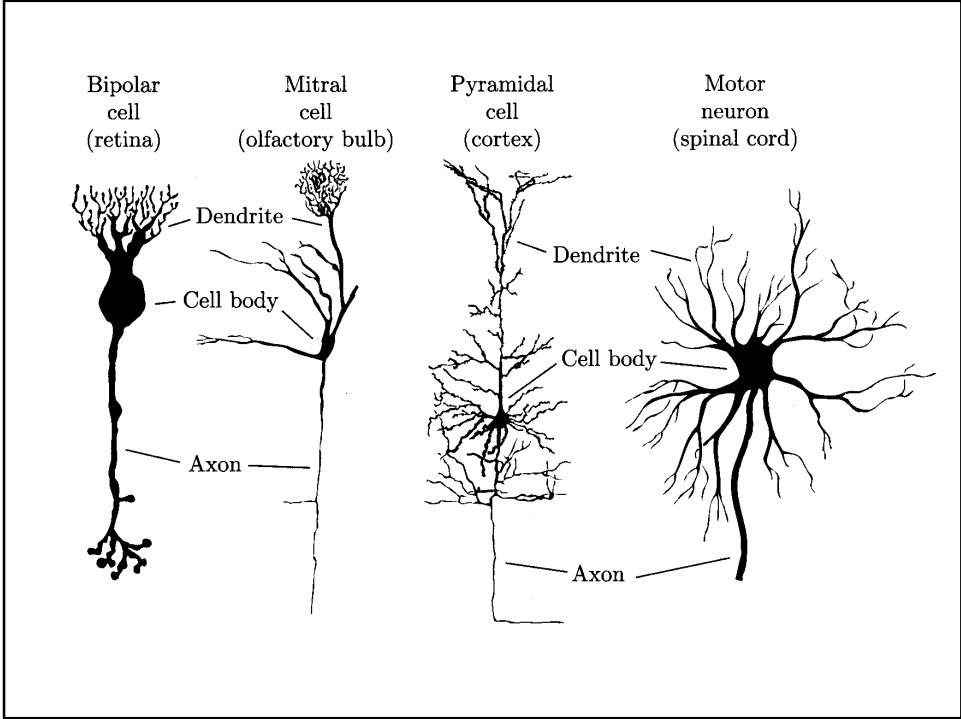
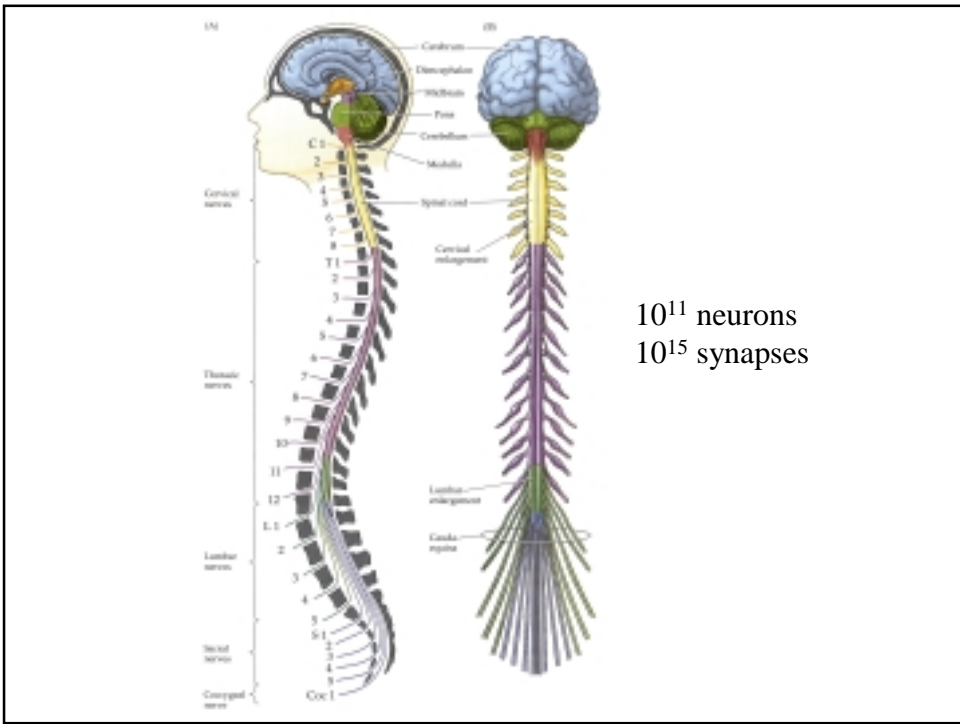
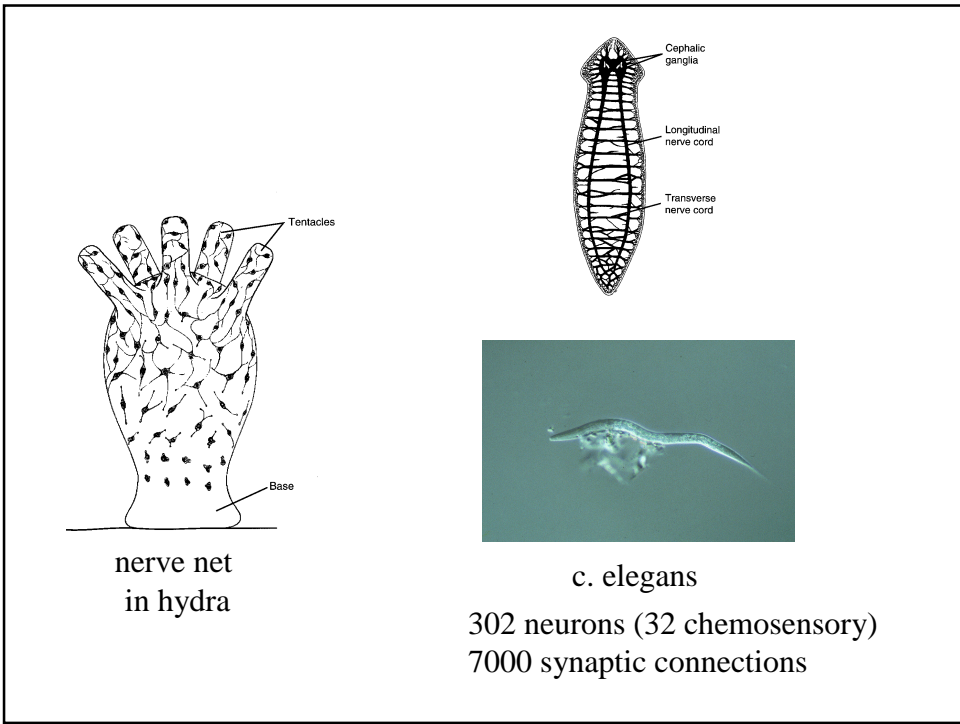


