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Decoding attempted movements from human motor cortical activity recorded with a Stentrode

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Introduction: The Stentrode is a novel endovascular brain-computer interface (BCI) that is implanted endovascularly to record bilaterally from the primary motor cortex. The first-in-human trial (n=4) of the Stentrode demonstrated computer control and digital communication in people with amyotrophic lateral sclerosis (ALS) [1, 2]. An Early Feasibility clinical trial (NCT 05035823) began in the United States (US) in July 2022. Here, we demonstrate offline decoding of attempted movement patterns from the Stentrode electroencephalogram (EEG) recorded from the first participant in the US trial.

Material + Methods: In the US trial, three participants with ALS have been implanted with the Stentrode-BCI via a minimally invasive procedure, where a stent embedded with 16 electrodes was deployed into the superior sagittal sinus adjacent to the motor cortex. Data acquisition and system training with the Stentrode began approximately 7 weeks after implantation. The participants underwent training tasks that consisted of 5-s (± 1 s) rest periods followed by a 5-s period of movement attempt, in which 5 repetitions of attempted movement occurred. The movements attempted were: right ankle, left ankle, right hand, and left hand. The data were bandpass filtered (1-500 Hz), notch filtered at 60 Hz, and segmented into 200 ms windows with 80% overlap. A Neural Network (NN) was implemented to classify the data offline into balanced classes of either rest or one of the attempted movements.

Results + Discussion: Here we present early results from the first US participant. This work shows the ability to record motor-related activity with the Stentrode. *Fig 1 A* shows an example of the EEG signals spatially filtered with PCA. Unlike previously reported results [1,2], data from this participant shows synchronization of beta and low gamma during attempted moments. *Fig 1 B* shows classification accuracy from one day of neuroprosthesis training, with 18 repetitions of each movement. The 2-, 3-, and 5-class models all performed above the level of chance. However, only the 2-class model performed at a level suitable for BCI use (ie >80% accuracy). Furthermore, the bandpass filtered signals were utilized directly as features fed into the NN, demonstrating an end-to-end model without the need for explicit feature extraction.

Significance: Clinical trials of the Stentrode BCI are now underway at 3 sites. Results demonstrate successful decoding of motor intent from endovascular EEG signals recorded from participants with severe paralysis due to ALS. This work demonstrates offline decoding of motor attempts using a NN as an end-to-end model that extracts features and performs classification in a single step.

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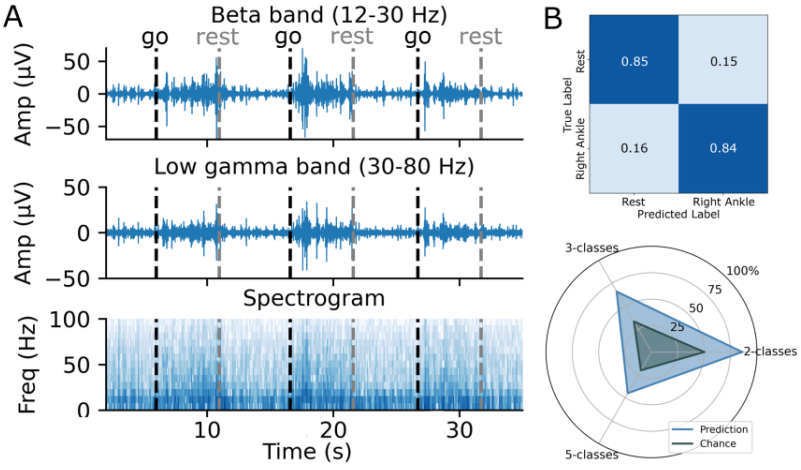

Figure 1. A. *Example data of the first principal component from one participant, while attempting movement of their right ankle.* ***B.*** *Offline classification accuracy and example confusion matrix from one day of motor prosthesis training.*

References

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