Using Free/Open-source software to analyze breathing in neonatal rat pups

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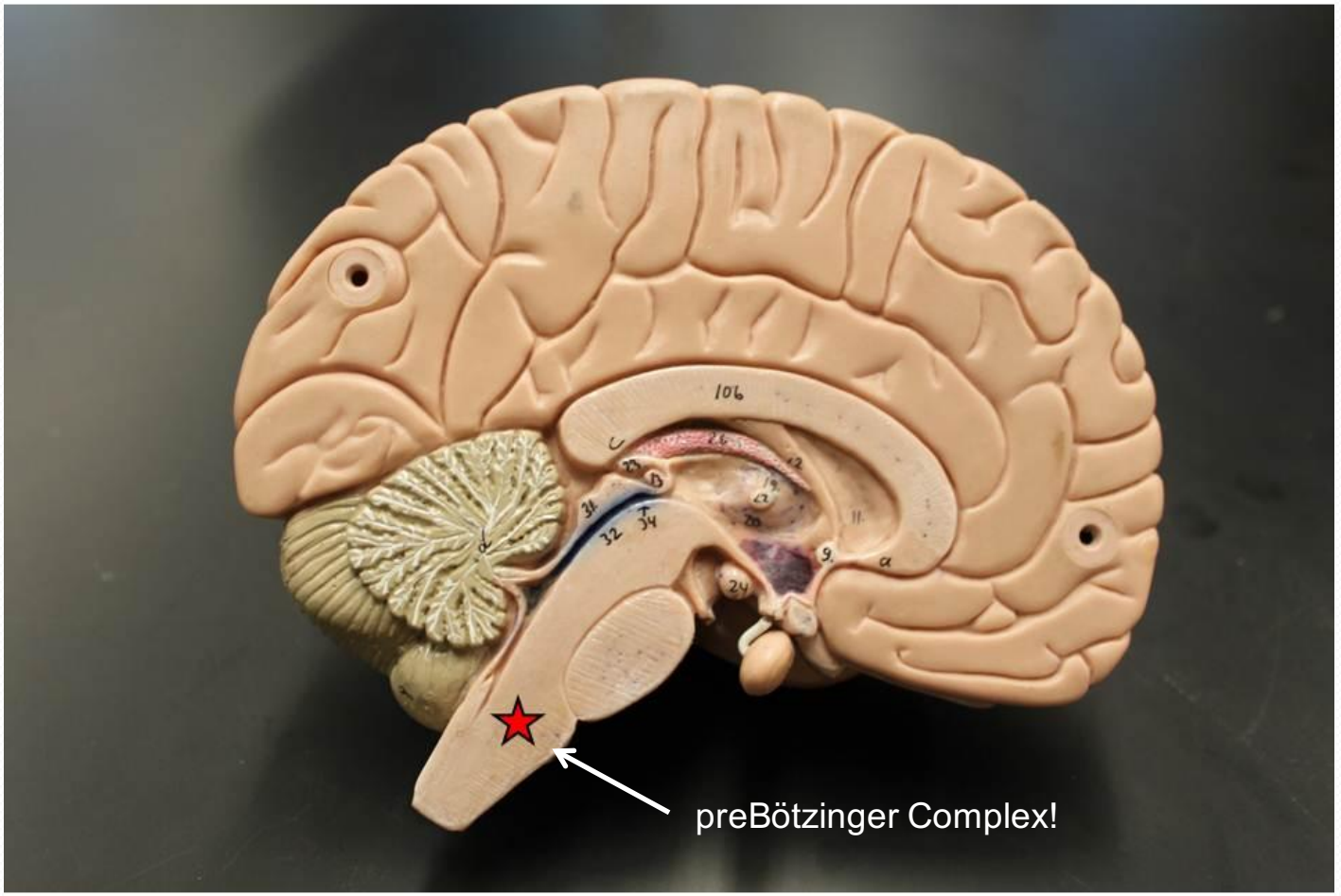
Background

- In the US and the UK more than 500,000 babies are born prematurely each year

- These babies are more susceptible to infection which often manifests as respiratory problems such as *apnea,* or *periodic breathing*.

