Multiscale Model of Neural Control of Breathing

Ilya A. Rybak
Department of Neurobiology and Anatomy
Drexel University
College of Medicine
Philadelphia, PA
USA

Alona Ben-Tal
Department of Mathematics,
Massey University, Albany
New Zeeland

Thomas E. Dick
Department of Medicine
Case Western Reserve University
Cleveland, OH
USA

Julian F. R. Paton
Department of Physiology
University of Bristol, Bristol
United Kingdom

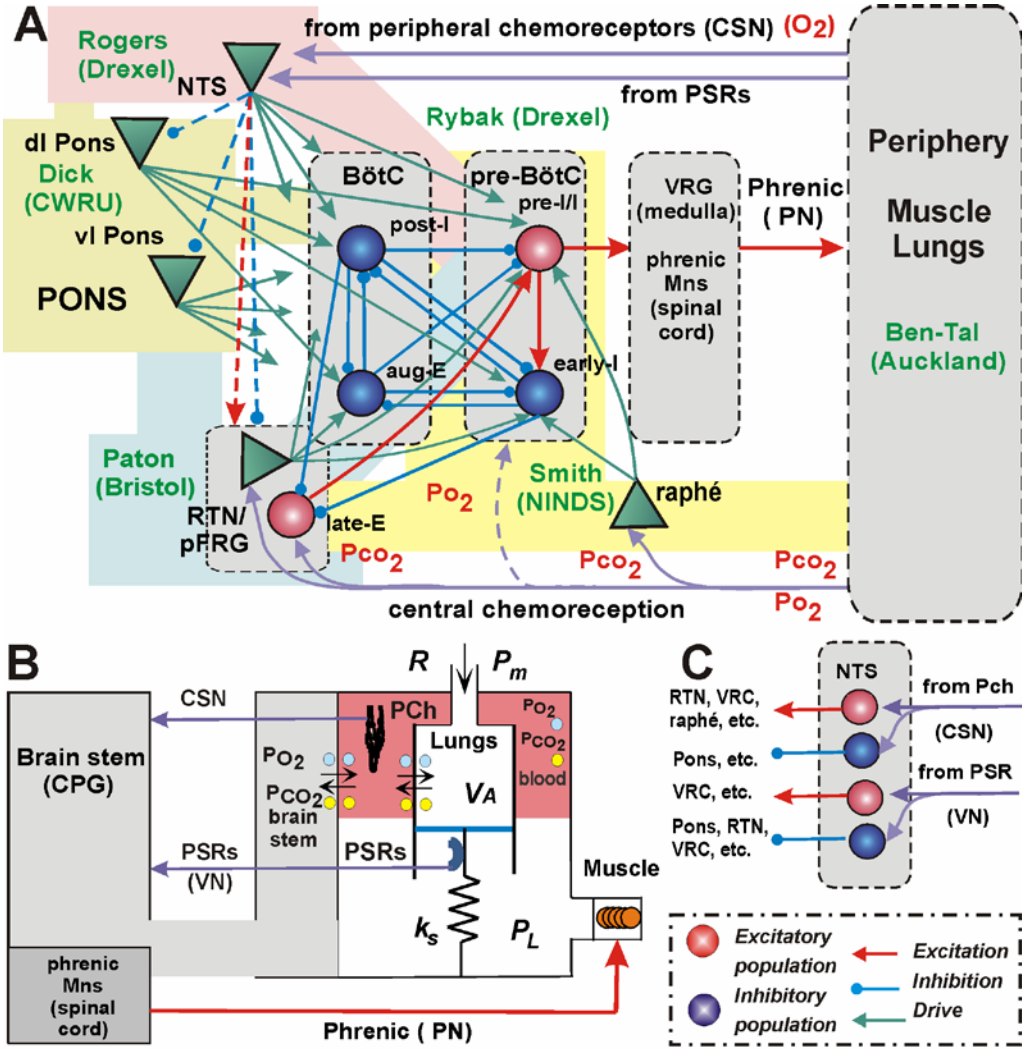
Robert F. Rogers
Department of Neurobiology and Anatomy
Drexel University
College of Medicine
Philadelphia, PA
USA

