Speech Processing in Humans: Insights from Neural Signals

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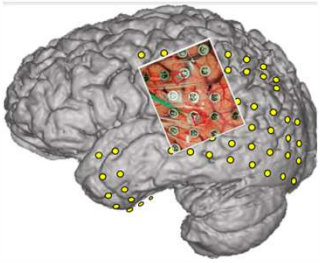
Research Focus:



+ Analyzing neural signals from the Face Motor Cortex and Wernicke's Area of a human brain (during speech) to understand language processing
+ Utilizing a dataset from an epilepsy patient for the purpose of examining correlations between speech perception and production
+ Deriving common trends in speech processing, the identification of speakers/other nuances, and exploring the relationship between the Wernicke's Area and Face Motor Cortex
+ Contributing to the studying of comprehension of language, speech disorders, and neurological processes
+ Delivering the dataset on open-source platforms and publishing its relevant findings for a refined understanding of brain-speech interactions and their clinical implications

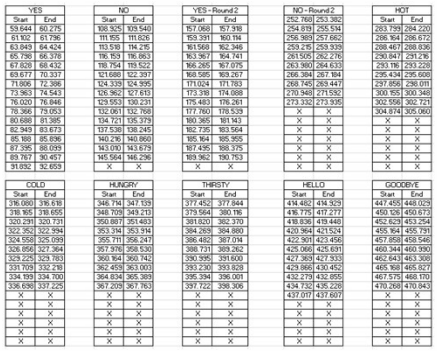
> Progress/Timeline <

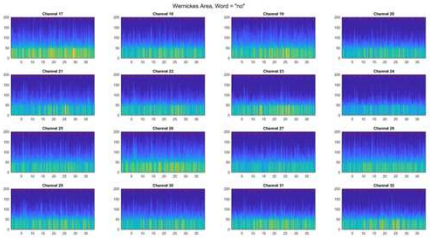
Fall'22:

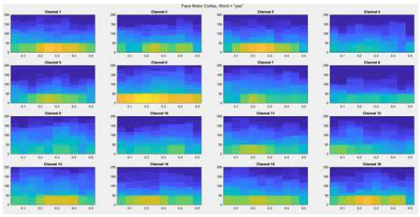
+ Oct – Dec: Onboarded/Familiarized with the Project, Lab, and Technologies

Spring'22:

+ Jan – Mar: Curated, captioned, and timestamped the dataset
+ Mar: Tested the data with Google APIs, and ChatGPT, for initial analyses
+ Apr – May: Coded in MATLAB producing collections of spectrograms for pattern identification, and data visualization of experimental words







Fall'23:

+ Aug – Sep: Data pre-processing for Machine Learning tasks, testing environments, setting up ASU research computing services for the project
+ Oct: Studying ML techniques/models appropriate and relevant to the data type, size, etc.

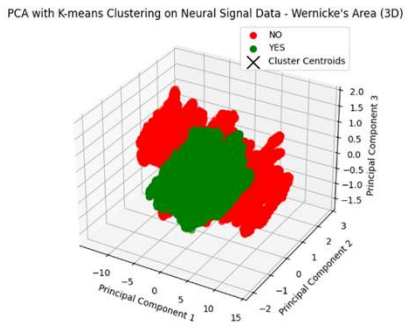
Future: Complete ML analyses, open-source dataset, & publish findings

- Findings & Results -

Up to this point, two significant discoveries regarding the analysis of neural signals during human speech have been made.

1) As evident in the spectrograms displayed to the right, plotting each channel over multiple iterations of an experimental word has provided valuable insights into the predominant channels associated with each word.
2) Likewise, the K Means graph, also visible on the right, has revealed distinct clusters that the research team has been able to discern across all observed channels for different words.

Ongoing research continues to delve further into potential connections between the Wernicke's Area and the FMC, along with speaker identification, and other common trends.



| Statistics & Definitions |

Duration of Experiment: 15:25.567367s

Size of Dataset: 32 (Channels) x 27767022 (Records: 30000 per second)

Channels: 16 (Face Motor Cortex) + 16 (Wernicke's Area)

Experimental Words: yes, no, hot, cold, hungry, thirsty, hello, goodbye, more, less, alphabets, numbers

Speakers: (3) Interviewer, Participant, Observer

Repetitions: 1 to 50 Samples (varying word to word)

Wernicke's Area: Responsible for a human's ability to comprehend languages, process grammar, and interpret/recognize speech

Face Motor Cortex: Generates signals to direct body movement

Tools & Technologies!

ASU Research Computing
Arizona State University

~ Relevant Readings & Resources ~

L1: Extracting Features from Time Series (Christian Herff and Dean J. Krusienski)

R1: Neural Decoding of EEG Signals using Machine Learning (Maham Saeidi and Waldemar Karwowski)

L2: Classification of Spoken Words using Surface Local Field Potentials (Spencer Kellis, and Bradley Greger)

R2: Decoding Spoken Words using Local Field Potentials Recorded from the Cortical Surface (Spencer Kellis)

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