Does structure in neural activity match anatomical structure?

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Introduction

Information in the brain is carried in correlated network activity. Until recently, it has been difficult to record responses from multiple brain regions simultaneously. This meant that studies on network behaviour were restricted to studying only one region at a time. The development of 'Neuropixels' probes have allowed extracellular voltage measurements to be collected from multiple brain regions simultaneously. In this project, we used data collected from five different brain regions to compare distributions of correlated activity within these regions, and between these regions.

We then used these measurements to create networks between the neurons in these five regions. We used a cutting edge community detection algorithm to find communities in these networks. We are currently in the process of comparing these communities to the anatomical distribution of their constituents.

Main Objectives

1. To compare the distributions of spike count correlations (r_{SC}) and mutual information ($I(X;Y)$) in different regions.
2. To detect any communities in the networks created by these measurements, either within or between the anatomical regions.
3. To compare the communities detected in the spike count correlation networks to those detected in the mutual information networks.
4. To compare the network communities to their anatomical distribution.

Data

Using two probes, spiking activity was simultaneously collected from over 800 neurons in an awake mouse brain for a period of 84 minutes. During this period, the mouse and was shown various visual stimuli. The 800 neurons were distributed across 5 different brain regions: **V1, hippocampus, thalamus, motor cortex**, and **striatum**.

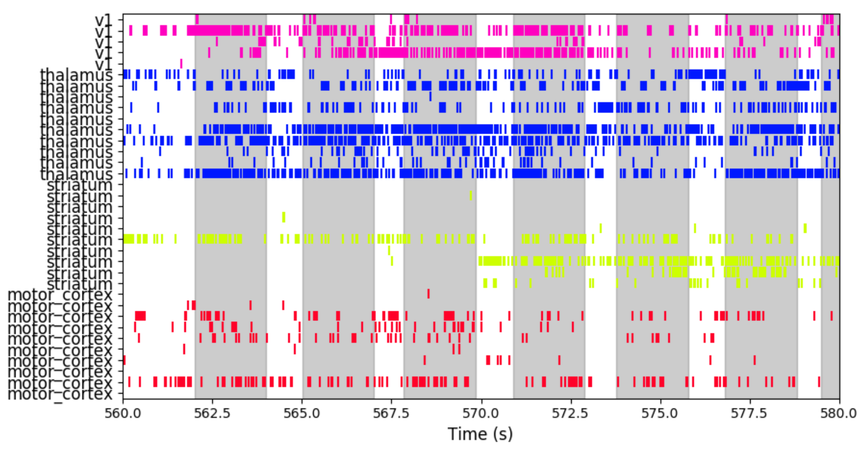

Figure 1: Raster plot showing a the firing times of a subset of the cells, during a subset of the experiment time. Shaded areas indicate times when a visual stimulus was present.

Materials and Methods

Spike Count Correlation, r_{SC} We measured Pearson's correlation between the spike counts of neurons in pairs.

Mutual Information, $I(X;Y)$ We measured the mutual information between the spike counts of neurons in pairs.

Network Noise Rejection We used a recently developed method to split the networks created by these measures into signal and noise [2].

Consensus Clustering We used consensus clustering on the signal network to investigate any communities within these networks.

Results

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Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 1: Table caption

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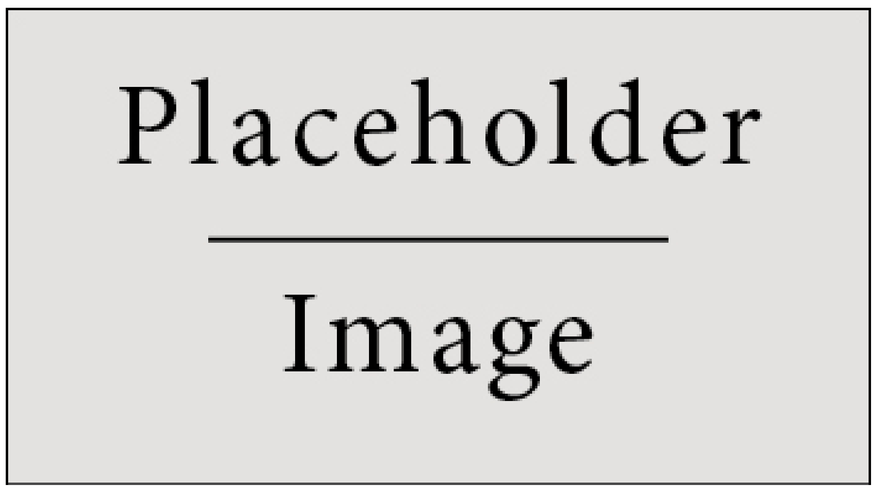

Figure 2: Figure caption

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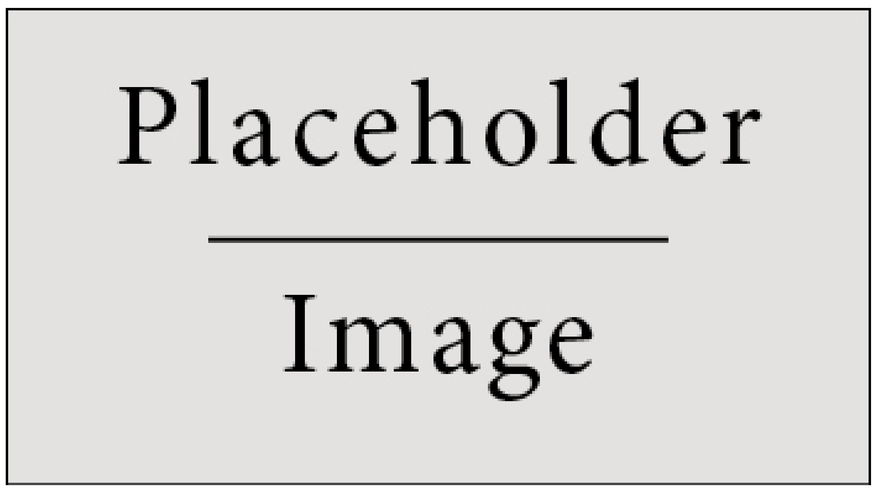

Figure 3: Figure caption

Conclusions

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Forthcoming Research

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Acknowledgements

I would like to thank Dr. Nick Steinmetz (University of Washington, Seattle) for making the dataset used in this project publicly available.

References

[1] James J. Jun, Nicholas A. Steinmetz, Timothy D. Harris, *Fully integrated silicon probes for high-density recording of neural activity*. Nature 551, 232–236, (2017)

[2] Mark D. Humphries, Javier A. Caballero, Mat Evans, Silvia Maggi, Abhinav Singh, *Spectral rejection for testing hypotheses of structure in networks*. arXiv:1901.04747v1 [cs.SI], (2019)