Dimensionality Reduction in spatio-temporal MaxEnt models and analysis of Retinal Ganglion Cell Spiking Activity in experiments
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Retinal spike response to stimulus is constrained, on one hand by short range correlations (receptive field overlap) and on the other hand by lateral connectivity (cells connectivity). This last effect is difficult to handle from statistics because it requires to consider spatio-temporal correlations with a time delay long enough to take into account the time of propagation along synapses. Although MaxEnt model are useful to fit optimal model (maximizing entropy) under the constraints of reproducing observed correlations, they do address spatio-temporal correlations in their classical form (ising or higher order interactions but without time delay). Birn in such models somewhat integrates propagations effects, but in an implicit form, decision being severely bias-data [1]. To resolve this issue we have considered spatio-temporal MaxEnt model formerly developed e.g. by Vazquez et al. [2]. The price to pay, however, is a huge set of parameters that must be fitted to experimental data to explain the observed spiking patterns statistics. There is no prior knowledge of which parameters are relevant and which ones are contributing to overfitting. We propose here a method of dimension reduction, i.e. a projection on a relevant subset of parameters, relying on the so-called Susceptibility matrix closely related to the Fisher information. In contrast to standard methods in information geometry though, this matrix handle space and time correlations.

We have applied this method for retina data obtained in a diurnal rodent (C/0day degus, having 30% of cones photoreceptors) and a 252-MEA system. Three types of stimuli were used: spatio-temporal uniform light, white noise and a natural movie. We show the role played by time-delayed pairwise interactions in the neural response to stimuli both for close and distant cells. Our conclusion is that, to explain the population spiking statistics we need both short-distance interactions as well as long-distance interactions, meaning that the relevant functional correlations are mediated not only by common input (i.e. receptive field overlap, electrical coupling) but also by long range connectivities.

**Methods**

Recordings: Extracellular recording of the electrical activity of retinal ganglion cells in vitro was performed in rodent (C/0day degus) and primate (Macaca mulatta) retinae. Retinal whole ganglia were cut from adult animals (3-4 months) and transplanted in vitro (DiovaCulture). Neurons were cultured for 7-14 days in a normal physiological solution containing glucose, lactate, pyruvate, and glutamine. The cultures were then fixed in formaldehyde and processed for immunofluorescence. The stained preparations were imaged using confocal microscopy.

Stimuli: A binary raster was used to drive the retinal circuitry. The stimuli were generated by a computer program that controlled the light intensity and duration of illumination. The illumination pattern was designed to elicit a range of responses from the retinal ganglion cells.

Firing rates: The firing rates of individual ganglion cells were recorded using high-speed video cameras. The firing rates were normalized by dividing the number of spikes per second by the number of cells in the recorded field.

**References**


**Conclusions**

Retinal whole ganglia were cut from adult animals (3-4 months) and transplanted in vitro for 7-14 days. The cultures were then fixed in formaldehyde and processed for immunofluorescence. The stained preparations were imaged using confocal microscopy. The firing rates of individual ganglion cells were recorded using high-speed video cameras. The firing rates were normalized by dividing the number of spikes per second by the number of cells in the recorded field.

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