

TITLE: Temporal dynamics of neural activity in the olfactory receptor neurons during odor exposure

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Introduction: Interdisciplinary research that combines experimental approaches with computational analyses and modeling has the potential to greatly facilitate our understanding of how neurons interact within and across brain regions to process information. We use combined statistical and experimental approaches to address how sensory information is encoded in a simplified olfactory system, the antennae of the Caribbean spiny lobster (*Panulirus argus*).

Method: We use calcium imaging of the Olfactory Receptor Neurons (ORNs) of the spiny lobster to examine spontaneous Ca^{2+} oscillations and odor-induced transients. Data sets were collected in Derby lab by Dr. Manfred Schmidt, consisting of recording of neural activity in response to stimulation to different odors. Consistent with previously published research the ORN can be excited (depolarized) by some odorants and inhibited (hyperpolarized) by others. The dynamics of neural activity at the population level are less well characterized however.

Results: One of the issues concerning these data is that the effectiveness of the calcium imaging decreases as a function of time. As a result, statistical analysis on the raw data can introduce artifacts related to the decay of the optical imaging signal. To address this situation we employed signal-processing methods, such as low and high-pass filtering to identify these trends. We carried on simple analysis of the neural activity traces pre and post odor exposure, and we determined that a large majority of the units have excellent signal to noise ratio. We then used eigenvalue/eigenvector methods, such as Principal Component Analysis (PCA), in conjunction to clustering techniques to project the data from the original large-dimensional space to a reduced-dimension subspace. This analysis indicate that different regions of this space, corresponding to different population activity patterns, can be associated to baseline, spontaneous and odor-induced activity.

Conclusion: In agreement with previous published research for single-units analysis, our findings indicate the existence of different dynamical states for the ORN populations. In addition, these methods can now characterize the magnitude of the odor-evoked responses at the population level, offering a direct way of quantifying the output response as a function of the each odor presentation. In the future, we plan to use these methods to compare odors with different identities and/or concentration, and use the findings as the input component for computational modeling of odor processing in the antennae of the spiny lobster.