Jeffrey. C. Smith
NINDS/NIH
Bethesda, MD
USA

NINDS/NIH Grant R01 NS069220

MSM Consortium Meeting, October 5, 2011

Multiscale Model of Neural Control of Breathing



NINDS/NIH Grant R01 NS069220

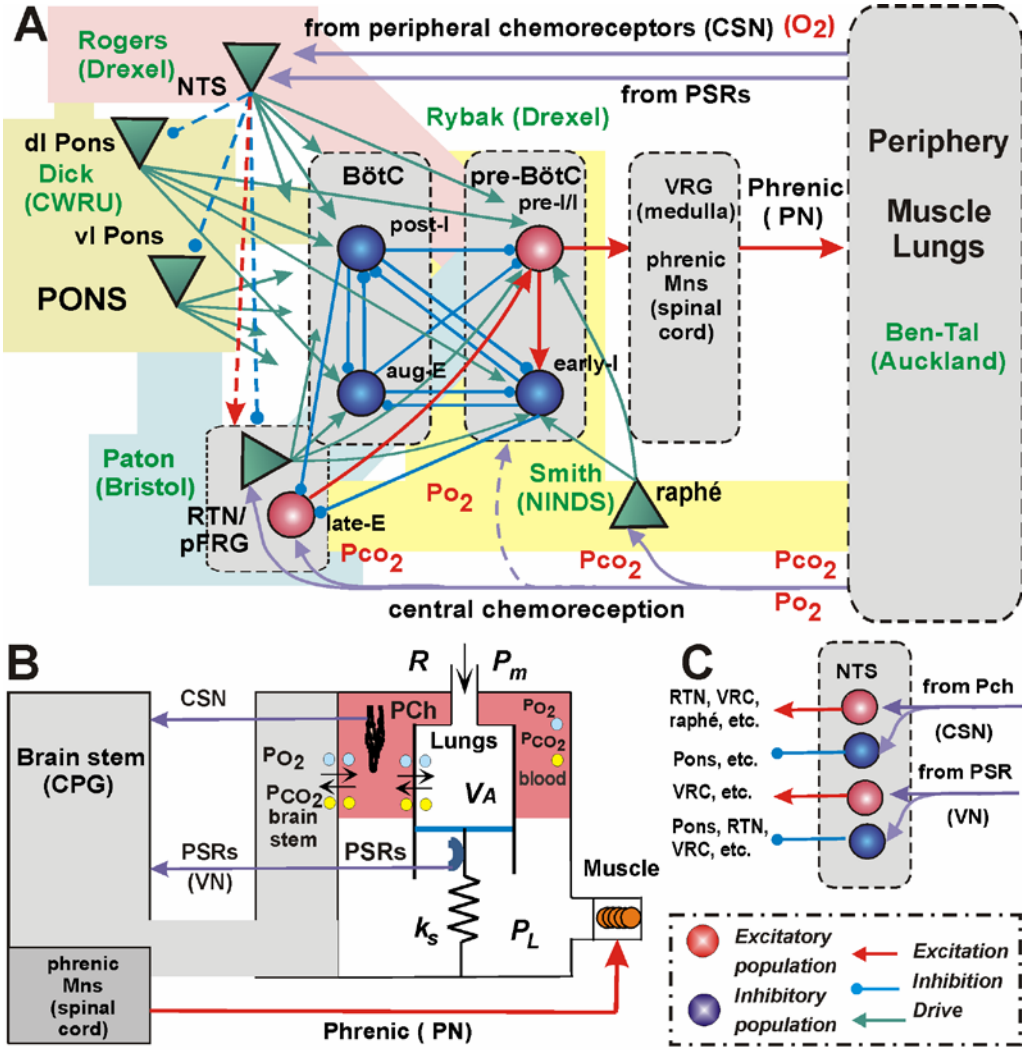
Multiscale Model of Neural Control of Breathing

Question:

What can we learn from simple models to study complex systems?

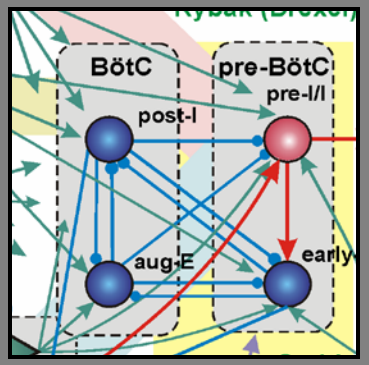
NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing



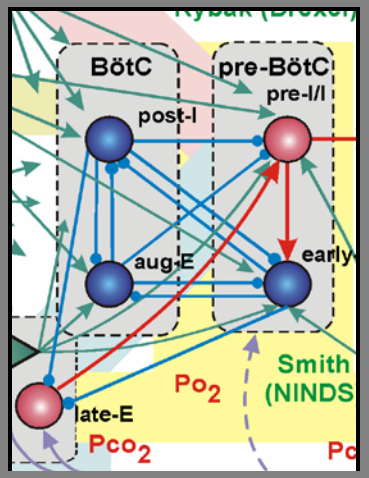
NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing



NINDS/NIH Grant R01 NS069220

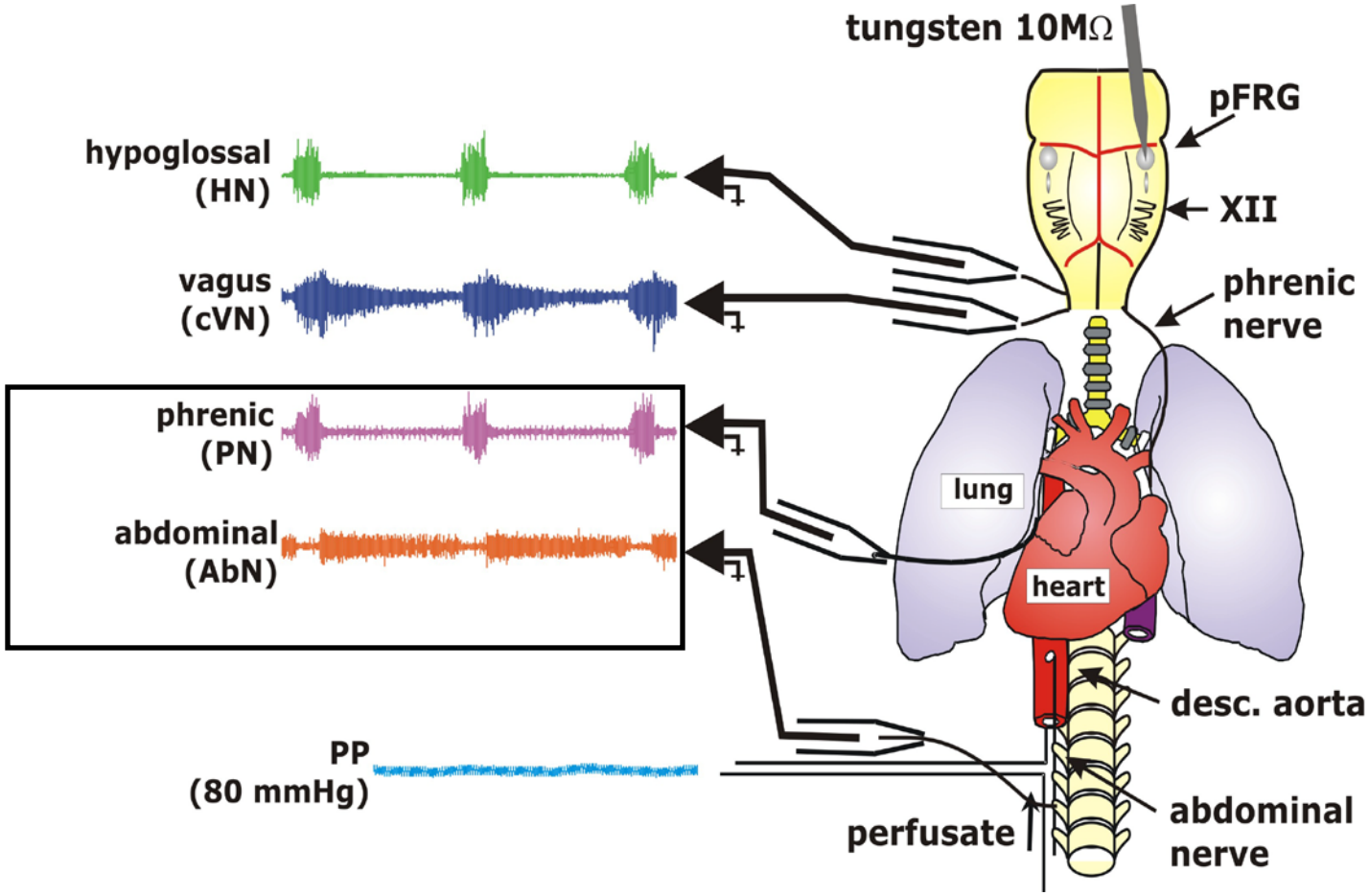
Multiscale Model of Neural Control of Breathing



