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Exploring the network structure of concerted activity in the primate retina using maximum entropy methods[1]

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All visual signals in the brain originate in the electrical activity of retinal ganglion cells (RGCs). Standard models implicitly assume that RGCs signal information independently of one another. However, several studies have demonstrated that significant concerted activity in pairs of RGCs may fundamentally alter visual signals. We recorded the electrical activity of several hundred RGCs in peripheral monkey retina. The regular mosaic organization of RGCs indicated that we recorded from nearly every cell in a region of the visual field. In the presence of constant illumination, pairs of RGCs fired synchronously several-fold more often than expected by chance, indicating significant network interactions. Synchrony was localized and universal amongst cells of the same type indicating that it arises from local and highly stereotyped circuitry. To test whether concerted firing can be explained by known pairwise interactions, we used a maximum entropy approach borrowed from statistical mechanics to predict concerted activity. The model accurately reproduced the data. This suggests that network interactions in the primate retina are well approximated by a nearest neighbor Ising model and concerted activity can be understood based on local interactions within a neural population.

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