Measuring Dynamics of a Pattern-Generating Circuit in the Marine Mollusk *Aplysia californica*

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**Abstract**

- The goal of this project is to monitor in real time the activity of all neurons in a neural circuit that controls well-defined behaviors in a biologically-relevant context.
- To this end, we are combining nerve recordings of the circuit’s motor output with recordings of multi-unit activity in the neural circuit using two-dimensional multi-electrode arrays.

**Introduction**

- Because of its large, identified neurons, *Aplysia californica* is a model system for understanding the neural basis of behavior. One model behavior that has been intensively studied in *Aplysia* is feeding behavior, because it provides insights into motivated behavior and multi-functionality.
- The majority of previous studies have focused on recordings from single neurons, or small groups of neurons. However, many interesting aspects of neural dynamics can only be understood by looking at populations of neurons.
- We have therefore used a high-density multi-electrode array (MEA) to simultaneously record many neurons in the circuit that controls feeding motor programs in *Aplysia*, the buccal ganglion. Preliminary data suggest that we will be able to understand the dynamics of neural activity in this ganglion during motor programs.

**Results**

**Figure 1**: Anatomy of the buccal ganglion of *Aplysia californica*. This circuit generates the activity patterns controlling feeding behaviors. The constitutive neurons are anatomically well-defined.

**Figure 2**: High-density electrode array. The array has 120 electrodes (100 µm pitch) covering an area of 1.2 mm².

**Figure 3**: Experimental setup for simultaneous recordings of multiunit activity and motor output. The size of the left buccal ganglion fits on the surface of the MEA.

**Figure 4**: Nerve recordings are performed with suction electrodes.

**Figure 5**: Electric potential across the buccal ganglion at three different points in time, from top to bottom. A) Traces of field potentials from the 120 electrodes. Rhythmic patterns are readily apparent. Dashed red line indicates the time point. B) Maps of electrical activity across the ganglion. C) Current source (red) and sink (blue) densities across the ganglion.

**Figure 6**: Activity patterns recorded from motor nerve BN2. The patterns correspond to the retraction phase of the buccal mass under stimulation of the contralateral nerve.

**Conclusions**

- We have demonstrated feasibility to record multi-unit activity in the ganglion, while simultaneously recording its motor output.
- In future studies, we will investigate the interplay and functional connectivity between the different neurons in the circuit.

**Reference**