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

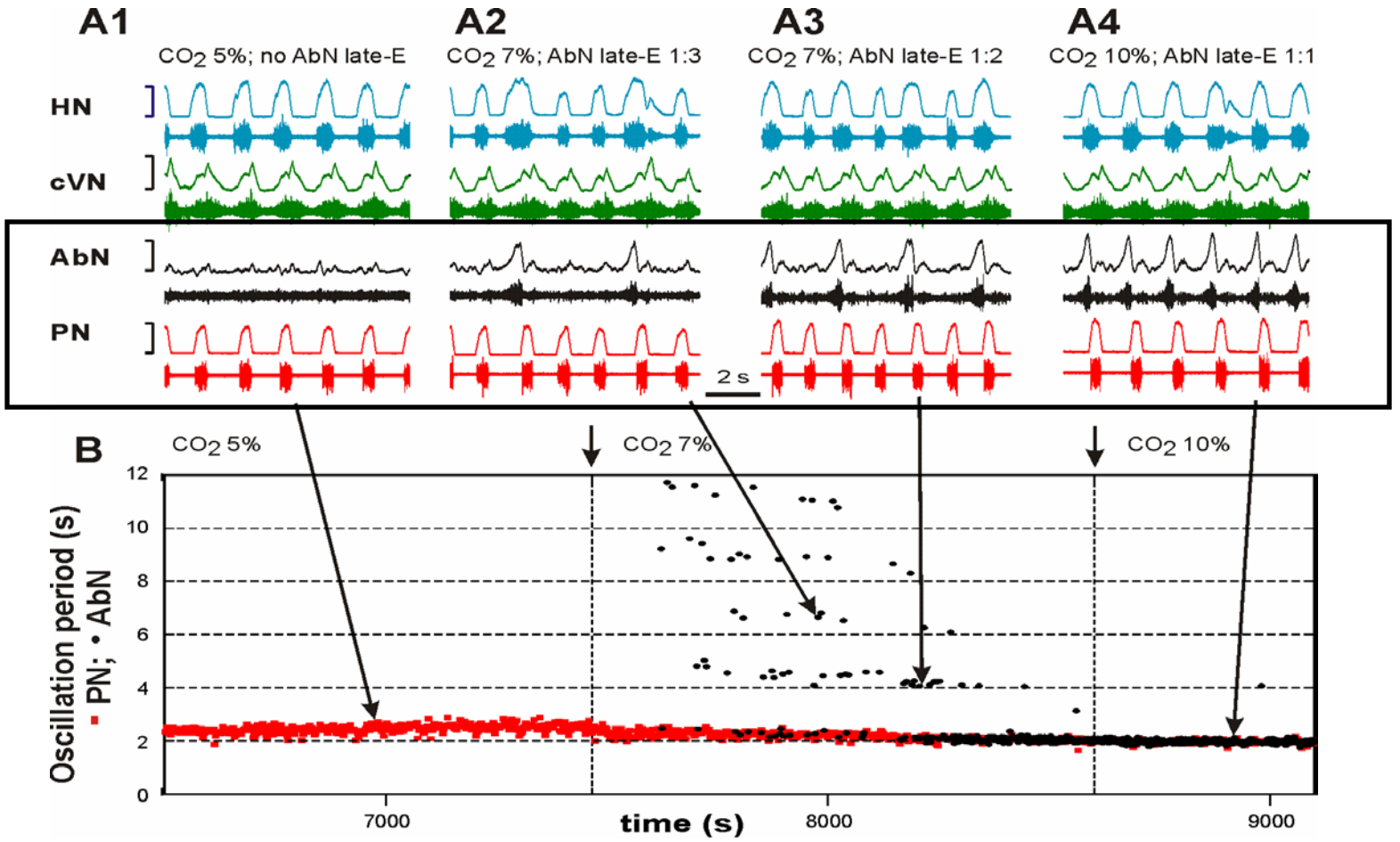
Generation and quantal acceleration of the abdominal late-expiratory activity development of hypercapnia (experimental data)



