**Overview**

This dataset contains iEEG neural recordings and mood measurements from adult human subjects undergoing inpatient monitoring for seizure localization. The experimental design, including explanation of metrics of interest, is detailed in Rao et al 2018. Each subject received an identifier: EC##. Electrode coverage varied across subjects and was solely dictated by clinical need. Note, each probe (with multiple channels) was named by the anatomical target of the probe. The spacing of electrodes and size of targets means that not all electrodes within a given probe will contact tissue in the anatomical target. MRI and CT reconstructions allowed us to assign the activity recorded on specific electrodes to different brain regions of interest.

A series of MATLAB scripts was used for extracting data, preprocessing, calculating spectral power, and statistics. A number of functions are called within scripts (included in this repository). EEGLAB functions are used for plotting to aid visualization and artifact rejection.

**Data Description**

iEEG during Continuous Stimulation

Each subject’s raw iEEG during continuous stimulation are saved in a separate folder. Three recording systems were used to acquire iEEG, and the data format differs slightly.

*Natus system (‘Clinical’ data)*: Files are named using subject identifier, ‘rawDuringContinous’, and the amplitude of stimulation applied. For non-OFC stimulation locations, the location of stimulation is also included in the file name. If no location is included in the file name, lateral OFC was the stimulation location. Each file contains:

* + rawData: iEEG data, channels x samples
  + selectAnatomy: Electrode names and locations; order corresponds to the order of data in rawData
  + Fs: Sampling rate (Hz)
  + patientID: Subject identifier
  + numChannels: Number of channels included in rawData

*TDT (Tucker-Davis Technologies)*: Files are named using subject identifier and a block number (e.g. B30), or can be identified by accompanying ‘TDT\_elecs\_all.mat’ or ‘TDT\_elecs\_special.mat’ files with electrode information. Each file contains the same variables as Clinical data.

*NeuroOmega data*: Files are named using subject identifier and ‘NO’ appears in file name. Each file contains:

* + rawData: iEEG data, channels x samples
  + selectAnatomy: Electrode names; order corresponds to the order of data in rawData
  + Fs: Sampling rate (Hz)

iEEG during Single-Pulse Stimulation

Each subject’s raw iEEG during single-pulse stimulation are saved as EC##\_rawData\_SPS.mat. Each of these files contains:

* + RawData: iEEG data, channels x samples
  + Fs: Sampling rate (Hz)
  + Anatomy: Electrode names and locations; order corresponds to the order of data in rawData

Group data are saved in SPS\_Group.mat, which contains:

* + patientID: Subject identifiers for electrodes in group analysis, corresponds to order of data in peakValuesBefore and peakValuesAfter
  + peakValuesBefore: Peak values of ERP before continuous stimulation, pulses x subjects
  + peakValueAfter: Peak values of ERP after continuous stimulation, pulses x subjects

iEEG during Natural Behavior

Each data file EC##\_data.mat contains:

* IMS: Structure array with IMS scores for this subject (time excluded to preserve PHI)
* ECoG: Structure array with raw ECoG data (from OFC channels) from a 4-minute window around each IMS.

Note: For each ECoG segment, "data" and sampling rate "Fs" are stored; data around one IMS may be broken into multiple segments by the recording device. Thus, the ECoG structure array may have more elements than the IMS structure array.

Behavior

Spreadsheets and mat files contain subject trait and behavior metrics:

* + KS\_OFCStim\_BehaviorData.mat: IMS, word valence, and CMS for stimulation tested in lateral OFC.
  + KS\_NonOFCStim\_BehaviorData.mat: IMS, word valence, and CMS for stimulation testing in non-lateral OFC locations.
  + KS\_SpeechRate\_6mA.mat: Speech rate for each subject during sham and 6mA OFC stimulation.
  + KS\_TraitScores.mat: BDI and trait score for each subject.
  + KS\_AllNormIMS.mat: Normalized score for every IMS datapoint, with identification of subject trait depression status.
  + KS\_AllNormIMS.xlsx: Normalized score for every IMS datapoint.
  + KS\_NumberIMSPerDat.xlsx: Number of IMS each subject completed each day; days are numbered sequentially (Day 1, Day 2, etc.) to help protect confidentiality.

**Description of Analysis Scripts and Outputs**

iEEG Analysis during Continuous Stimulation:

