

Computational Neuroscience & Neural Computing: Garrett Kenyon P-21

What is computational neuroscience?

- Using computer models as scientific tools for understanding biological nervous systems

What is neural computation?

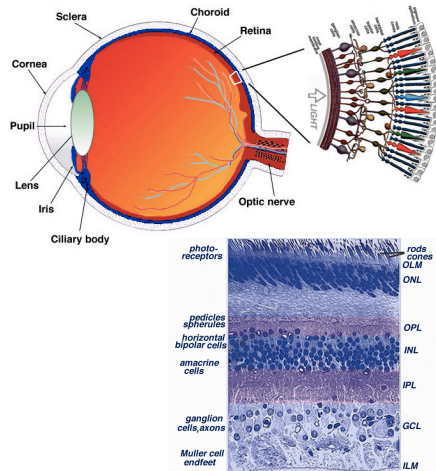
- Biologically inspired signal processing

Who are we?

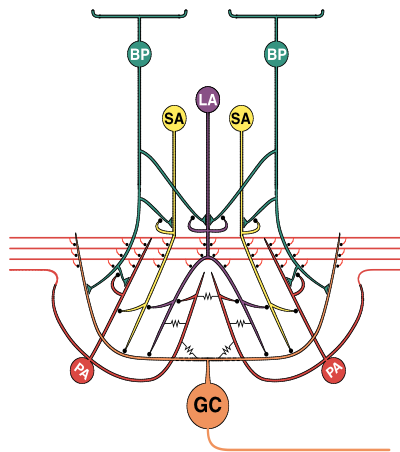
- 2 P-21 full time TSMs (Kenyon and Moses)
- 1 P-21 postdoc (Stephens)
- 5 GRAs and UGs (Jeffs, Moore, Yuen, Denning, Hill)
- LANL TSM collaborators (Rector P-21, George P-21, Travis EES, Theiler NIS, Moore NIS)
- Outside collaborators (Marshak U.TX, Elias U.DE, Mitchell SFI)



Computational Neuroscience: Retina



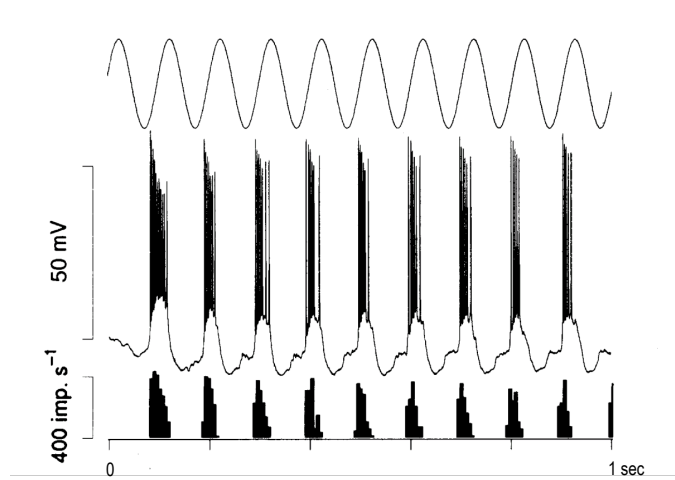
Kolb, Fernandez & Nelson



Kenyon et al, *J. Neurosci.*, (submitted)