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

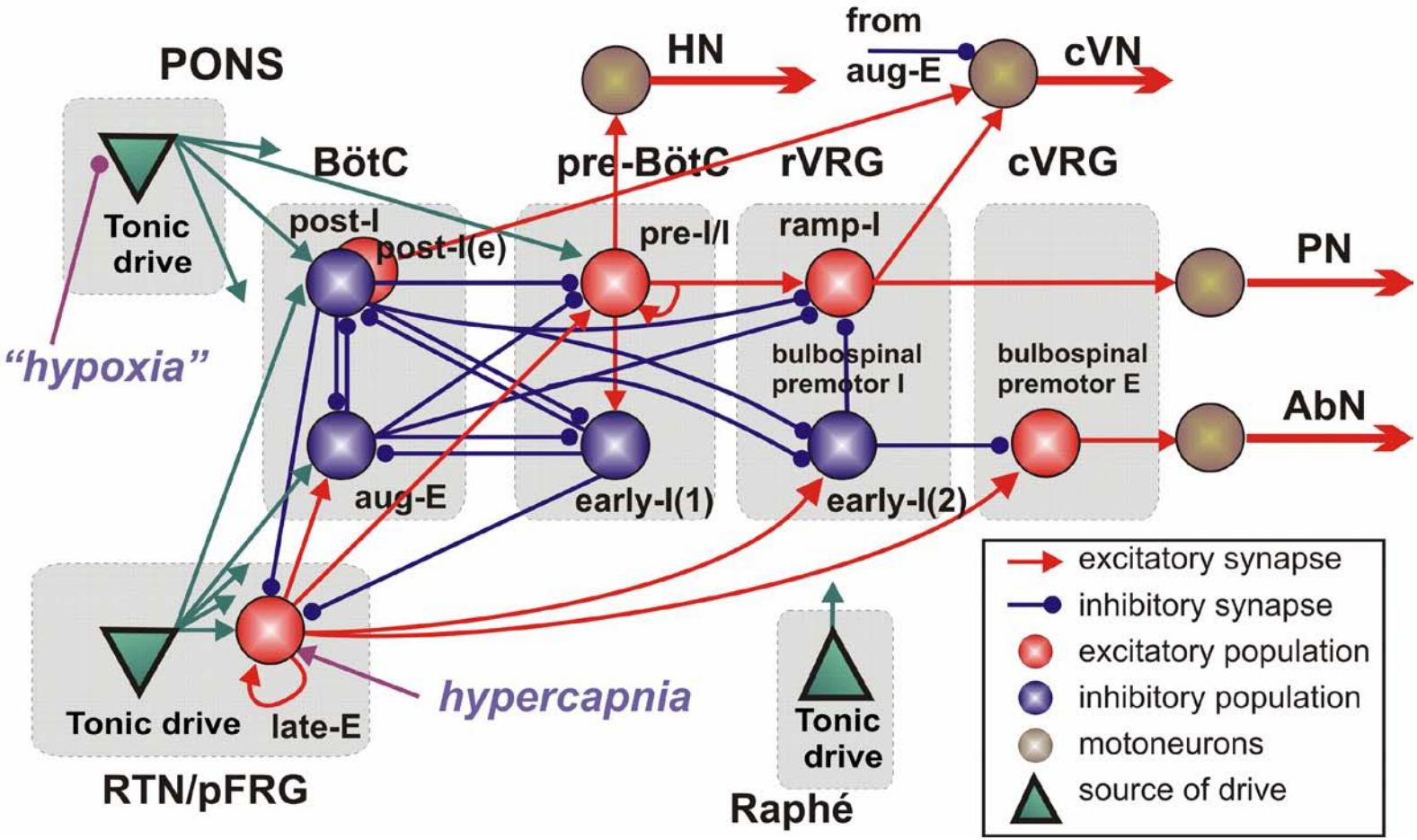
Generation and quantal acceleration of the abdominal late-expiratory activity with the development of hypercapnia (experimental data)



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

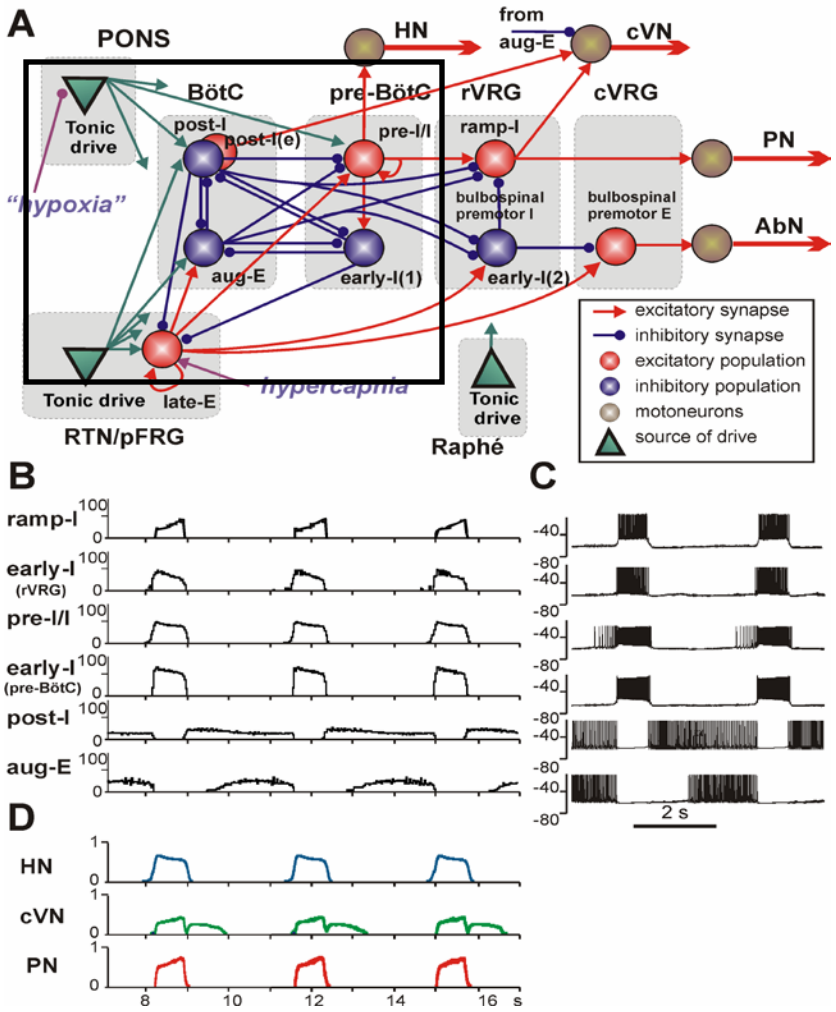
Complex computational model of the brainstem respiratory network



