Spatial extent of inputs to primate ganglion cells in natural viewing conditions

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Background

Pseudo-linear encoding models, where the first step is linear summation of the stimulus over space and time, have become the standard for predicting the responses of retinal ganglion cells (RGCs). They have been successful at predicting responses in some cases1-5. However, it is unclear how accurate this assumption of linearity is, given that there are many known nonlinear mechanisms that contribute to retinal light responses in specific stimulus conditions and cell types6,7. It is unknown whether primate RGCs sum visual inputs effectively linearly under the naturalistic conditions that it evolved to encode.

How accurate are pseudo-linear models in predicting primate ganglion cell responses to naturalistic stimuli?

Modeling

The linear-nonlinear Poisson model (LNP) is one of the simplest and easiest to use models, and has been shown to work fairly well. However, it does not capture correlated firing or precise spike train structure, which can be measured with more accurate generalization linear models (GLL). However, making these models flexible enough to work for natural scenes and still computationally tractable has proven difficult.

How do different types of pseudo-linear models perform on natural scenes?

Methods

Large-scale multielectrode recordings were performed in peripheral macaque retina ex vivo.

Natural scenes consisted of images from the van Hateren database8 with fixational eye movements simulated by Brownian motion9,10.

Previous work indicates that ON parasols integrate visual inputs more linearly than OFFPs 12. A similar asymmetry was observed in 13 preparations tested using natural scenes (shown, same as green preparation above).

What effect does peripheral stimulation have on RGC responses under natural viewing conditions?

Extra-classical receptive field effects

RGCs can receive peripheral input from outside their classical receptive fields, thought to be transmitted through wide field amacrine cells. How do peripheral stimuli influence responses of primate RGCs in natural viewing conditions? Do we need to include peripheral input in our models?

The spatial extent of inputs to ON and OFF parasol RGCs can be predicted from the classical receptive field.

The temporal filter is more biphasic and the spiking nonlinearity is more saturated for natural scenes.

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