The subfornical organ (SFO), a circumventricular organ that lacks the blood brain barrier (BBB), plays an important role in sensing various blood-borne signals from the peripheral circulation. SFO neurons integrate these signals and transmit them across the BBB to regulate critical autonomic functions, including cardiovascular and energy homeostasis. Previous findings from in vitro studies have established that SFO neurons exhibit a heterogeneity in their expression of ionic currents and consequent spiking behaviour, as well as their response to circulating peptides. Insight into the mechanisms behind this heterogeneity is critical for understanding how the SFO integrates and regulates autonomic function, but is currently lacking due to the limitations of patchclamp techniques.

To address this limitation, we developed a Hodgkin-Huxley style (HH) model of an SFO neuron, searching biophysical parameter values to match in vitro spike train data. The resulting HH model demonstrated the two major spiking behaviours exhibited by SFO neurons: tonic firing and bursting, where bursting is characterized by robust membrane potential bistability. These spiking behaviours were produced under different parameter values for a nonselective cation current, transient potassium current, persistent sodium current, and current noise. Established methods for neuronal spike train analysis were then used to classify SFO neurons based on their spiking behaviour, e.g. the coefficient of variation and distribution of interspike intervals, as well as their membrane potentials. Analysis of membrane dynamics characterized the neuronal mechanisms supporting these spiking regimes. These methods were further used to predict the behaviour of SFO neurons in response to the binding of angiotensin-II (ANG), a peptide hormone that acts within the SFO to influence various functions including blood pressure and fluid balance. Future use of this model will allow us to study the integration of ANG and other autonomic signals within the SFO.