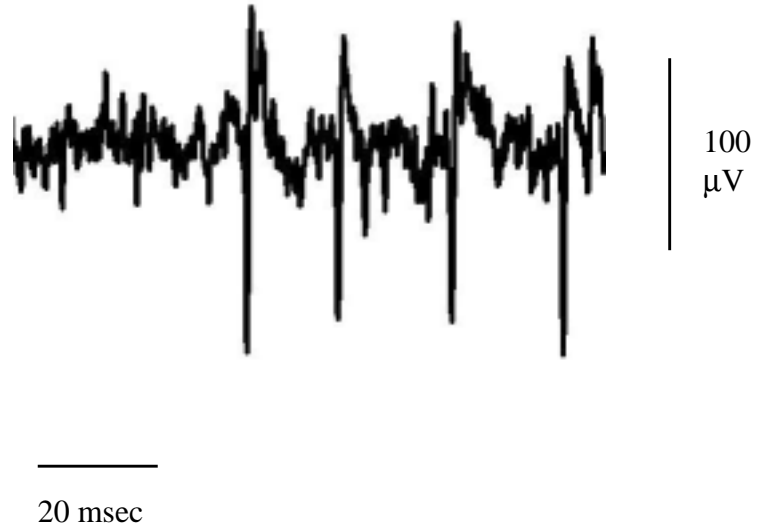
Overview of Neuronal Dynamics

Basic Features of Nervous System Organization





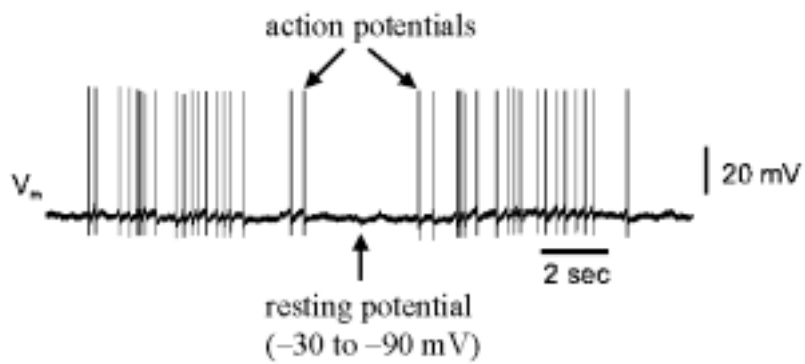
extracellular action potential

