SIMULATIONS OF SYNAPTIC POTENTIALS USING REALISTIC MODELS OF HIPPOCAMPAL PYRAMIDAL NEURONS. J. Wathey, W. Lytton, J. Jester and T. Sejnowski, Salk Institute, La Jolla, CA.

Different portions of a pyramidal cell may operate independently along one physiological dimension while interacting along another. Parameters that may be involved include voltage changes, second messengers, ion fluxes, morphological and metabolic changes. To assess the relative contribution of these influences, we have modeled an anatomically realistic CA1 pyramidal cell at different levels of physiological detail. We used the simulation program "CABLE" (M. Hines and J. Moore) with morphological data provided by D. Amaral.

Initially, we determined whether passive properties could produce asymmetrical voltage responses in apical and basilar dendritic fields to synaptic input on the opposite side. With low membrane resistance, a basilar tetanus showed 30% less influence on the apical region than a normalized apical tetanus produced in the basilar region. Even with maximal synaptic input, however, the resulting depolarization in the other compartment was only 5-10 mV with these parameters, too low to be significant. With passive somatic and dendritic membranes, the addition of a spike-generating axon had virtually no effect on the membrane potential elsewhere in the cell. Soma-generated spiking was reflected throughout the neuron and transformed a low frequency signal in the apical dendrites into passively conducted spikes in the basilar dendrites. Slower Ca^{++}-mediated spiking in the apical dendrites smoothed the signals received via the soma from the basilar dendrites to produce more consistent depolarization in the apical dendrites. These possibilities can be tested by studying interactions between different parts of pyramidal cells in slice preparations.