Segmentation of spoken speech from unlabeled ECoG signals: A pilot study with an ALS participant

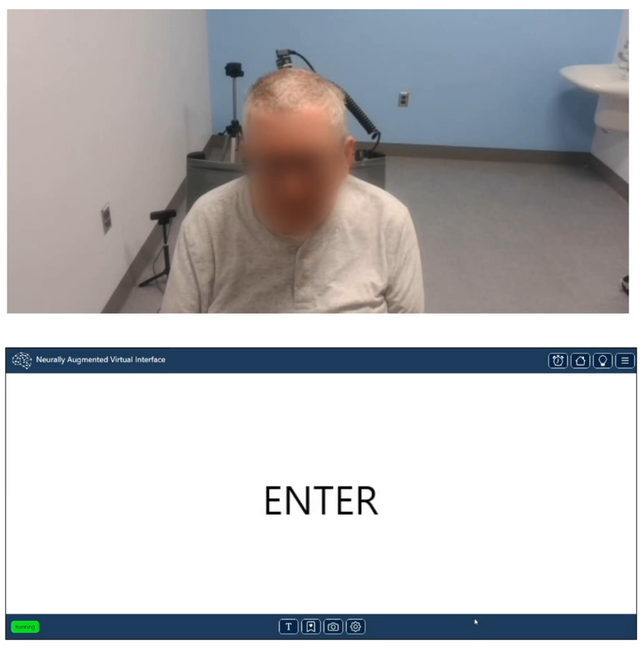
Miguel Angrick[1], Shiyu Luo[1], Qinwan Rabbani[1], Shreya Joshi[1], Daniel N. Candrea[1], Griffin W. Milsap[2], Chad R. Gordon[1], Kathryn Rosenblatt[1], Lora Clawson[1], Nicolas Maragakis[1], Francesco V. Tenore[2], Matthew S. Fifer[2], Nick F. Ramsey[3], Nathan E. Crone[1]

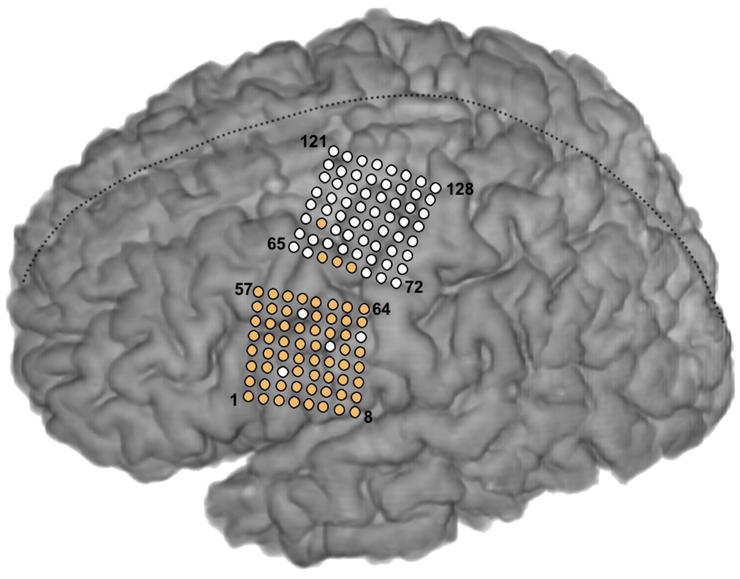
[1]The Johns Hopkins University, Baltimore, MD, USA; [2]Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA; [3]UMC Utrecht Brain Center, Utrecht, The Netherlands