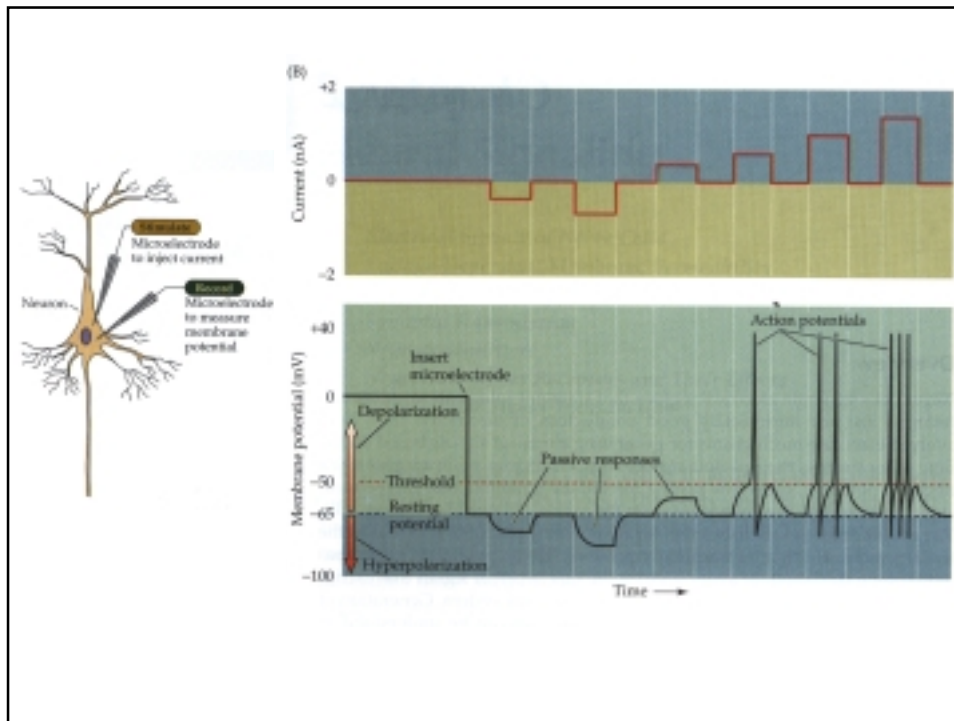


Intracellular Recording

$$V_m = V_i - V_e$$

(trans)membrane = intracellular - extracellular



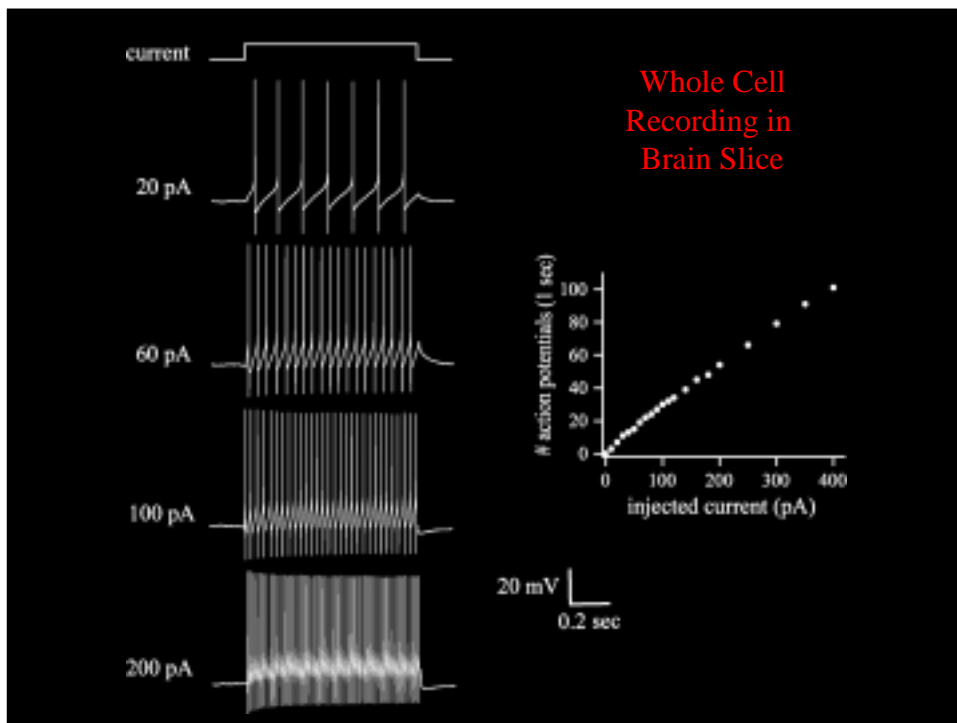
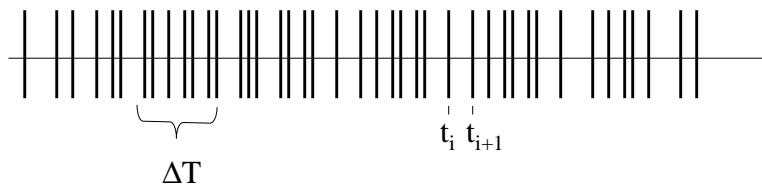


