

Session/Poster#

Presenter

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Biophysically Detailed Cellular and Network Models of Right Atrial Ganglionic Plexus

The heart's rhythm is generated by the sino-atrial node (SA), which receives direct parasympathetic input from the vagus nerve along with input from the intrinsic cardiac network (ICN), known as “the little brain” of the heart. The ICN comprises neurons clustered together into ganglia of 10s to 100s cells, which further conglomerate into plexi on the surface of the heart. The Right Atrial Ganglionic Plexus (RAGP) contains around 6 to 12 thousand such neurons and is critical in the cardiac response to vagal activity.

The RAGP receives input from two brainstem nuclei, the Nucleus Ambiguus (NA) and the Dorsal Motor Nucleus of the Vagus (DMV). The NA provides a fast lane via myelinated B-fibres responsible for reflexive changes in heart rate, such as the baroreflex and chemoreflex. In contrast, the DMV provides a slow lane via unmyelinated C-fibers and influences ventricular contractility but not heart rate.

We constructed 104 unique biophysical neuron models with Hodgkin-Huxley-based ion channels using single-cell transcription data from 321 neurons. Our neuron models were validated against published electrophysiological data, demonstrating the ability to build biophysical models solely from genetic data. We classified our neuron models as having either a phasic or mixed response during simulated current-clamp experiments.

We surveyed the literature for additional data characterizing the inputs, synaptic plasticity, and connectivity constraints. We used this information with our biophysical neuron models to build a network model in NetPyNE of the RAGP. We explored the parameter space for synaptic strengths to determine a physiologically plausible range of input intensity and interconnectivity. We used this model to examine the role of RAGP in regulating the vagal control of the heart.