Title: Cross Correlation of in vivo Neuropixel Recordings of Neuronal Responses During Evoked OKR in the Mouse Superior Colliculus

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Abstract

This project aims to analyze the neuronal responses in the mouse superior colliculus (SC) during the optio-kinetic reflex (OKR) using *in vivo* Neuropixel recordings. By performing cross-correlation analysis on local field potential (LFP) recordings from thousands of neurons, we seek to identify functional neuron ensembles that are involved in the OKR and its integration with visual inputs. This proposal outlines the problem statement, literature survey, proposed work, dataset details, evaluation methods, tools, and milestones.

Problem Statement/Motivation

The optio-kinetic reflex (OKR) is an involuntary eye movement critical for tracking and detecting movements in the visual field. The superior colliculus (SC) plays a significant role in integrating OKR with visual inputs from the retina. The primary objective of this project is to perform cross-correlation analysis on neuronal responses recorded via Neuropixel probes in the SC of mice. By understanding the functional connectivity and identifying neuron ensembles, we aim to shed light on the neural mechanisms underlying OKR. The findings could have broader implications for understanding sensory-motor integration and related neural processes.

Literature Survey

The current dataset is novel and unpublished, with no directly related previous work. However, the following methods paper describes the general technique of gathering neural recordings in the mouse SC:

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

This paper outlines the methodology for recording neuronal activity using high-density electrodes but does not include specific analysis of neural activity during evoked OKR.

Proposed Work

Data Collection and Preprocessing

The dataset includes recordings from 133 experiments, each conducted with a 386-channel Neuropixel probe implanted in the SC of live mice. The data has been pre-processed using Kilosort software for spike sorting. The primary tasks involve:

- Combining measurements from Kilosort into a single CSV file organized by animal, recording session, and each neuron.
- Performing quality checks to identify and handle missing values (NaNs) through visual inspection and automated scripts.

Analysis and Evaluation

The project involves performing cross-correlation analysis to identify functionally linked neurons within the SC. Each recording per neuron will be treated as a vector and organized into matrices by sessions/animals. Various correlation metrics will be employed to detect associations between neuronal activity attributes, such as amplitude, duration, rise time, and decay time.

Dataset

The dataset is stored on private Google Drive and has been downloaded onto two PCs for redundancy. Details include:

- **Number of Experiments:** 133
- **Number of Channels per Experiment:** 386
- **Total Neurons Recorded:** Approximately 27,000
- **Attributes Recorded:** Amplitude, duration, rise time, decay time

Given the confidentiality of the data, it is not publicly accessible.

Evaluation Methods

- **Metrics:** Correlation coefficients and other statistical measures to determine the strength of associations between neuron activities.
- **Existing Solutions:** Comparison with standard techniques in neural data analysis to validate findings.

Tools

- **Python3**
- **SciPy**
- **Matplotlib**
- **NumPy**
- **Pandas**
- **MATLAB**

Milestones

1. **Week 1-2:** Data combination and initial quality checks.
2. **Week 3-4:** Initial cross-correlation analysis on a subset of the data.
3. **Week 5-6:** Full dataset analysis and identification of neuron ensembles.
4. **Week 7:** Finalize analysis, prepare results, and complete documentation.

References

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