Rhythms of the Nervous System
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Rhythms of the nervous system have been linked to important behavioral and cognitive states, including attention, working memory, associative memory, bottom-up feature binding, object recognition, sensory motor integration, perception and language processing. Pathologies in the rhythms have been linked to schizophrenia and Alzheimer's disease. Although these rhythms have been detected both in vitro and in vivo, how they participate in cognition is still not understood. The general aim of this proposal is to make use of biophysical information about cells and synapses in modeling studies to understand the origin and mechanisms of coherence of the various rhythms displayed in nervous system. Some of this information exists from previous experiments. Other data will be gathered in experiments proposed here. The proposal focuses on three important rhythms: gamma (30-80 Hz), beta (12-30 Hz) and theta (4-11 Hz). A major goal of this work is to understand how the mechanisms that produce the rhythms influence the way the nervous system processes structured input. There are many experimental paradigms that produce different versions of rhythms with the same frequency range. These are analogues of different in vivo situations, and can have different reactions to pharmacological perturbations. In different versions of the same frequency rhythm, there are different synaptic conductances that are critical and there may be different classes of interneurons participating. The modeling aims to probe the roles of the different intrinsic and synaptic currents in producing the individual rhythms and the interactions among them, including nesting rhythms and the transitions among them that are associated with changes of behavioral state. Experiments, done in tandem, aim to reveal more details of the electrophysiological and pharmacological properties of the classes of interneurons, and roles of electrical synapses in producing rhythms. There will also be experiments aimed at teasing out different rhythms in different layers of the neocortex. Other experimental paradigms will probe effects of sensory stimuli, the importance of synaptic plasticity in the transformation among rhythms, and the conditions under which nesting of gamma and theta occur. We will also study, both experimentally and via modeling, separated networks that produce a coherent gamma rhythm, and networks distributed over space.

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