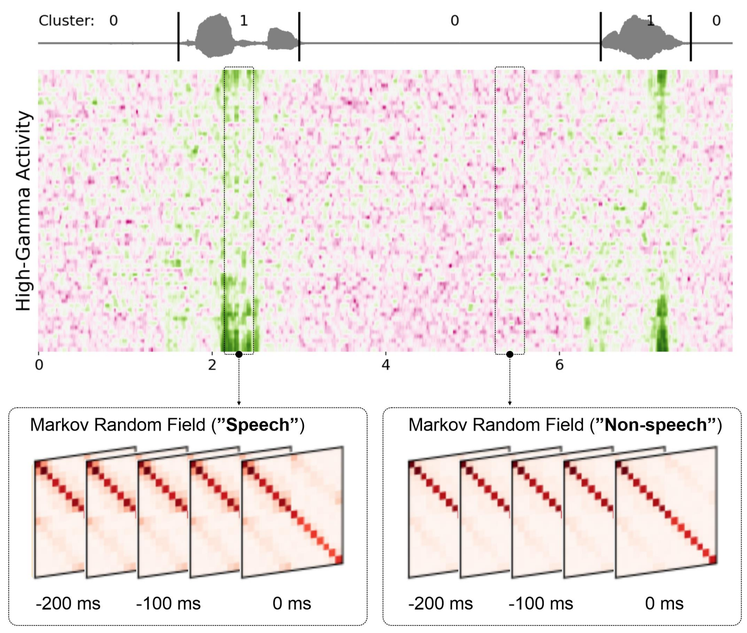
Motivation

- Brain-Computer Interfaces (BCIs) can potentially restore communication for people living with neurological disorders
- Approaches to speech synthesis require targets time-aligned with neural activity for successful model training
- Becomes more difficult to obtain in later stages of disease progression, if at all
- This pilot study makes first step toward acoustic-free modeling aimed at identifying spoken speech from ECoG
- Participant with ALS enrolled in ongoing CortiCom clinical trial (ClinicalTrials.gov, NCT03567213)
- Approved by the Johns Hopkins Institutional Review Board (IRB) and the FDA under an investigational device exemption (IDE)

Experiment Design & Approach

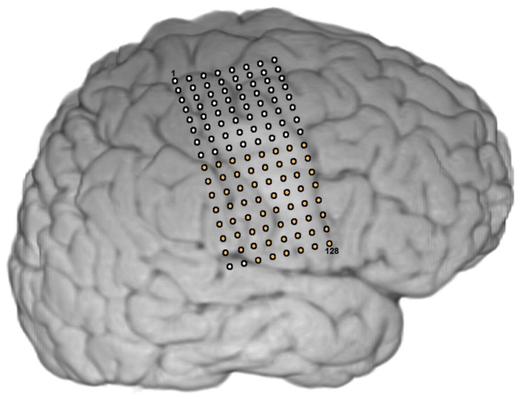


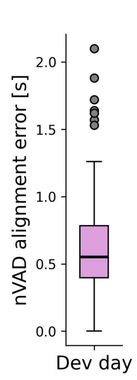


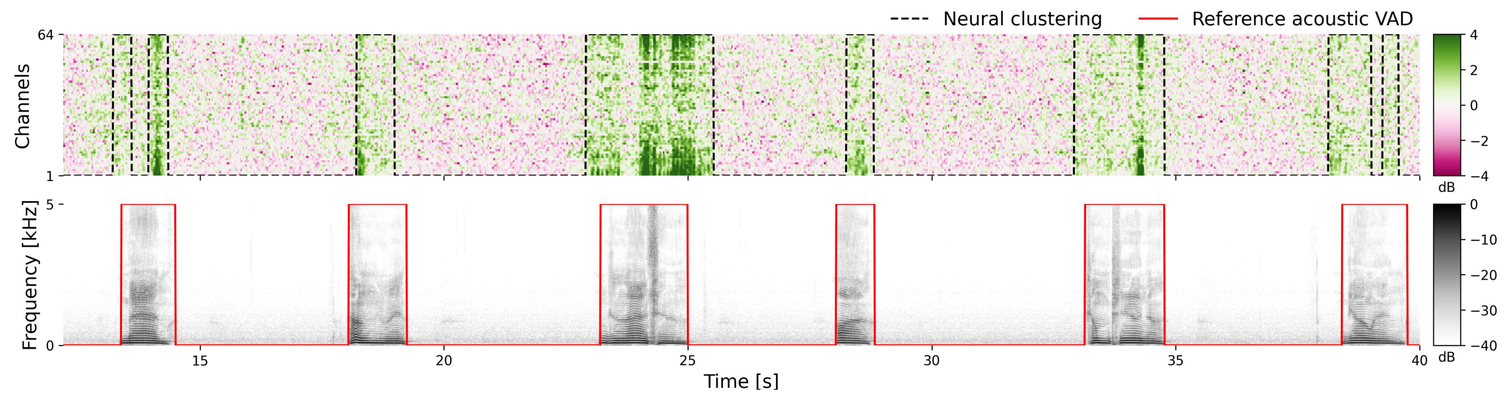


- Acquired ECoG activity during overt production of single words from a pool of 50 words (10 recording days)
- Utilized graph-based clustering algorithm designed to find subsequences in multivariate time series data