Breathing rhythm originates in the *medulla oblongata*

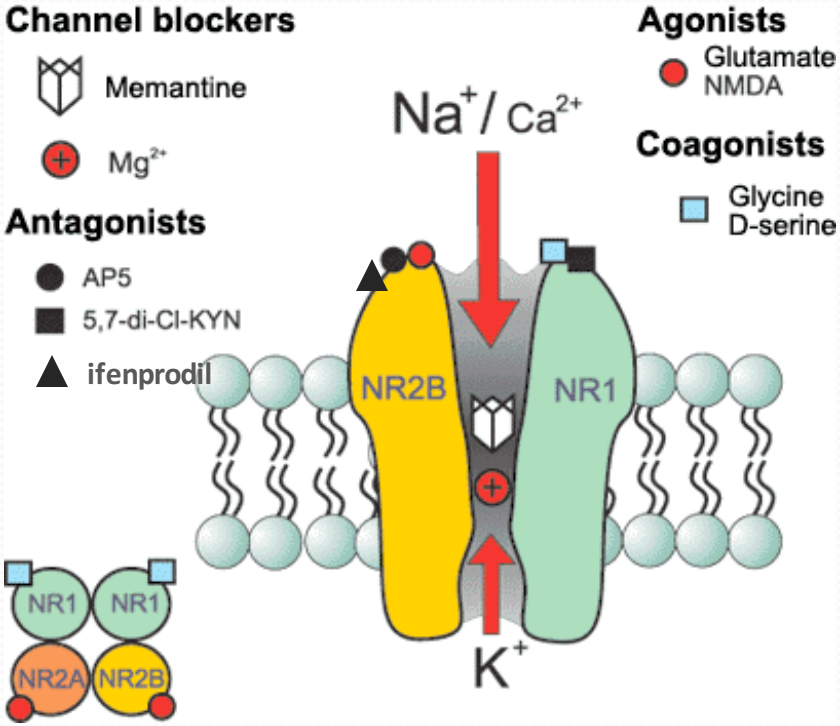


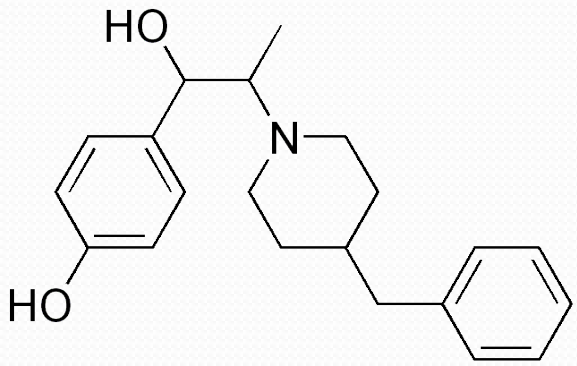
Background

- Synaptic inputs to nTS neurons—excitatory post-synaptic currents (EPSCs) primarily—are altered by the pro-inflammatory cytokine, IL-1β.
- Changes in synaptic inputs may be mediated by prostaglandin E_2 receptors but this has not yet been tested.
- To assess changes in synaptic inputs, we developed an analysis tool that allows us to quantify changes in synaptic events (EPSCs).

NMDA receptors

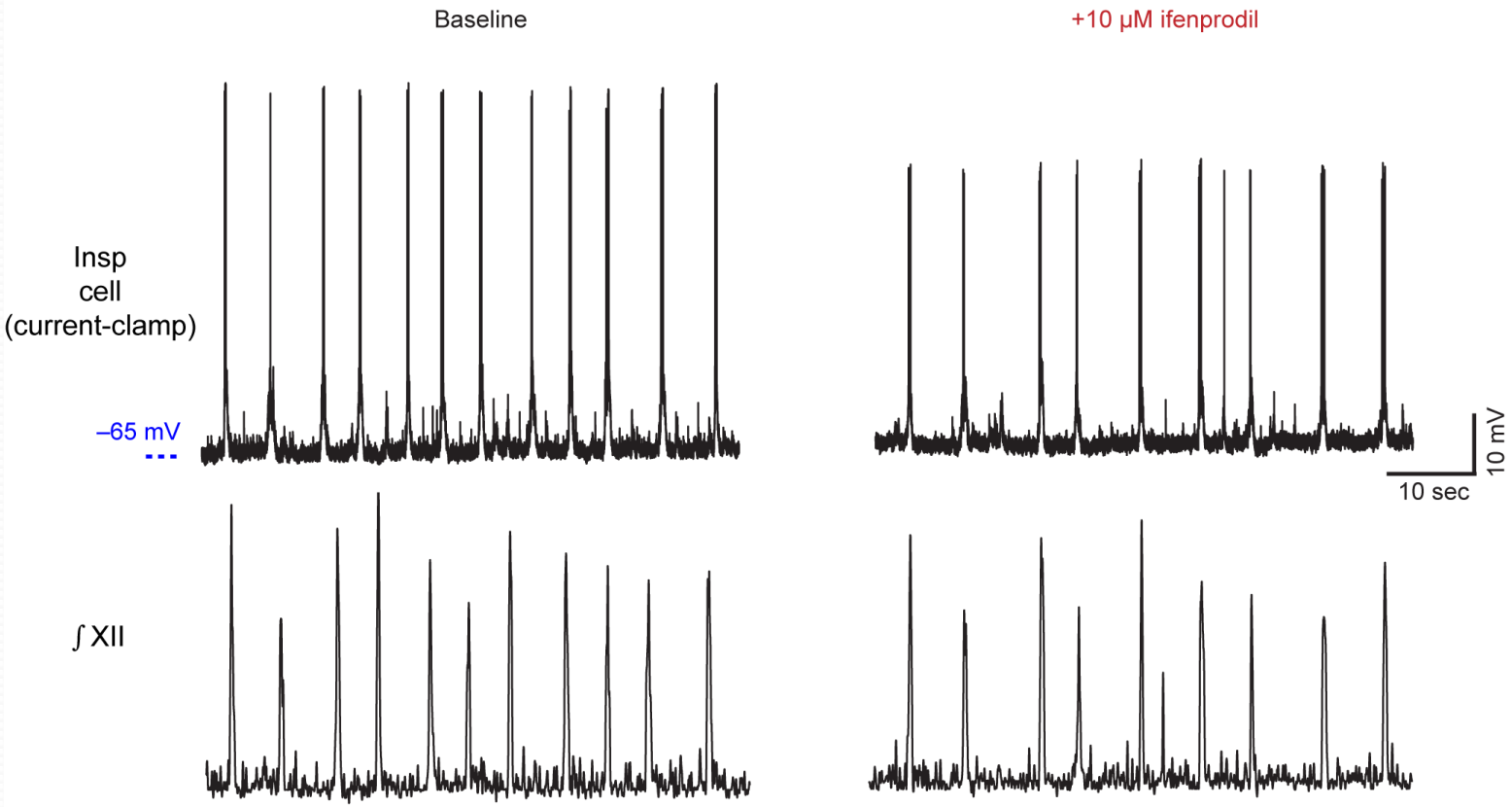
- NMDA (N-methyl-D-aspartate) receptors are ionotropic glutamate receptors that are non-specific (pass cations)
- NMDA receptors are key excitatory drivers for breathing rhythm