## Fast Spiking Interneuron - Response to Current Injection

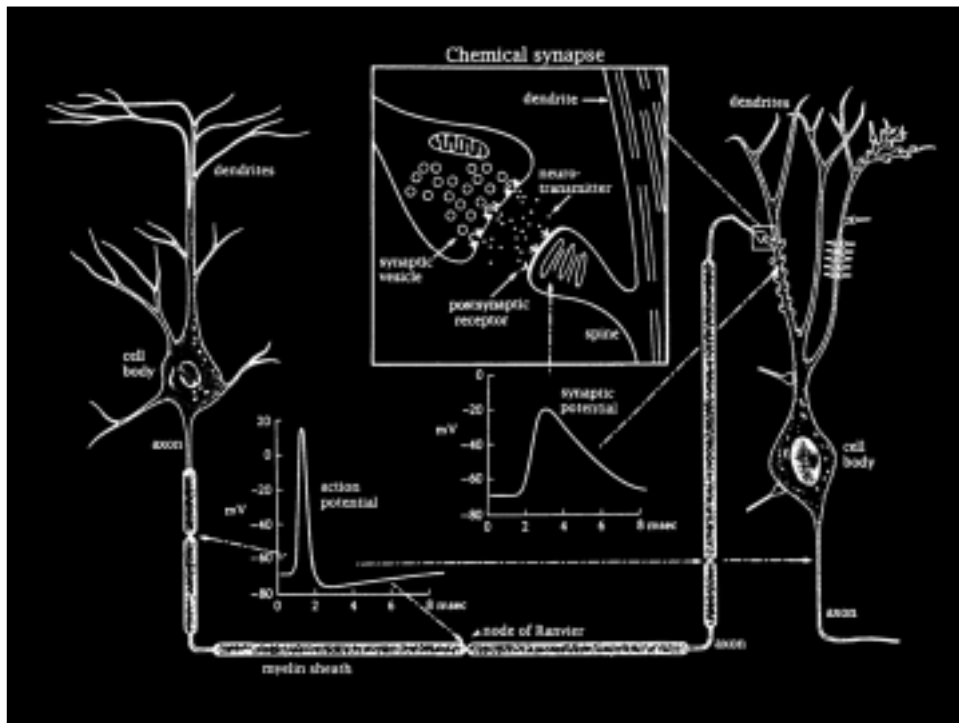
Brain Slice Intracellular Recording

encoding: mean firing rate

$$f(t) = \frac{1}{\Delta T} \int_t^{t+\Delta T} \sum_{i=1}^{n_i} \delta(t' - t_i) dt'$$



# Thalamocortical Neurons Have Two Firing Modes



## Neuronal Dynamics: electrical and chemical signals

- biophysics of single neurons
- interactions between neurons

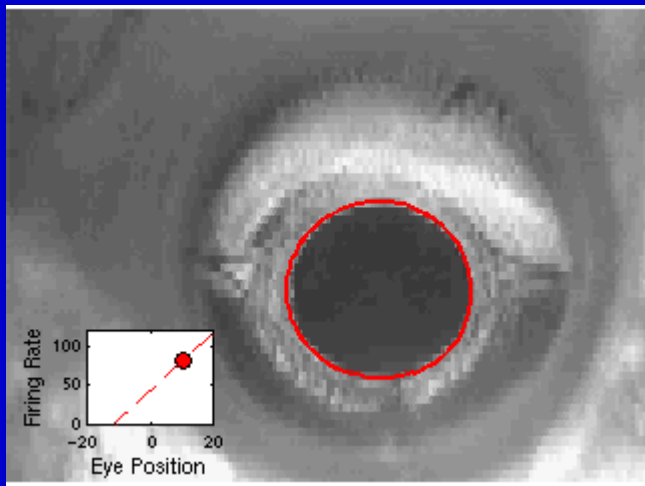
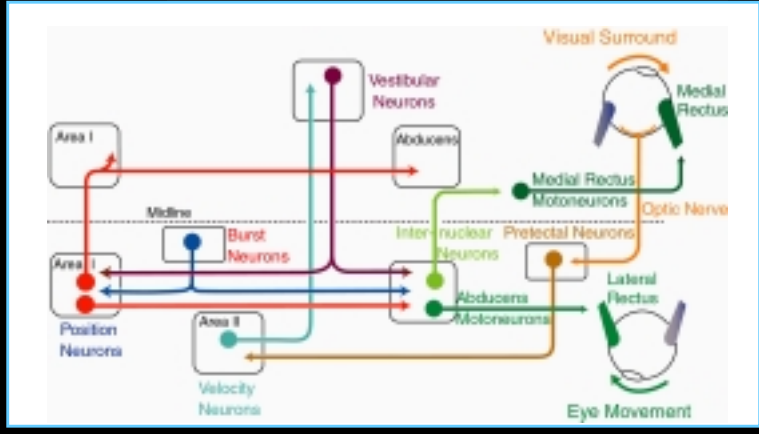
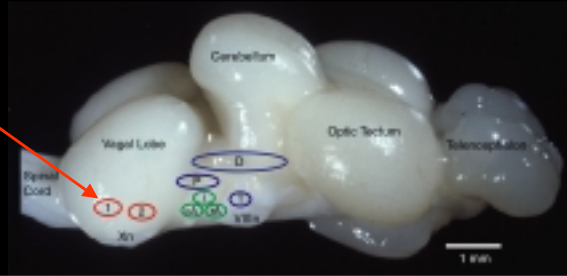
Encoding: how are sensory stimuli, motor control commands, memory, reward represented in these signals

