Excitatory and inhibitory interactions in core interneuron circuits of the respiratory central pattern generator

The pre-Bötzinger complex (pre-BötC) is an essential core component of the brainstem respiratory rhythm-generating circuitry and receives convergent synaptic inputs from numerous neuron populations. Phasic excitatory and inhibitory synaptic inputs during the respiratory cycle are thought to dynamically shape membrane potential trajectories/spiking patterns of pre-BötC neurons. These inputs reflect the functionally interacting neuron populations in the rhythm generation circuits. We have elaborated a technique for the reconstruction of patterns of synaptic conductances from membrane potential trajectories obtained by sharp microelectrode intracellular recording from pre-BötC respiratory neurons in the perfused brainstem-spinal cord preparations of mature rats. This preparation provides favorable conditions for intracellular recordings due to its incredible mechanical stability. We distinguished different types of inspiratory and expiratory pre-BötC neurons and analyzed changes of excitatory and inhibitory synaptic conductances throughout the respiratory cycle from current-clamp recordings. The different types of neurons showed specific characteristic patterns. The reconstructed patterns of inhibitory and excitatory synaptic conductances allow us to define and classify the types of respiratory neural populations involved in respiratory rhythm generation and their interactions. The functional excitatory and inhibitory interactions indicated by these studies are generally consistent with circuit architecture proposed in our previous models to account for rhythm generation and a three-phase respiratory pattern.