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

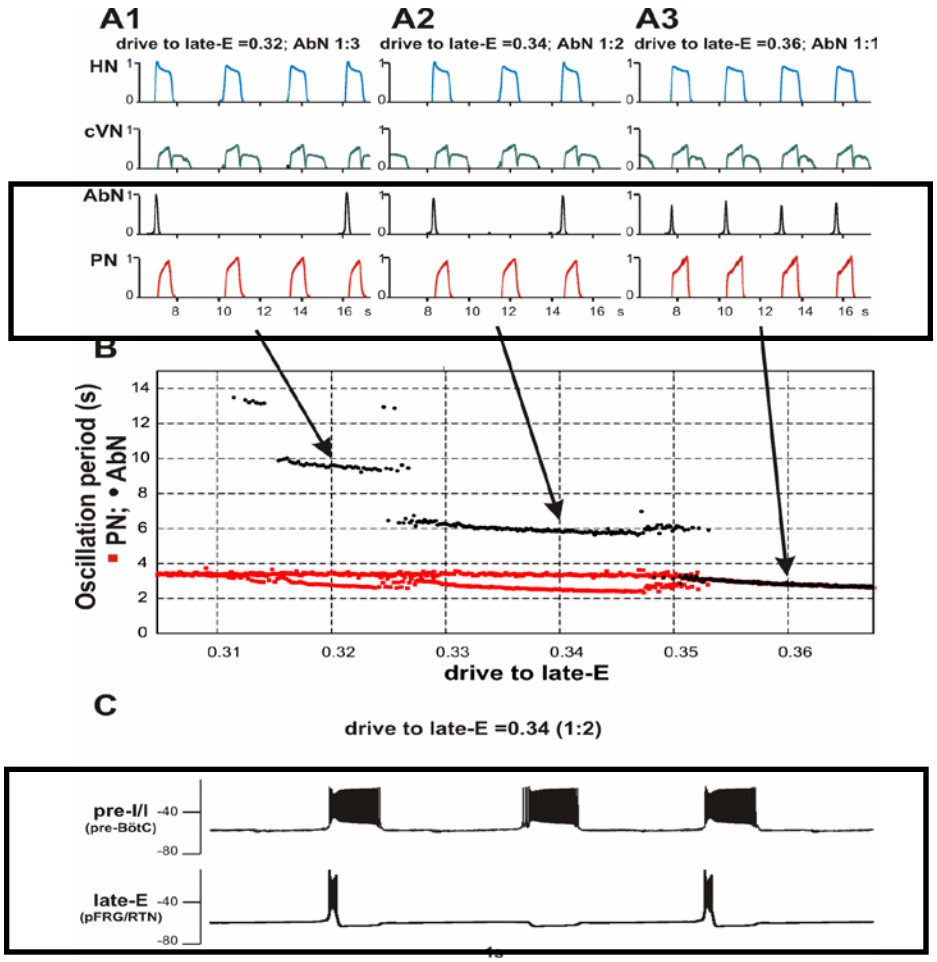
Complex computational model of the brainstem respiratory network



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

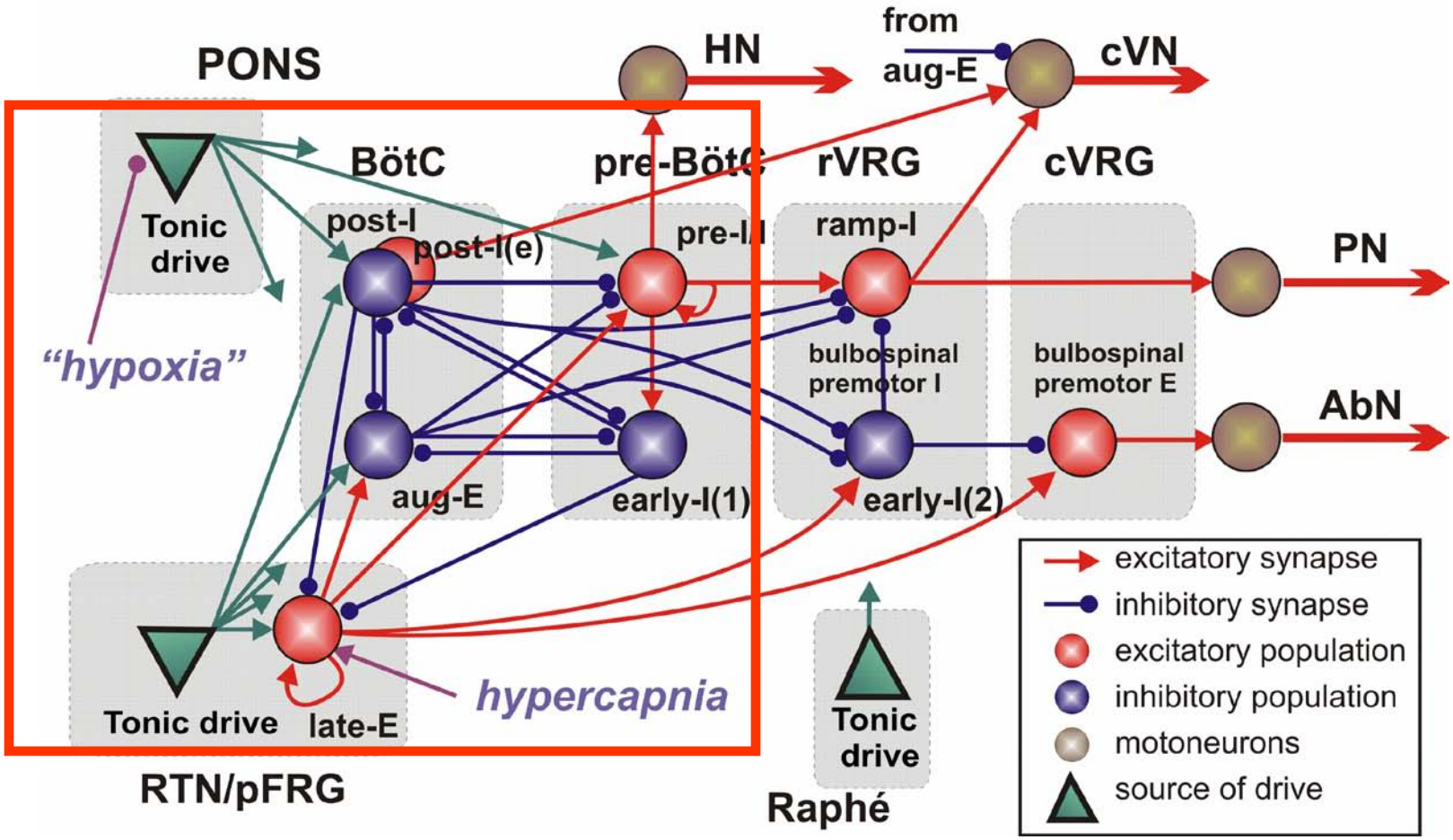
Generation and quantal acceleration of the abdominal late-expiratory activity with development of hypercapnia (model)