Neural Computation: coding + dynamics

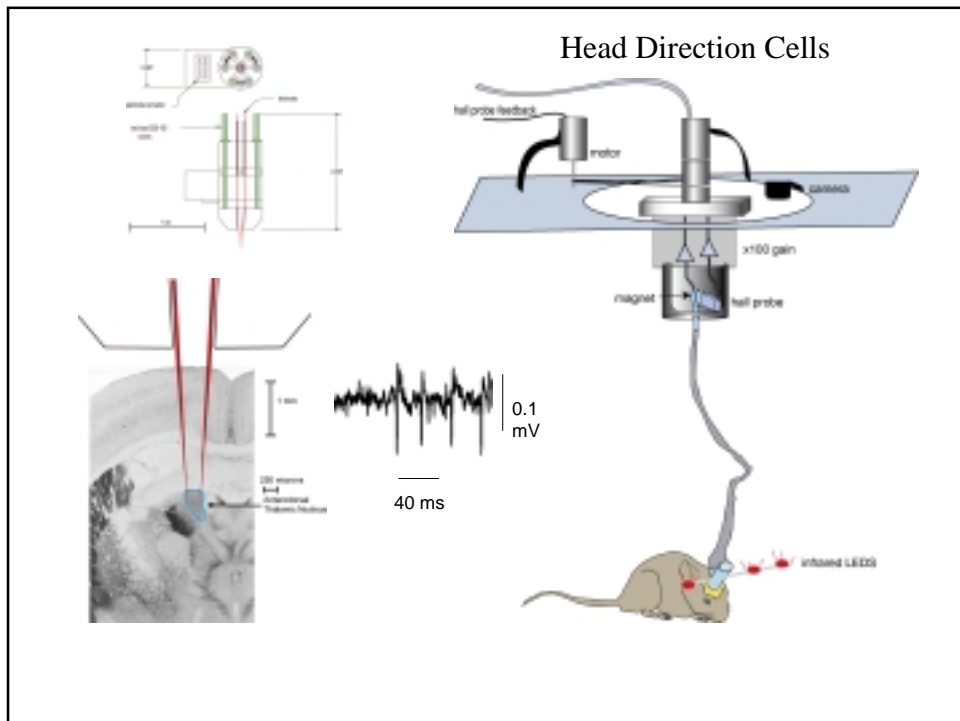
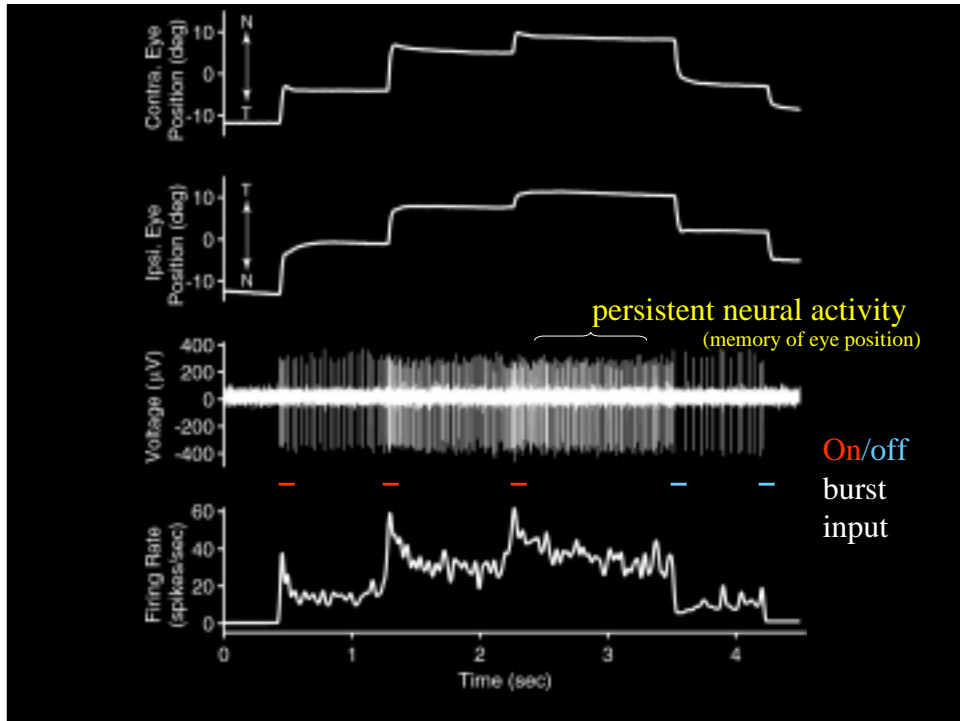
## Eye Fixation During Spontaneous Horizontal Eye Movements

