Department of Mechanical and Biomedical Engineering

Simulations of brainstem respiratory networks modeled from multi-neuron recordings

Professor Kendall F. Morris
Professor
Department of Molecular Pharmacology and Physiology Neuroscience
Morsani College of Medicine, University of South Florida, USA

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Venue: Room B6619 (MBE Conference Room), AC1

Abstract

A great deal of morbidity and mortality worldwide results from the dysregulation of cardiorespiratory control. Advances in treatment will be incremental without a deeper understanding of the brainstem neural networks that play an important integrative role in the regulation of breathing and circulation. We investigate the distributed cardiorespiratory brainstem network, including rostral medullary neurons in the region of the retrotrapezoid nucleus, dorsolateral pons, nucleus tractus solitarius, raphé and ventrolateral cardiorespiratory column that integrate central and peripheral afferent inputs and produce appropriate motor control. Our model is the decerebrate or anesthetized, adult cat. We use multi-electrode arrays to record extra cellular signals from many neurons simultaneously. We measure firing rate responses, respiratory and cardiac cycle triggered histograms and infer effective connectivity with such tools as cross correlation and the gravity method. Results include: 1. Multiple cardiorespiratory rhythms in neurons. 2. Predictive models of airway protective reflexes such as cough and swallow. We have also developed a
system for computer simulation of the models. The system includes a hybrid stochastic neural network composed of integrate-and-fire neuron populations coupled with a deterministic respiratory system mechanical model. The simulations produce realistic respiratory output, cough and swallow. The results suggest a distributed brainstem network architecture with connectivity that shapes the respiratory motor pattern via overlapping circuits that modulate afferent influences on breathing, cardiovascular control and airway defensive reflexes.

About the Speaker

Prof. Kendall Morris holds the position of Professor of Molecular Pharmacology & Physiology in Morsani College of Medicine of University of South Florida. He received his PhD. Degree from University of South Florida in 1993 major in Medical Science, Physiology. His research interest is in the field of cardiorespiratory control. His lab routinely records simultaneously the activity of over 100 neurons in the brainstem neural networks and statistically infer connectivity and the reconfiguration of connectivity in response to sensory input. They have developed model and simulate network functions to make predictions that guide in vivo experiments. The results have shown evidence of how brainstem networks participate in a type of respiratory memory termed long-term facilitation and the first evidence that the network in the brainstem that produces the respiratory rhythm reconfigures, i.e. makes a decision, to produce the very different behaviors of coughing and swallow.

All are welcome!
Enquiry: 3442 8420

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