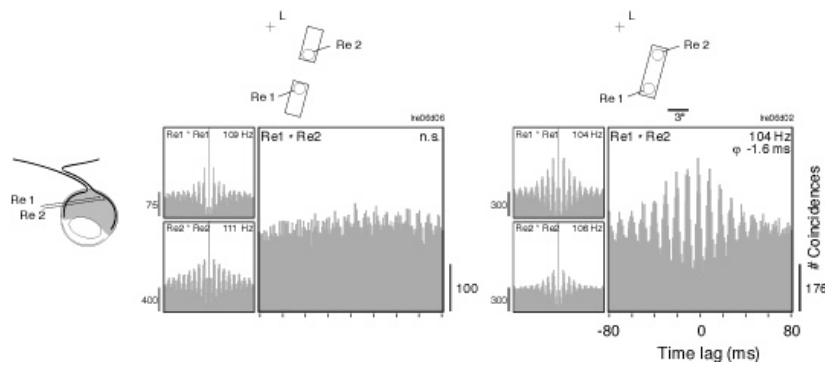
Firing Rate Encodes Local Intensity



Dacey & Lee, *Nature*, 1994



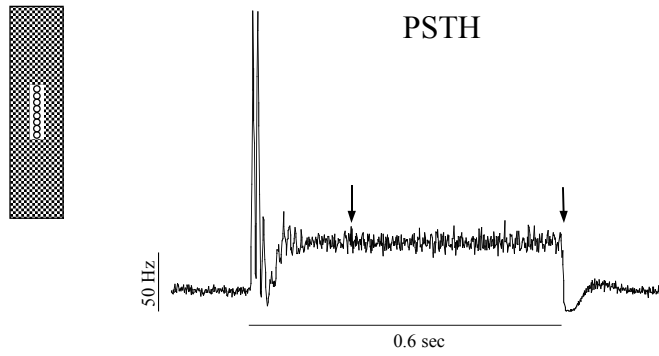
Synchrony Encodes Global Topology



Neuenschwander & Singer, *Nature*, 1996



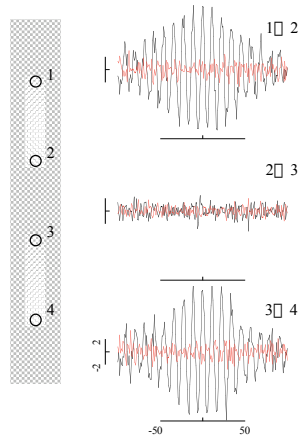
Realistic Light Responses in Model



Kenyon et al, *J. Neurosci.*, (submitted)



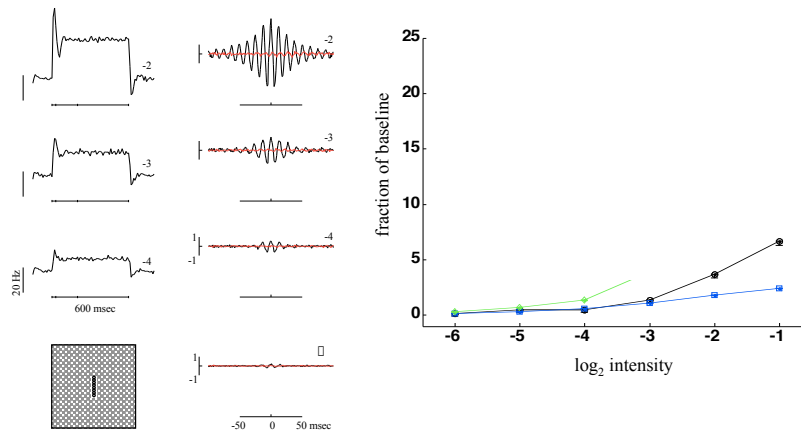
Feature-Selective Synchrony in Model



Kenyon et al, *J. Neurosci.*, (submitted)



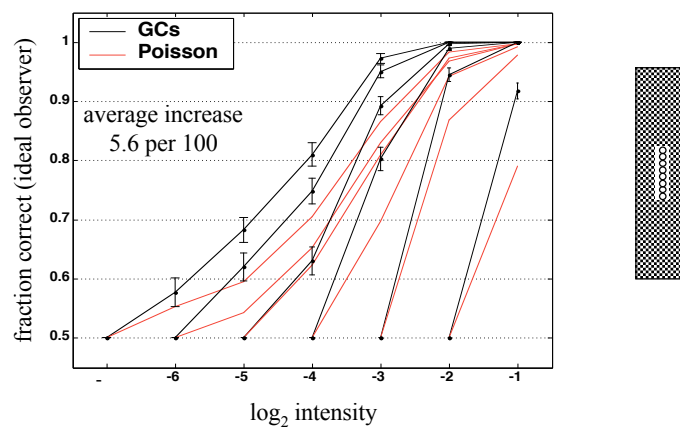
Synchrony Encodes Local Attributes



Kenyon et al, *J. Neurosci.*, (submitted)



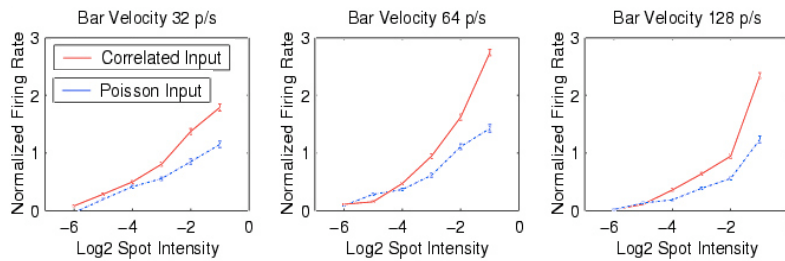
Improved Intensity Discrimination



Kenyon et al, *J. Neurosci.*, (submitted)



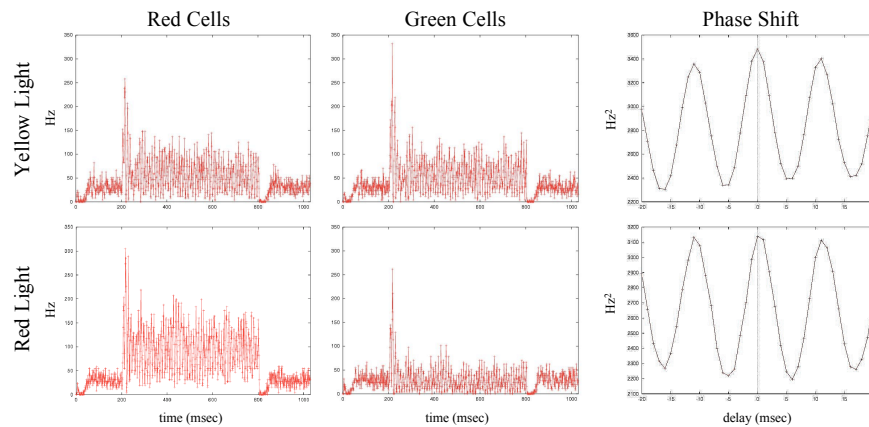
Improved Detection of Moving Bars



Moore, Jeffs & Kenyon et al, *ARVO Abs.*, (submitted)



