Cross correlation of *in vivo* Neuropixel recordings of neuronal responses during evoked OKR in the mouse superior colliculus

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https://github.com/neoygaj/CSPB-4502-project.git

Description

The optio-kinetic reflex (OKR) is an involuntary eye movement, including saccades, that plays an important role in surveying a visual scene and enables humans and animals to detect and track sudden movements in the visual field. The accessory optic system (AOS) and nucleus of the optic tract are part of the subcortical neural pathway that control the OKR and are mediated by the superior colliculus (SC), which integrates the OKR with visual input from the retina. The goal of this project is to perform cross-correlation of attributes of local field potential (LFP) recordings, acquired by Joshua Hunt (a PhD candidate in the Neuroscience Program at CU Anschutz), with thousands of individual responses per unit (putative neuron) for roughly 27,000 units recorded from implanted 386-channel Neuropixel probes in response to saccades evoked by drifting contrast gratings.

Prior Work

This dataset is unpublished and includes novel data, therefore there is no directly related previous work. There is one methods paper that describes the general technique of gathering neural recordings in the mouse SC(**1**), however, this does not include specific analysis of neural activity involved with evoked OKR activity.

1. Sibille, J., Gehr, C., The, K.L., Kremkow, J. “Tangential high-density electrode insertions allow to simultaneously measure neuronal activity actross an extended region of the visual field in mouse superior colliculus”, Journal of Neuroscience Methods, Volume 378. (2022)

Datasets

The dataset includes recordings from 133 experiments/sessions (1 recording session per day) from the 386-channel electrodes implanted in the SCs of live mice. The responses are pre-processed with spike-sorting performed with Kilosort software. There are 1000's of responses for roughly 27,000 units/neurons and response characteristics are listed, such as amplitude, duration, rise time and decay time. Recordings from one or a few units will be used to test the analysis pipeline before processing the entire dataset.

The datasets are on a privately shared Google Drive folder. I have already downloaded all of the data onto 2 PC machines (at work and at home). The data is unpublished and considered confidential but can be shared if required for the project. However, there is no public link available at this time.

Proposed Work

The main task to prepare the data for analysis will be combining the measurements generated by Kilosort into a single CSV file, organized by animal, recording session, and each unit/neuron within those groups. The plan is to work with the CSV data as a data frame using Pandas and Python3. It is helpful that the preprocessing has already been mostly completed, however, quality checks will be performed to identify missing values or “NaNs”. This will be done visually by plotting the data, and also by checking each expected value in each segment of the data with an automated script.

List of Tools

- Python3
- SciPy
- MatPlotLib
- NumPy
- Pandas
- MATLAB

Evaluation

After the data is integrated and cleaned, correlation analysis and cross correlation will be performed with the goal of identifying SC neurons that are functionally linked, which will be determined by positive or negative correlation, in order to identify neuron ensembles within the recorded population. Each recording per neuron will be a vector and organized into sessions/animals as matrices. Multiple types of correlation coefficients or other metrics will be used to detect associations between the activity attributes of individual neurons within each animal/session. It is expected that functional ensembles will be identified, possibly several per animal, that suggest that SC subnetworks exist that govern different aspects of The OKR and integration with visual input from the retina.