Predictive Information for Temporal Patterns in a Retina

Kevin Sean Chen[1,2], Chun-Chung Chen[1] and Chi-Keung Chan[1,3]*,

[1]Institute of Physics, Academia Sinica, Taipei, Taiwan, Republic of China
[2]Department of Life Science, National Taiwan University, Taipei, Taiwan, Republic of China
[3]Department of Physics and Center for Complex Systems, National Central University, Chungli, Taiwan, Republic of China

The ability to predict time-dependent stimulations precisely in time is generic in sensory neural systems. However, direct measurement of predictive information for temporal patterns and the corresponding biophysical mechanism are still lacking. Here, by recording activities from bullfrog retina under stochastic pulse intervals in a multi-electrode array system, we measure information encoding the future intervals provided from firing patterns. We show how time scales of the varying intervals affect the ability to encode stimuli and make predictions, and find that the performance is optimized when the mean time interval is from 200 to 250 ms. Furthermore, correlation time between intervals must be larger than 2-4 second in order to produce proper predictions. In fact, these two parameters can also be revealed by measuring the dynamic range and relaxation time scale of omitted stimulus response (OSR) in retina under periodic stimuli. A neural model that actively tunes its oscillating frequency towards the input temporal pattern captures signatures from experiments. These results demonstrate predictive coding for temporal information in retina and suggest the crucial role of the underlying adaptive process.