Identification of Speech Segments

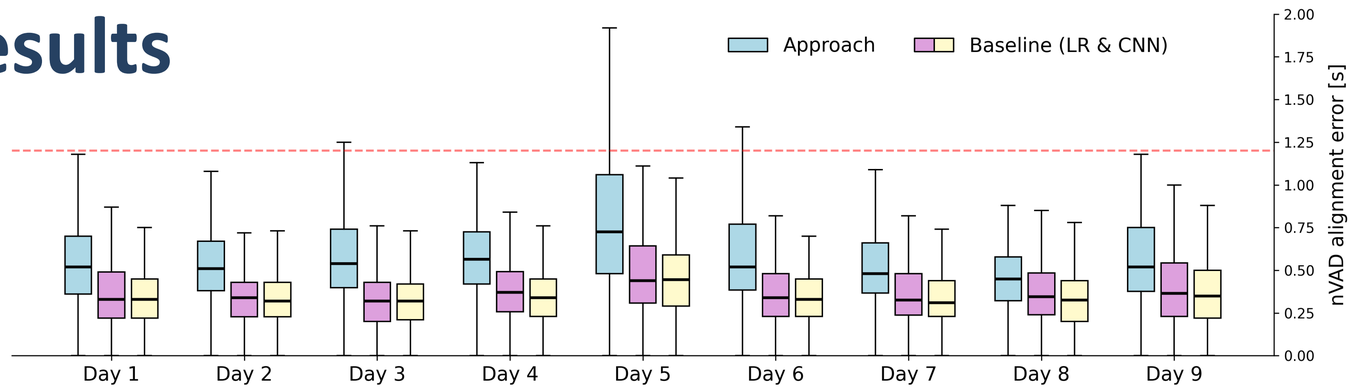


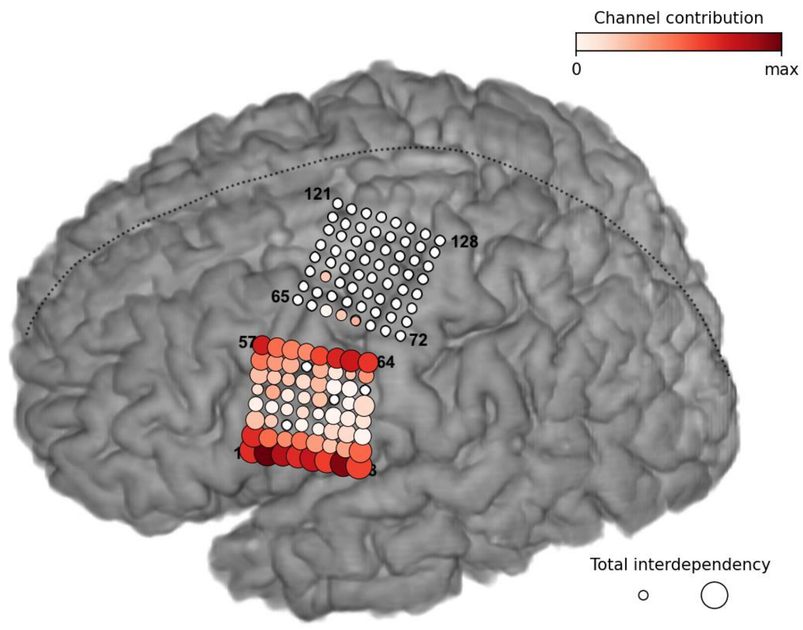




- Obtained hyperparameters from epilepsy patient
- Inferred cluster classes through experiment design

Results





- Estimated labels used to train predictive model (RNN) for real-time decoding
- Compared with models trained on ground-truth acoustic information
- Cluster assignment mainly driven by activity differences in a subset of electrodes

Research reported in this publication was supported by the National Institute of Neurological Disorders And Stroke (NINDS) of the National Institutes of Health (NIH) under Award Number UH3NS114439. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.