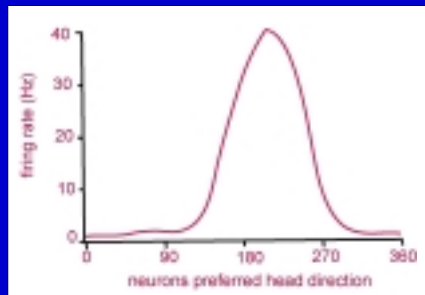
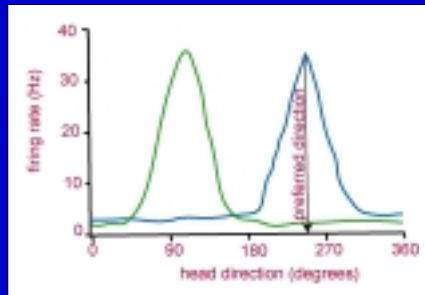
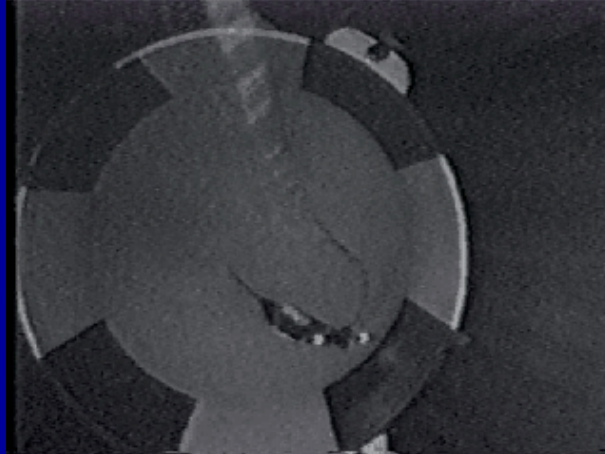


Area 1  
(velocity-to-  
position neural  
integrator)

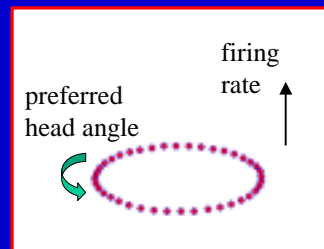








Neural Dynamics  
During Integration  
(ring network)



persistent pattern of activity  
that “rotates” to new position  
with integration of vestibular  
head velocity signals

## Eye Fixation

## Head Direction Cells

Neural Signal: action potential

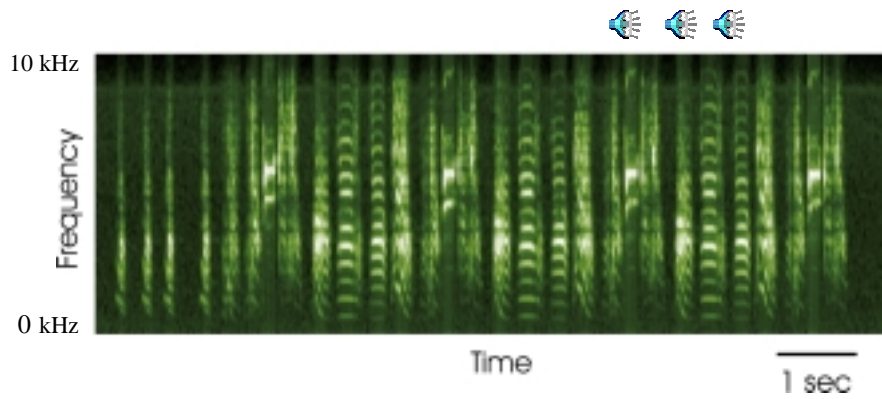
Encoding: mean firing rate encodes  
motor command (eye position) or  
“computed” head direction in  
laboratory frame of reference

