

Scale Issues in Brain Science

- Communities of Organisms in a Life World
 - Navigate a world of inanimate, animate stimuli
 - Other species: harvesting, predator/prey relationships
 - Same species - cooperative behavior, mating
 - Releaser behaviors
 - Complex social behaviors and communication
 - Human institutional behavior

Scale Issues in Brain Science

- Nervous System has sub-networks
 - Peripheral : Sensory transducers, Motor effectors
 - Ganglia, Spinal: simple? computations, reflexes, transmission
 - Brainstem, Midbrain, Cortex
 - Diffuse endocrine, hormonal modulators
 - Grey matter cortex - processing
 - White matter cortex - transmission, communication

Scale Issues in Brain Science

- Regions - Cortical Brodman's areas
 - Observable in imaging, injuries (lesions), pre-surgery stimulation
- Cortex
 - Vertical Laminar Structure
 - Horizontal Columnar Structure
- Sub-Cortical Nuclei
 - Hard to observe in humans

Scale Issues in Brain Science

- Long Range Networks: Brain state
 - Observable in imaging like fMRI, PET, MEG
- Local Networks and Neuropil
 - Excitatory, Inhibitory Populations
 - Short Range, Long Range Connections
 - Observable in Local Field Potential EEG in animals, MEG
 - Observable via correlations between single neurons

Scale Issues in Brain Science

- Neuron
 - Synapse->In (dendrite)->Body->Out (axon)
 - Observable as spikes: rates, interval probabilities, return maps (nonlinear technique)
- Dendritic Fields and substructures
 - Ion channels, voltage sensitive geometry,
 - Weak Electotonic (voltage field) coupling via gap junctions
- Synapse substructure

Scale Issues: Time, Spike Level

- Spike Firing sensory 10/ s , 100/sec in motor
- Area Responses-each stage 30ms, sensory response correlated to behavior, recognize 10 common objects/ sec
- Synchronization Epochs
- Functional Epochs 50-250 ms

Scale Issues: Time, Wave Level

- EEG waves - δ , θ , (6, 10, 40)
- Evoked Potential EEG - many cortical areas
 - <1 sec

Scale Issues: Time, Learning

- Adaptive Synapses or Dendritic Processing
- milliseconds
- Short Term Learning - seconds
- Long Term Learning - hours, days