P-442

Exploring Functional Diversity in PEc Neurons using Single-Unit fMRI Mapping

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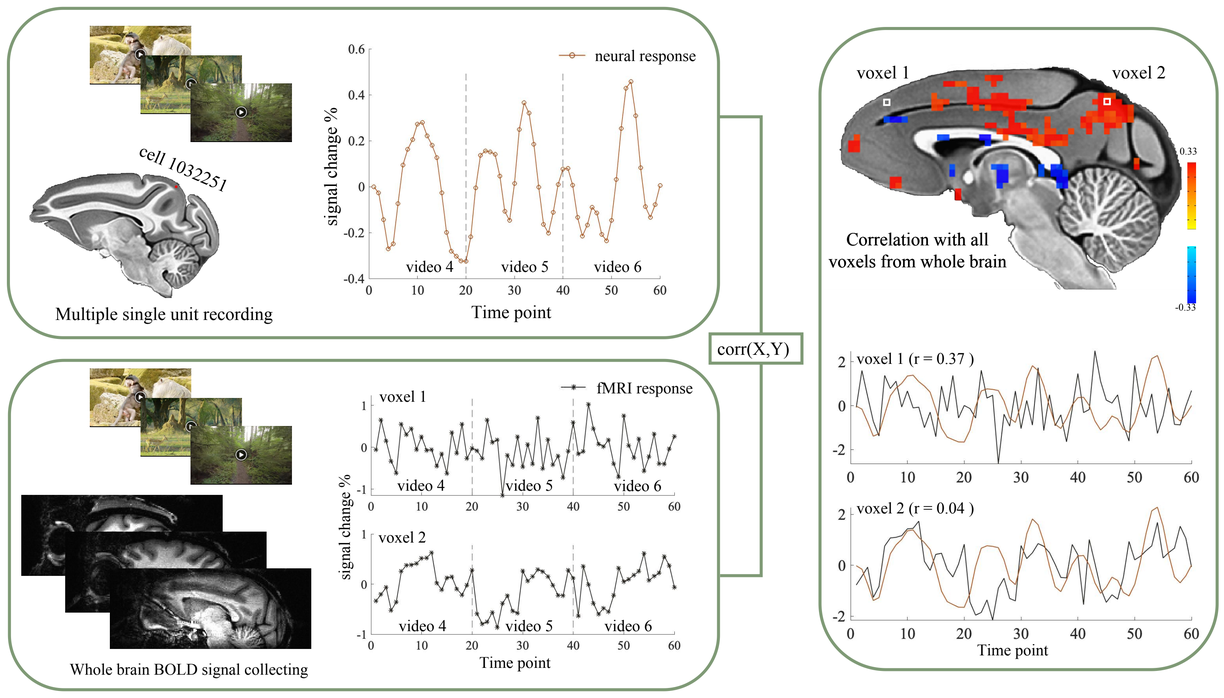
Introduction

- Previous functional neuroimaging studies have highlighted the role of the posterior parietal cortex in various cognitive tasks such as episodic memory retrieval, visuo-spatial imagery and self-processing operations. However, little research has investigated the neuronal responses in relation to whole-brain BOLD activation dynamics under naturalistic conditions such as movie-viewing. Here, we aimed to explore the functional diversity of neurons in the PEc area of the dmPPC by combining whole-brain fMRI with single-unit recordings.

Method

Whole-brain functional maping for each individual neuron during natural viewing paradigm

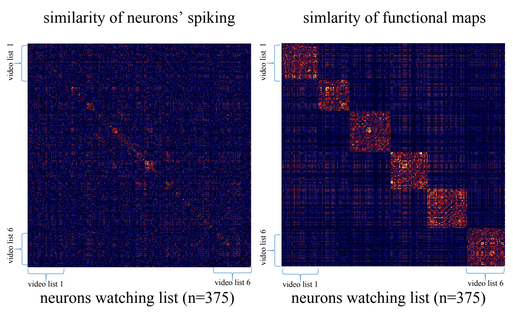


- Electrophysiological single-unit spike data from three macaques‘ PEc area (375 neurons in total) and whole-brain fMRI images from two different macaques was obtained during a video watching paradigm.
- 18 30s video clips depicting primate, non-primate and scenery were used in current study.
- For each neuron, we computed a whole-brain correlation map by considering its shared time course with all voxels with the fMRI images under the same naturalistic movie-viewing conditions.
- All PEc neurons were clustered based on their whole-brain correlation pattern with a k-means clustering algorithm.

