Sighing: an inspiration with larger amplitude or longer duration?

Consuelo Morgado-Valle, Luis Beltran-Parrazal.

Centro de Investigaciones Cerebrales. Universidad Veracruzana, Xalapa.
Instituto de Neurobiología, UNAM

Breathing is a continuous behavior essential for life in mammals and one of the few behaviors that can be studied in vivo in intact animals awake, anesthetized or decerebrated and in highly reduced in vitro and in situ preparations. ThepreBötzinger complex (preBötC) is a small nucleus in the brainstem that plays an essential role in normal breathing and is widely accepted as the site necessary and sufficient for generation of the inspiratory phase of the respiratory rhythm (Smith et al., 1991). Throughout life, plasticity of preBötC neuronal network is a must.

Adaptations must be made “on the fly”, i.e., while still functioning, and there is little margin for error. The respiratory rhythm must be modulated in the short-term during processes such as locomotion, exercise, and sleep, and in the long-term by illness, changes in altitude, and aging. Also, respiration must be integrated with speech, swallowing, chewing, and defecation.

As result of synaptic interactions, preBötC inspiratory neurons burst a train of action potentials on top of a 5-20 mV depolarization lasting 0.3-0.8 s dubbed inspiratory drive. Each inspiratory burst is repeated every 3-10 s, a period named interbust interval. Evidence shows that although the preBötC is not a chemosensitive nucleus, it is susceptible to modulation from chemosensitive areas such as the nucleus of the solitary tract (NTS) and the retrotrapezoid
nucleus/parafacial respiratory group (RTN/pFRG). This modulation leads to the emergence of new respiratory patterns such as sighing (Li et al., 2016). Here, we aimed to characterize the sigh burst and pattern at inspiratory neuron and motor output levels. We evoked sighing by bath applying the peptides bombesin or substance P (SP) to the brainstem transverse slice preparation that includes the preBötC and the XII nerve (XIIn). In whole cell patch clamp recordings from inspiratory preBötC neurons, we found that sighing is better described as an increase in burst duration rather than in amplitude. Using either single neuron or XIIn burst, sighing can be predicted by an algorithm that incorporates burst duration. This result suggests that the signal cascades stimulated by peptides to evoke sighing interfere with the mechanisms for burst termination at the single-cell level.