration of the vocal tract and vibration of the vocal folds. They are manipulated by tongue position in the oral cavity which is part of the articulatory system of speech production.
- Vowels are differentiated by the listener based on vowel formants (frequency peaks in the sound spectrum).
- The formants are a function of the supralaryngeal articulatory space consisting of the pharynx and oral and nasal cavities.
- The absolute values and relative distance from one another allow listeners to use formant values to categorically determine which vowel is being produced.
- F1 is related to the volume of the pharyngeal cavity and the tightness of vocal tract constriction.
- F2 is related to the length of the oral cavity.
- F3 correlates with lip rounding.



VOWEL QUADRILATERAL



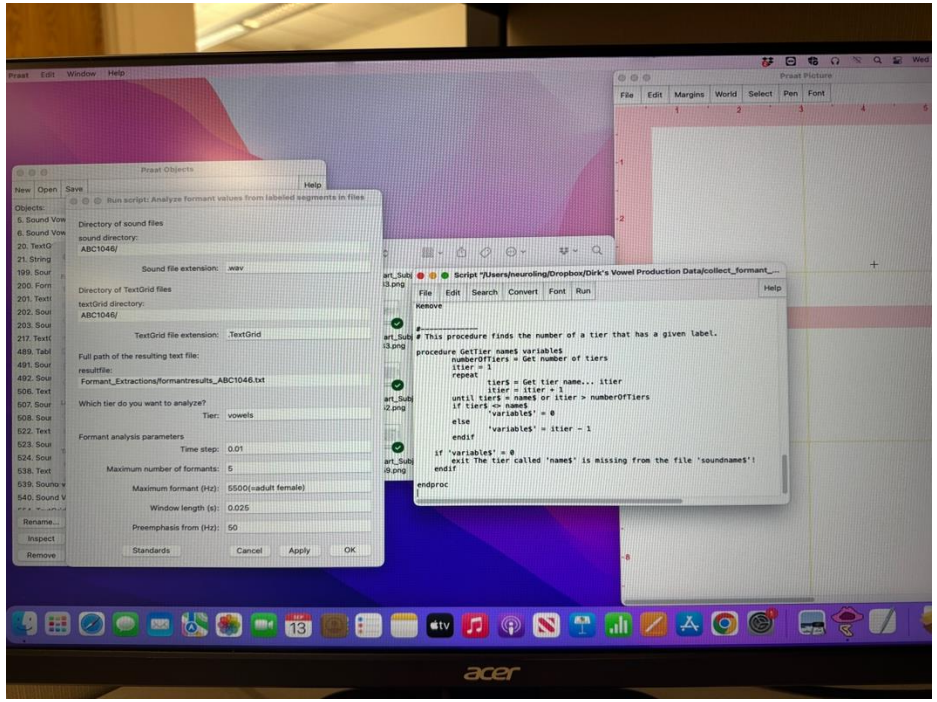
SONOGRAM OF DIFFERENT VOWELS



Data transcription

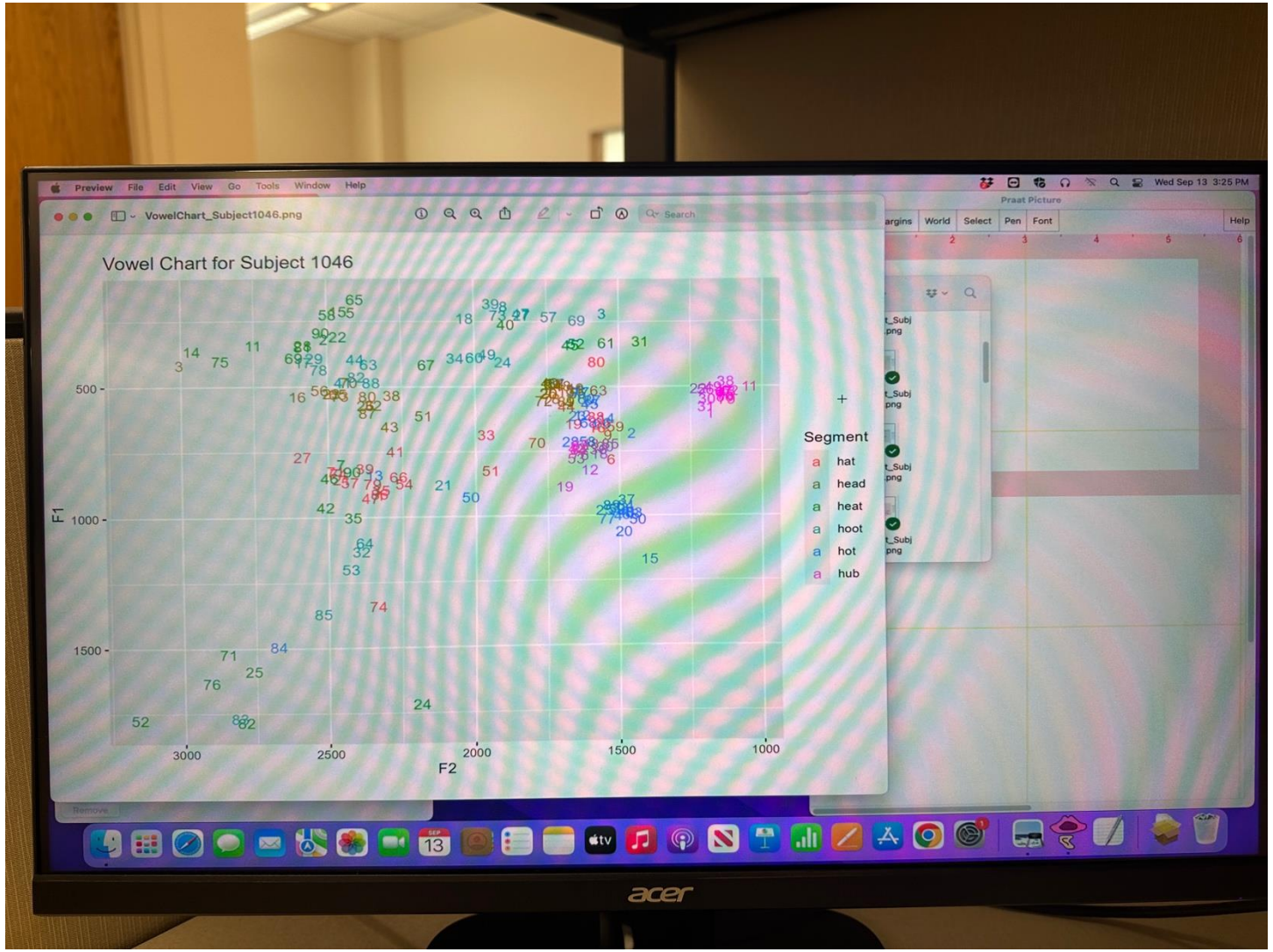
Since February, I have used *Praat* (a phonetic software) to mark the vowel boundaries of each trial.

I have also labeled each trial with the target word spoken.



Formant extraction

- After each trial for a participant is transcribed, a dedicated script in *Praat* is used to extract the formant measurements (in hertz).
- We collected data for F1, F2, and F3.
- The formant extraction process gives us all 90 trials for each participant matched with trial numbers, target words, and the three quantified formants.



Vowel chart creation

Once all the extracted formants and corresponding target words and trial numbers are merged into one Excel sheet, we use a dedicated *R* script to create visual representations for each participant.

Mistakes were made…

Unfortunately, there is room for error when trying to organize and contain data in this fashion.

Some of the many issues we have come across in data manipulation:

- Trials are transcribed with the incorrect target word and must be re-transcribed.
- A trial (or multiple) do not contain a target word.
- A trial (or multiple) did not get transcribed at all.
- Trials are missing or only contain static.
- The participant has a non-native English accent making transcription more difficult.

Next steps…

After all vowel charts have been visually checked, I will use a statistical regression model to find correlation between scores in both areas of cognition and gross motor skills and the vowel formant variance.

If significant correlation exists, there is a way to indirectly measure cognitive ability through the aging process. Cognitive assessments can be time consuming and confounded with deficits caused by natural aging processes, so having a measure such as vowel acoustics to predict cognitive assessment scores would serve as a faster and easier measure of cognition.

Theories about the autonomy of cognitive and motor functions vary, but one goal of this research is to further explore the relation between these two important functions of the brain. Future research focused on the specialization of brain functions may also add to the knowledge of the connection of cognition and motor abilities. This research would most likely incorporate neuroimaging techniques.

Because there are six target words, there is bound to be vowel sounds that exhibit more variance than others. Despite no statistical backing (yet), I have observed two vowels in particular, /i/ and /a/ that show more variance in both male and female speakers. The vowels that show the least variance thus far are /^/ and /u/.