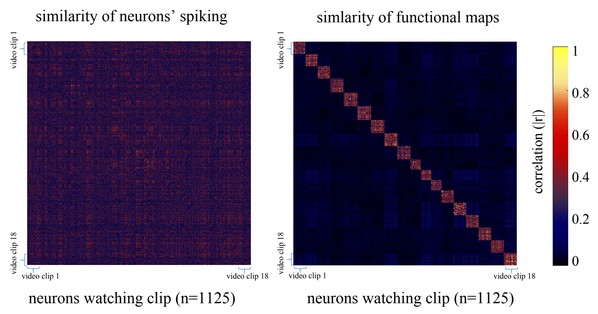
Results

A. Experience dependent similarity revealed by neurons' functional maps but not spiking rate

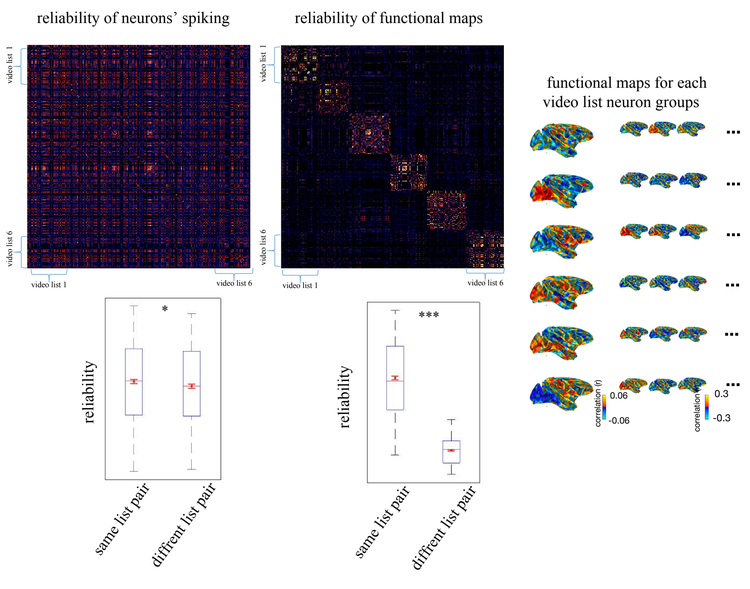
a. correlation matrix of concantented 6 video lists



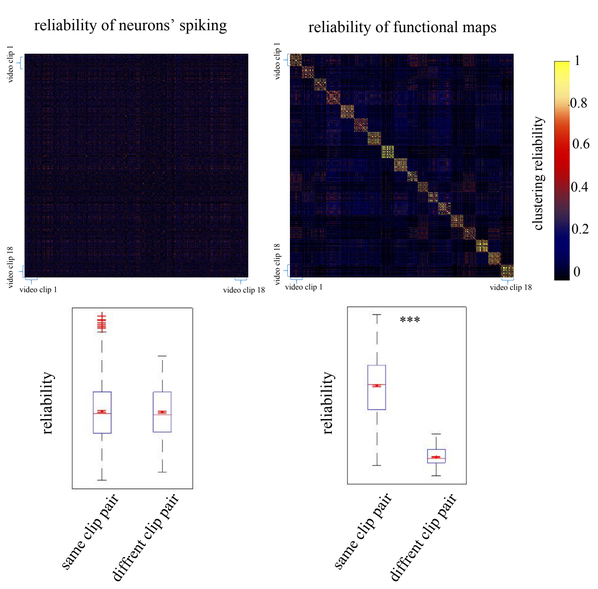
b. correlation matrix of single 18 video clips



c. k-means reliability of concantented 6 video lists



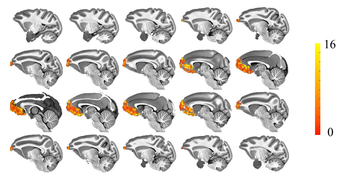
d. k-means reliability of single 18 video clips



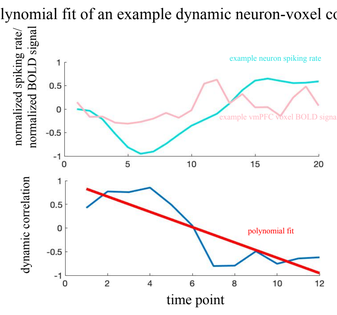
*reliability in kmeans: two neurons are significantly more likely to be classified as same group under same experiences. k-means reliability results are replicated with correlation matrix results

B. Neuron-voxel dynamic coupling during video viewing

a. Heatmap showing the likelihood of a voxel (only vmPFC chosen as ROI) being significantly correlated with a neuron. This map depicts the coupling for all 375 neurons.

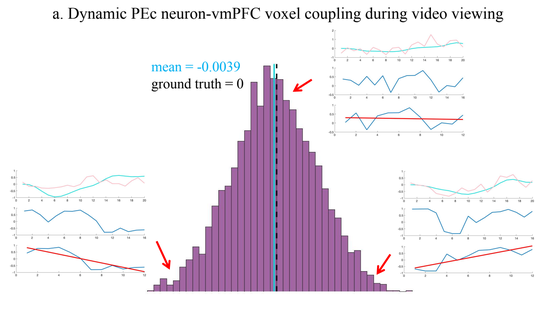


b. polynomial fit of an example dynamic neuron-voxel couping



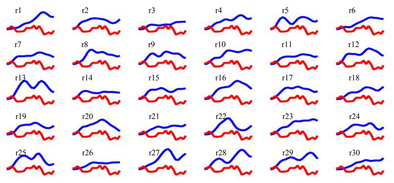
C. Varied patterns of dynamic coupling of PEc neuron-vmPFC voxels during video watching

a. Dynamic PEc neuron-vmPFC voxel coupling during video viewing

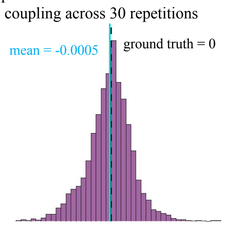


D. neuron-voxel coupling decreased across repetition

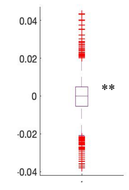
a. 30 repetitive video viewing of example neuron-voxel couping



b. density plot of trend coefficients of neuron-voxel coupling across 30 repetitions



c. average trend effect showed decreased across repetition



Conclusion

Our results characterize the functional heterogeneity of PEc neurons. The functional maps revealed they are experience-dependent. Taking vmPFC as an example site, we further demonstrated the neurons' spike dynamics are coupled closely with vmPFC voxels and that their temporal dynamic coupling vary greatly within this population, reflecting functional heterogeneity.

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