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

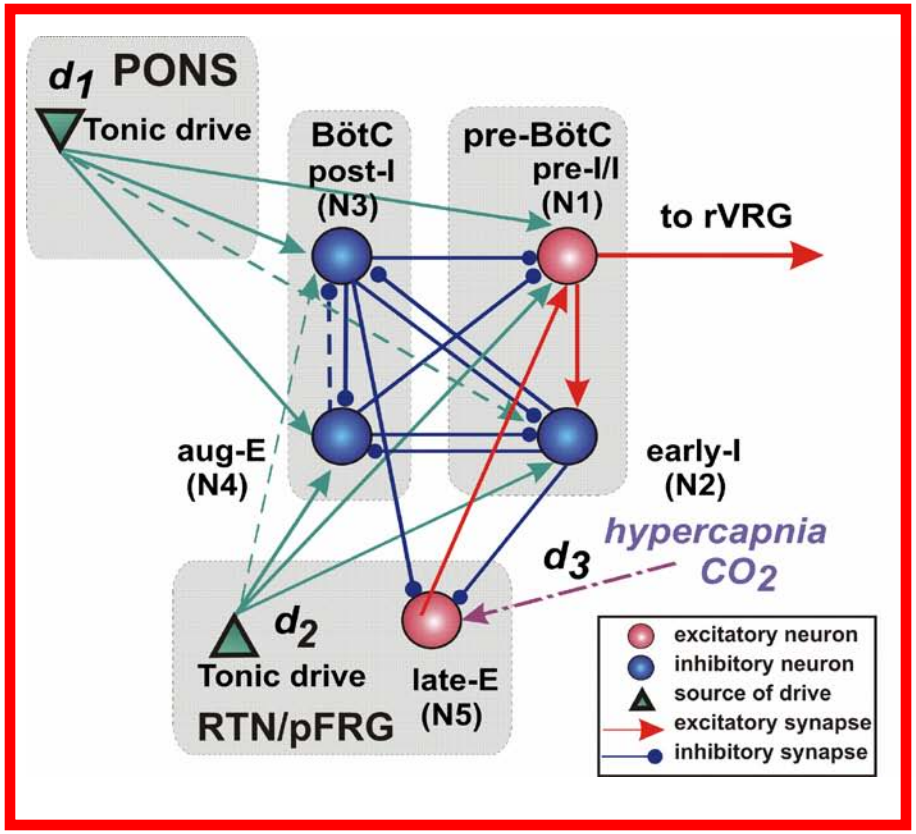
Complex computational model of the brainstem respiratory network