* KS\_DuringContinuousStim\_ArtifactRejection.m: First processing script for iEEG recorded immediately before, during, and after continuous 100Hz stimulation; input are raw data in mat format from one of the three recording systems used (more information below); anatomical labels of electrode locations are also required (saved in an accompanying file for two data formats). This script removes stimulation artifact from iEEG and performs other preprocessing steps. Recording and subject specific parameters are applied to extract data from channels within brain regions of interest. The processed data are saved and used by subsequent scripts (# replaced by appropriate numbers): EC##\_preprocessedDuringContinuous\_#mA\_FreqBands.mat, which contains variables:
  + preprocessedStimData: Preprocessed data from channels in regions of interest, channels x samples; these data are downsampled
  + selectVerifiedAnatomy: Electrode names and locations corresponding to channels in preprocessedStimdata
  + patientID: Subject identifier
  + stimFreq: Frequency of electrical stimulation
  + removeOrReplace: User selection to remove or replace (with Nans) time periods of data which were manually rejected
  + rejectionTimes: Start and end indices of original data (Fs sampling rate) that were manually marked for rejection
  + dsFs: Sampling rate of downsampled data (Hz)
  + Fs: Original sampling rate (Hz)
  + allRejectedChans: Channel numbers (based on selectAnatomy) that were selected for rejection
  + numVerifiedChans: Number of channels in preprocessedStimData
  + regionNames: Names of brain regions of interest
  + finalVerifiedRegions: For each channel, identifier of which region this channel is assigned to (order corresponds to regionNames)
  + finalVerifiedChanNames: Channel names and order corresponding to channels in preprocessedStimData
  + artifactBufferBefore: Number of samples (in Fs) before peak of stimulation artifact that should be rejected
  + artifactBufferAfter: Number of samples (in Fs) after peak of stimulation artifact that should be rejected
  + artifactStarts: Indices for the start of all artifact periods (each corresponding to a single stimulation pulse, in Fs)
  + artifactEnds: Indices for end of all artifact periods (each corresponding to a single stimulation pulse, in Fs)
  + plotStimStart: Index for start of stimulation block (in Fs)
  + plotStimEnd: Index for end of stimulation block (in Fs)
* KS\_DuringContinuousStim\_TimeAveragedSpectra.m: Input are preprocessed data during continuous stimulation. Mean spectral power is calculated before, during, and after stimulation for each channel. Processed data are saved for use in subsequent scripts (# replaced by appropriate numbers): EC##\_TimeAveragedSpectraPower\_#mA.mat, which contains variables:
  + meanBeforeStim: Average power before stimulation, channels x frequencies
  + meanDuringStim: Average power during stimulation, channels x frequencies
  + meanAfterStim: Average power after stimulation, channels x frequencies
  + freqs: Center frequencies at which spectral power was calculated
  + finalVerifiedRegions: For each channel, identifier of which region this channel is assigned to (order corresponds to regionNames)
  + finalVerifiedChanNames: Channel names and order corresponding to channels in preprocessedStimData
  + numVerifiedChans: Number of channels in preprocessedStimData
  + currentStim: Name of stimulation condition in this file
  + regionNames: Names of brain regions of interest
  + stimStartSample: Index for start of stimulation block (in dsFs)
  + stimEndSample: Index for end of stimulation block (in dsFs)
  + dsFs: Sampling rate of downsampled data (Hz)
  + Fs: Original sampling rate (Hz)
* KS\_DuringContinuousStim\_GroupLevel\_Power.m: Creates group-level plot and calculates statistics of changes in power across subjects. Input are EC##\_TimeAveragedSpectraPower\_#mA.mat files for all subjects.
* KS\_DuringContinuousStim\_GroupLevel\_PlotChangePower.m: Creates group-level plot and calculates statistics of changes in power across subjects. Input are EC##\_TimeAveragedSpectraPower\_#mA.mat files for all subjects.

iEEG Analysis during Single-Pulse Stimulation (SPS)

* MB\_CalculateERP.m: Processing script to calculate evoked potentials caused by single pulses of electrical stimulation. Input is raw data in mat format recorded during stimulation.
* MB\_PlotFigure4E.m: Plotting and statistics for Figure 4E
* MB\_PlotFigure4F.m: Plotting and statistics for Figure 4F
* MB\_PlotFigureS4.m: Plotting and statistics for Figure S4

iEEG Correlated with Mood Reports:

Analysis for correlation of OFC power with IMS consists of 4 main steps, each corresponding to one function:

* F1\_extractPowerFeatures.m: For each subject, extract log power features in 3 frequency bands from non-overlapping 10s windows.
* F2\_averagePowerFeatures.m: For each subject, average the extracted power features in a 4-minute window around each IMS datapoint and across all OFC channels.
* F3\_zScoreFeaturesAndIMS.m: For each subject, z-score the averaged power features and z-score the IMS scores.
* F4\_poolResultsAndComputeCorr.m: Pool the z-scored averaged power features and the z-scored IMS datapoints from all subjects together and correlate the two.

Behavior:

* KS\_OFCStim\_BehaviorData.m: Plotting and statistics of composite mood scores based on stimulation condition and subject trait (depressed/not depressed). Input is KS\_OFCStim\_BehaviorData.mat
* KS\_NonOFCstim\_BehaviorData.m: Plotting of composite mood score for stimulation in multiple brain regions. Input is KS\_NonOFCStim\_BehaviorData.mat
* KS\_SpeechRateAnalysis.m: Statistics and plotting to compare speech rate during sham and 6mA OFC stimulation. Input is KS\_SpeechRate\_6mA.mat
* KS\_PlotBDI.m: Script to create figure showing BDI scores for all subjects. Input is KS\_TraitScores.mat
* KS\_PlotIMS.m: Script to create boxplots of all IMS scores for all subjects. Input is KS\_AllNormIMS.mat
* KS\_OFCStim\_DiffCMS.m: Plotting of composite mood scores per subject. Input is KS\_OFCStim\_BehaviorData.mat