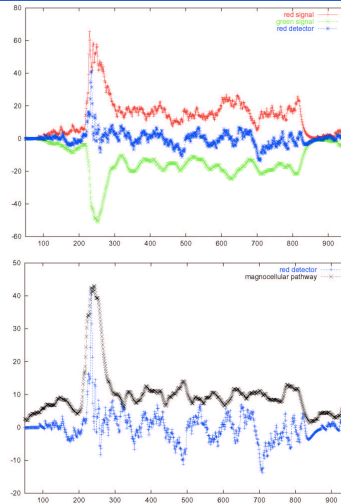
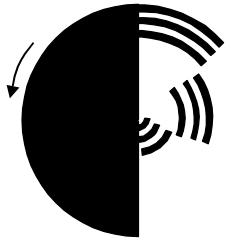
Phase Encoding of Color



Yuen, Moses & Kenyon



Benham Top

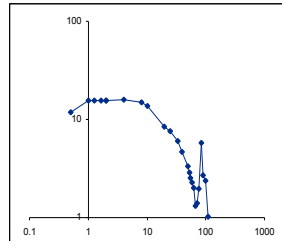


Hill, Moses & Kenyon

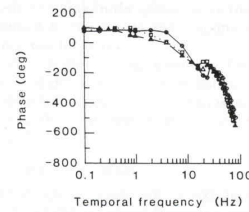
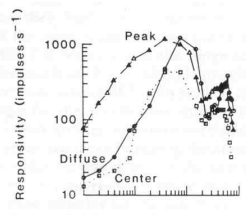
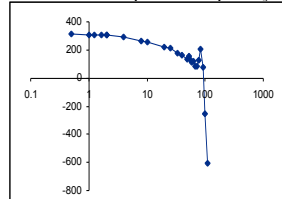


Resonance to Drifting Gratings

Response vs. Temporal Frequency



Phase vs. Temporal Frequency



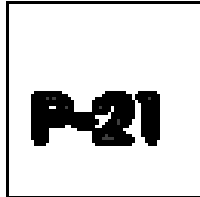
Frishman et al, *J. Gen. Physiol.*, 1987

Denning & Kenyon



Synchrony and Image Reconstruction

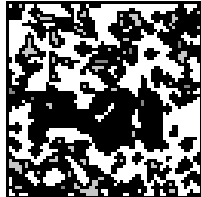
original image



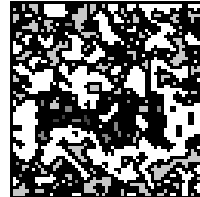
sum



coincidence



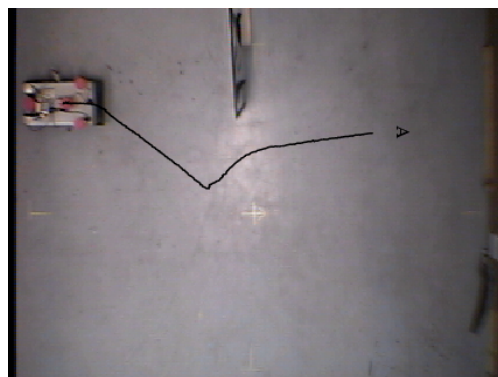
rate



Stephens, George & Kenyon



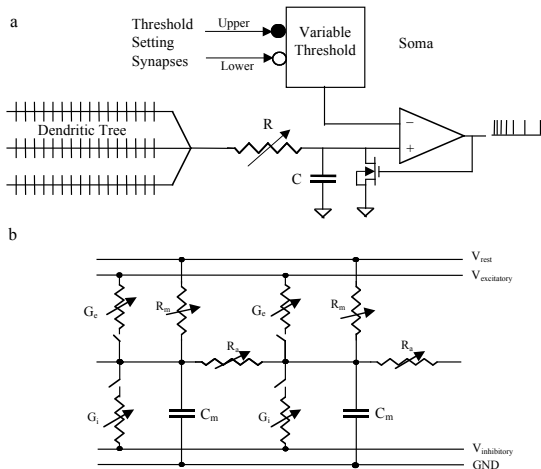
NeuroComp: Autonomous Navigation



Galbraith & Kenyon



Neuromorphs



Moses and Elias



Future Work

Computational Neuroscience

- Collaboration with Experimentalists (Singer, Rector, Espy)
- Retinal Encoding, Information Theory and Natural Images
- Biologically Realistic Retinal Models (Parallel Computing)
- Models of Barrel Cortex

Neural Computation

- Autonomous Navigation
- Neuromorphic Hardware and Real-Time Processing
- Distributed Sensor Networks and Collective Computation
- Automatic Target Recognition
- Tactile Discrimination and Hydrodynamic Following
- Speaker Identification and Speech Recognition