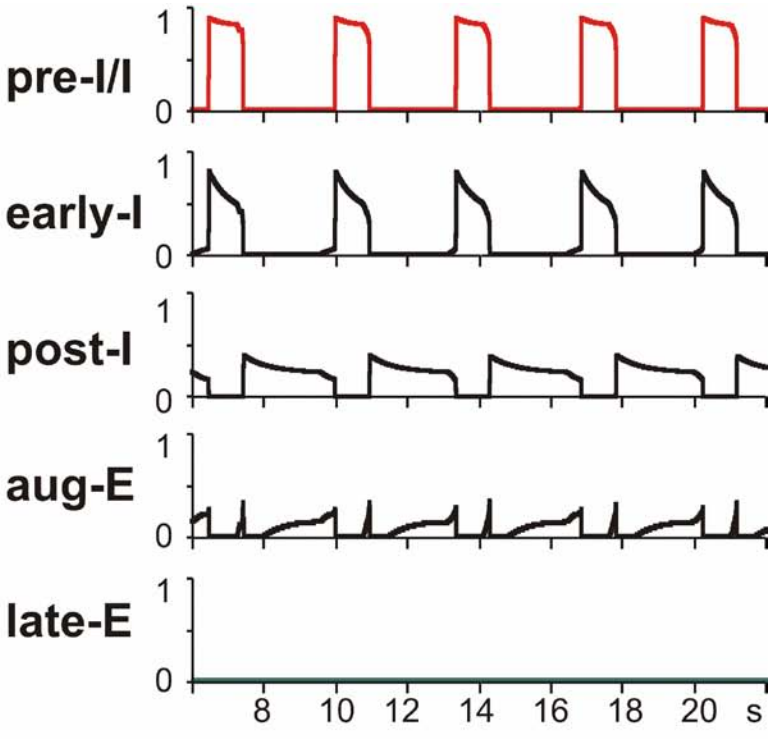


NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

Simplified model

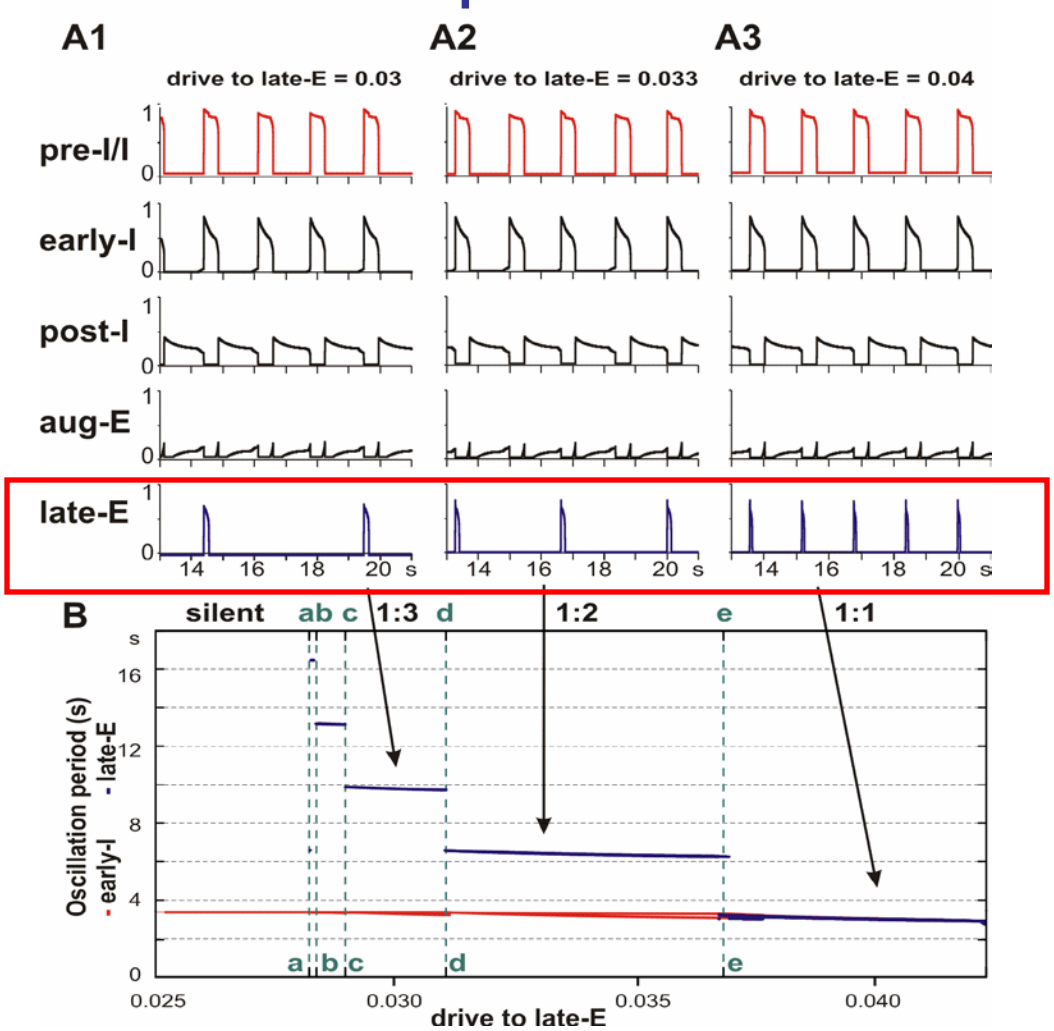




NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

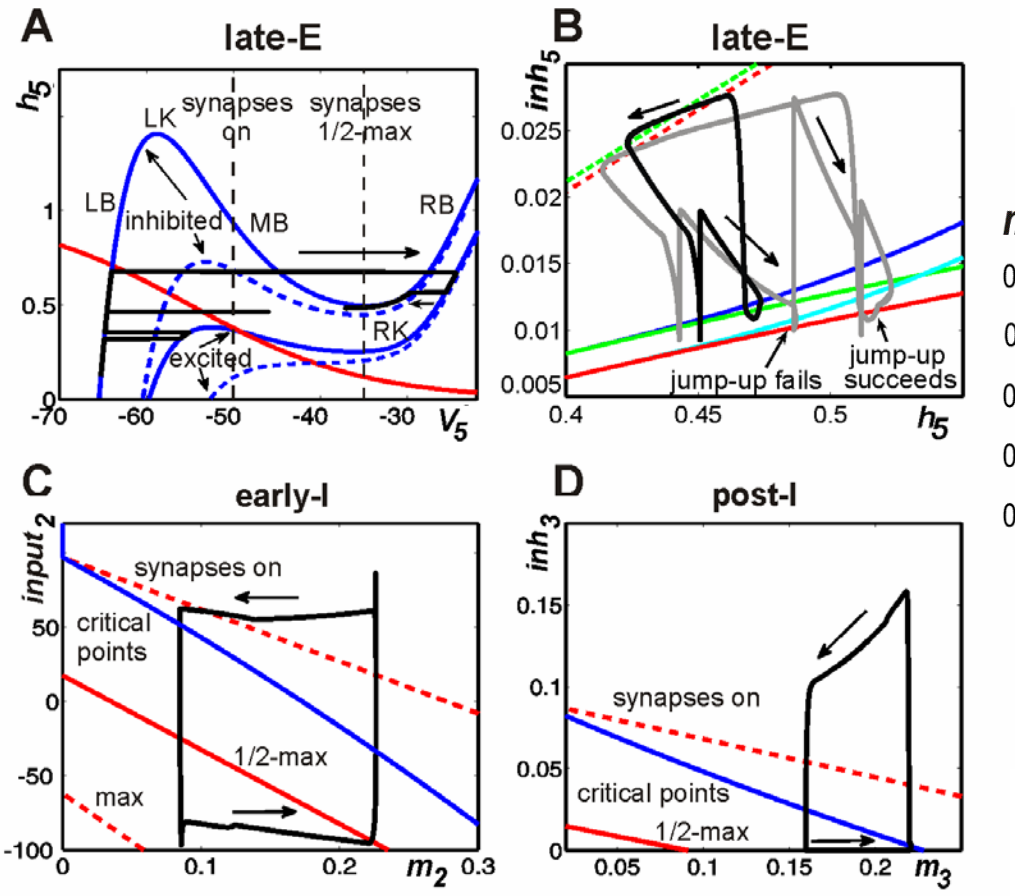
Simplified model

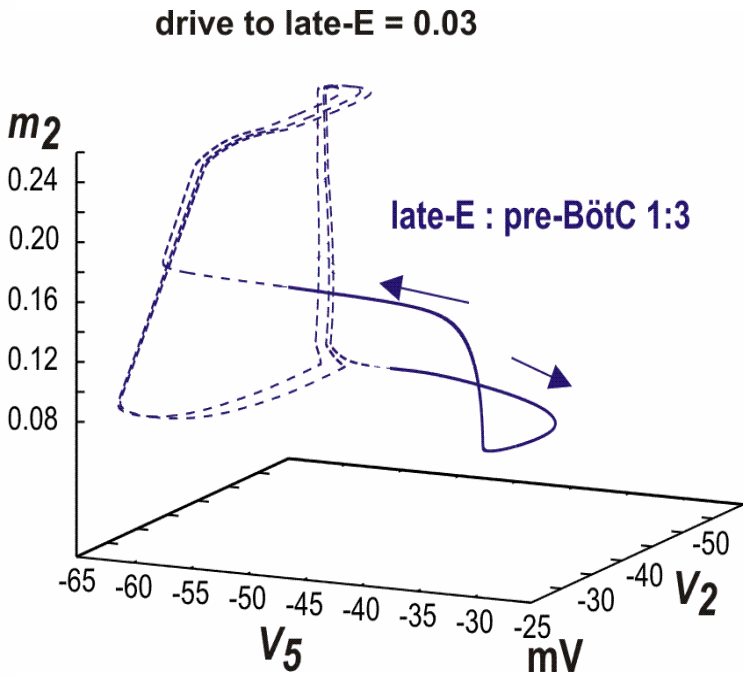


NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

Simplified model

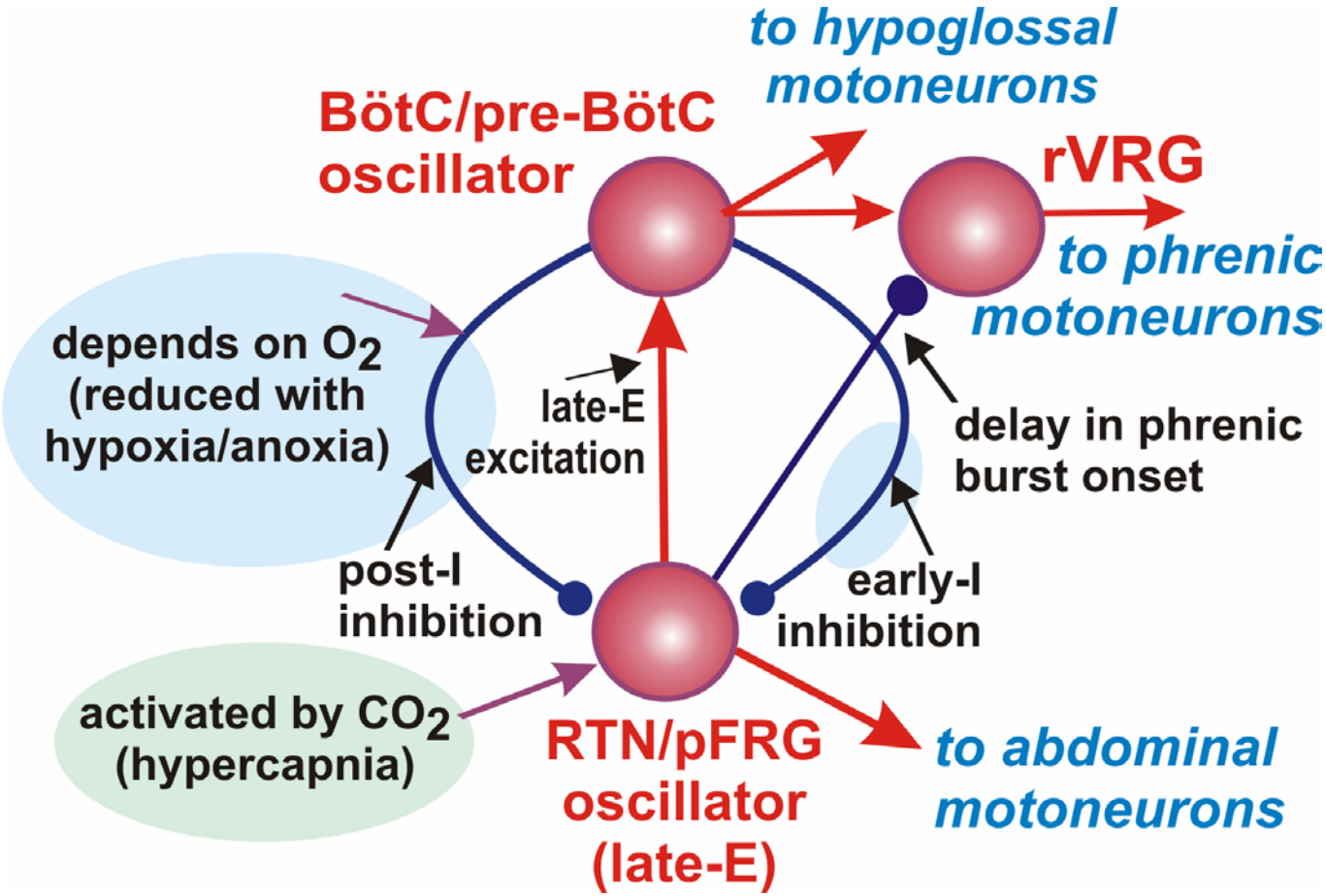




NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

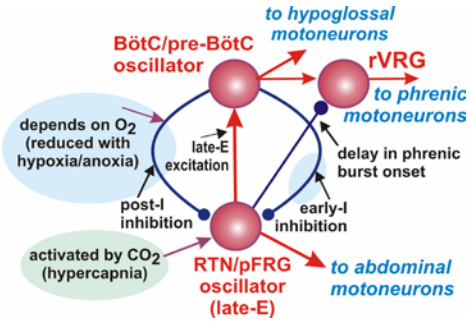
Proposed interactions between BötC/pre-BötC and pFRG/RTN



NINDS/NIH Grant R01 NS069220

Multiscale Model of Neural Control of Breathing

Proposed interactions between BötC/pre-BötC and pFRG/RTN



Analysis of both the simplified and full models provided a plausible mechanistic explanation of the appearance and quantal acceleration of the abdominal late-expiratory activity with development of hypercapnia.

It is suggested that under normal metabolic conditions the RTN/pFRG oscillator is inhibited by both the post-I population of BötC during inspiration and early-inspiratory (early-I) population of pre-BötC during inspiration.

Therefore the late-E oscillations can be released by either a hypercapnia-evoked activation of chemosensitive RTN/pFRG neurons overcoming this inhibition or a hypoxia-dependent suppression of RTN/pFRG inhibition by BötC-pre-BötC circuits.

NINDS/NIH Grant R01 NS069220