Biology and Medicine Through Mathematics Conference

2022

May 18th, 5:00 PM - 7:00 PM

Scale-free properties influence breathing rhythmogenesis.

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BAMM! Abstract

Scale-free properties influence breathing rhythmogenesis.

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The preBötzinger Complex (preBötC) of the lower brainstem generates the rhythm for breathing movements. The preBötC is conserved across all terrestrial mammals, including humans. The rhythm emerges from excitatory synaptic interactions among constituent neurons, and to explain this rhythm, the structure of the network must be characterized. Here we study how hypothesized properties of network connectivity within the preBötC influence the dynamics of the breathing rhythm. We simulated the preBötC as 1000 coupled theta-neurons (conditional oscillators) in various network configurations: an Erdős-Rényi network with uniform synaptic weights (ER-U), an Erdős-Rényi network with a log-normal distribution of synaptic weights (ER-LN), and a uniform synaptic weight network with "scale-free" connectivity generated using the Barabási-Albert algorithm (BA-U). We find networks with scale-free properties (ER-LN and BA-U) reproduce several important experimental results more readily than the classical ER network. These results were obtained using slice explants from neonatal mice which retain a rhythmically active preBötC and include: 1) effect of experimental manipulation of excitability on burst frequency, 2) the threshold activation (4 to 9 neurons) required to evoke a network burst, and 3) ablating 10% of preBötC neurons irreversibly stops the rhythm. Elucidating the network topology of this conserved and physiologically essential network could aid in understanding brain related respiratory disfunctions including apnea syndromes, opioid-induced respiratory depression, or respiratory failure in neurodegenerative diseases.