Reconstruction of synaptic inputs to pre-Bötzinger complex neurons in situ

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The pre-Bötzinger complex (pre-BötC) is an essential 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 and spiking patterns of pre-BötC neurons, but the temporal fluctuations of synaptic conductances have not been well characterized. We applied sharp microelectrode intracellular recording techniques to characterize spiking patterns, membrane potential trajectories, and synaptic conductances of pre-BötC respiratory neurons within in situ perfused brainstem-spinal cord preparations of mature rats, which provide favorable conditions for intracellular recording analysis of synaptic mechanisms during inspiratory (I) and expiratory (E) phases in a functionally intact brainstem. We distinguished different types of I and E pre-BötC neurons and analyzed changes of excitatory (Ge) and inhibitory (Gi) conductances throughout the respiratory cycle from current- and voltage-clamp recordings. The different types of neurons showed characteristic patterns of Ge/Gi fluctuations. Pre-I and ramp-I neurons exhibited strong excitatory inputs with maximal Ge of up to 80% and 60% of neuronal leak conductance, respectively. In pre-I neurons Ge increased in mid-E, was maximum during the I phase (defined by phrenic nerve activity) and then rapidly declined at I termination. Ge occurred primarily during the post-I period and was nearly an order of magnitude lower. Gi in aug-E neurons was maximum during I with lower, gradually declining values during the first half of E.

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