Dynamics: Persistent Neural Activity

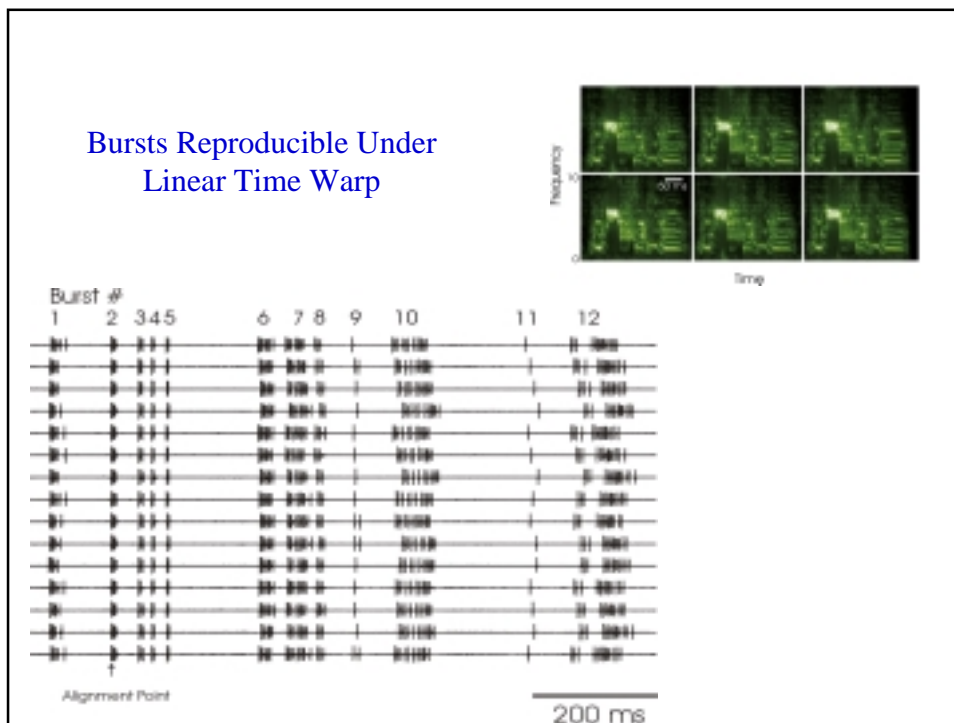
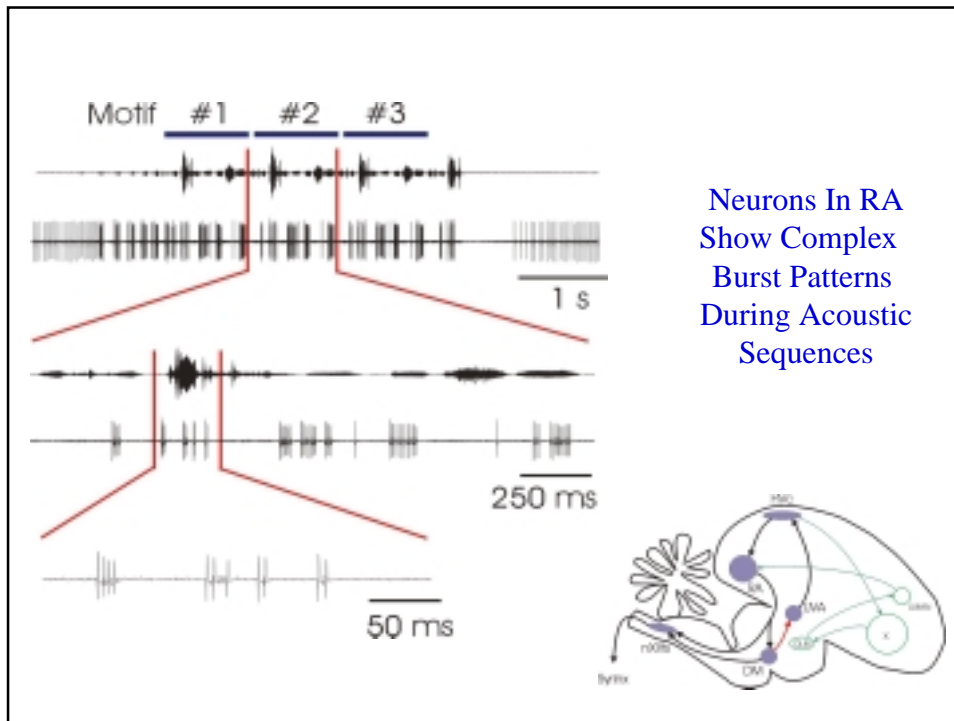


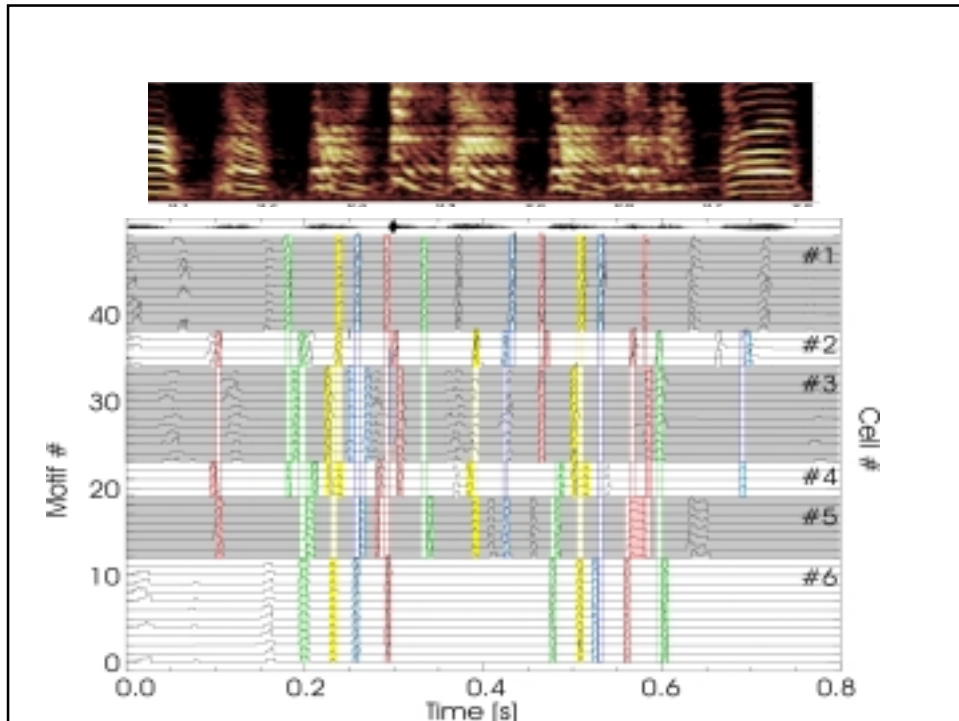
zebrafinch

A New Form of Neural Dynamics During  
Acoustic Sequence Production



(Fee)





## Bird Song Production

Neural signal: action potential

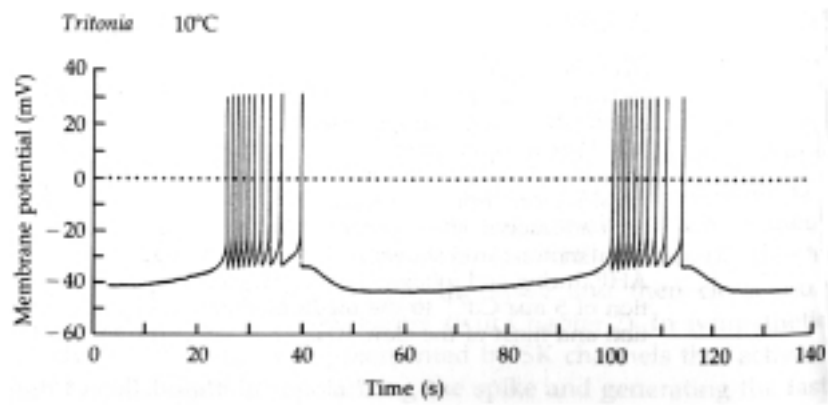
Encoding: bursts of action potentials signify articulator positions

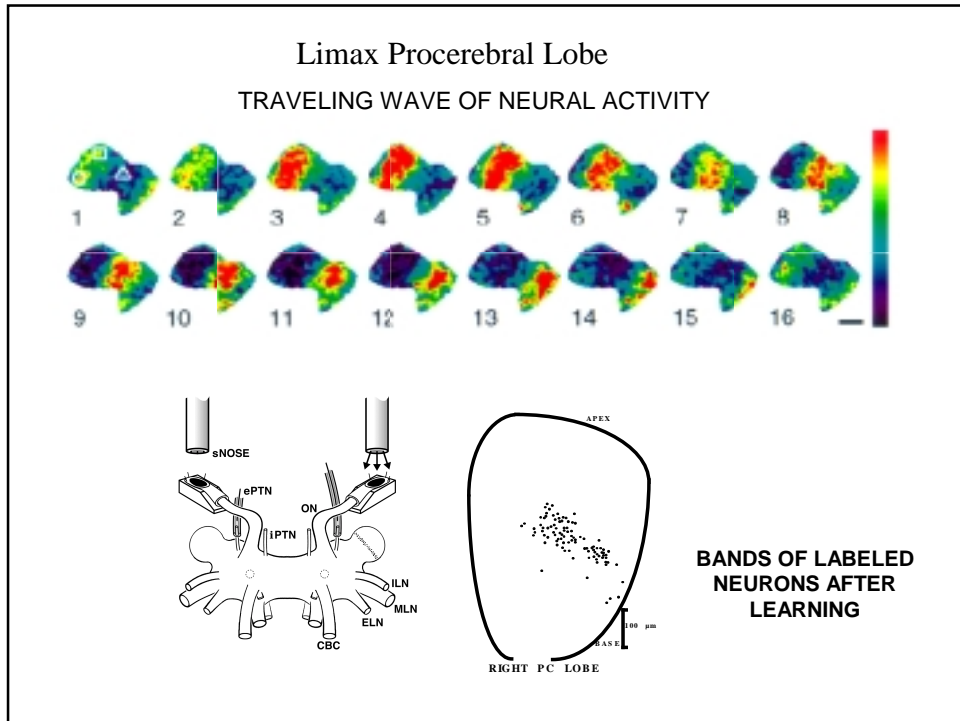
Dynamics: burst sequence with synchronized transitions

## Tritonia escape response



## Intrinsically bursting neuron





## Central Pattern Generators

## Olfactory Systems

Neural Signal: action potential/ sub-threshold membrane potential

Encoding: CPGs: muscle tension for rhythmic contractions, olfaction?

Dynamics: Oscillation (.7 Hz -100 Hz)



noise, fluctuation