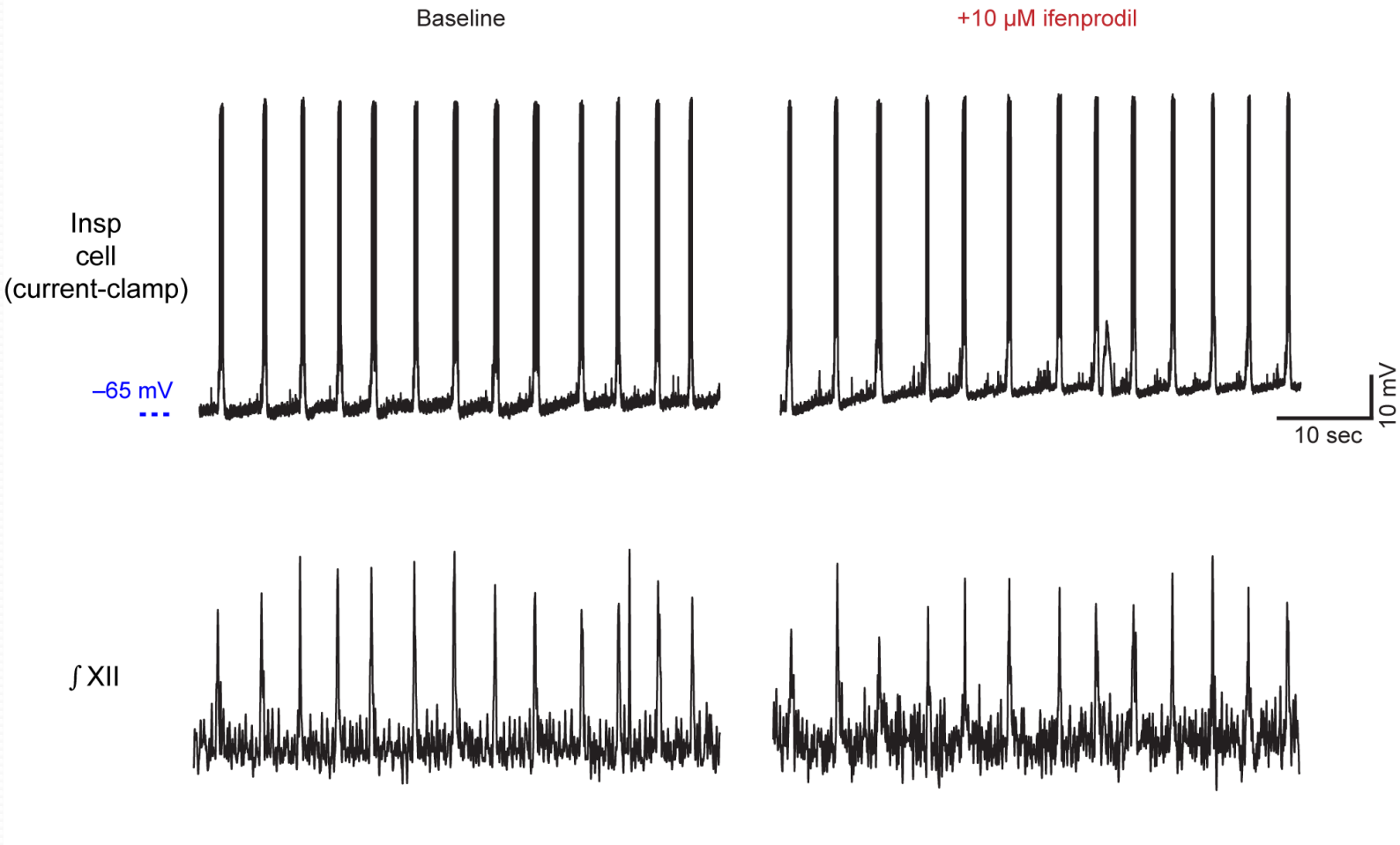


Ifenprodil

Inspiratory neuron from postnatal day 2 (P2) rat



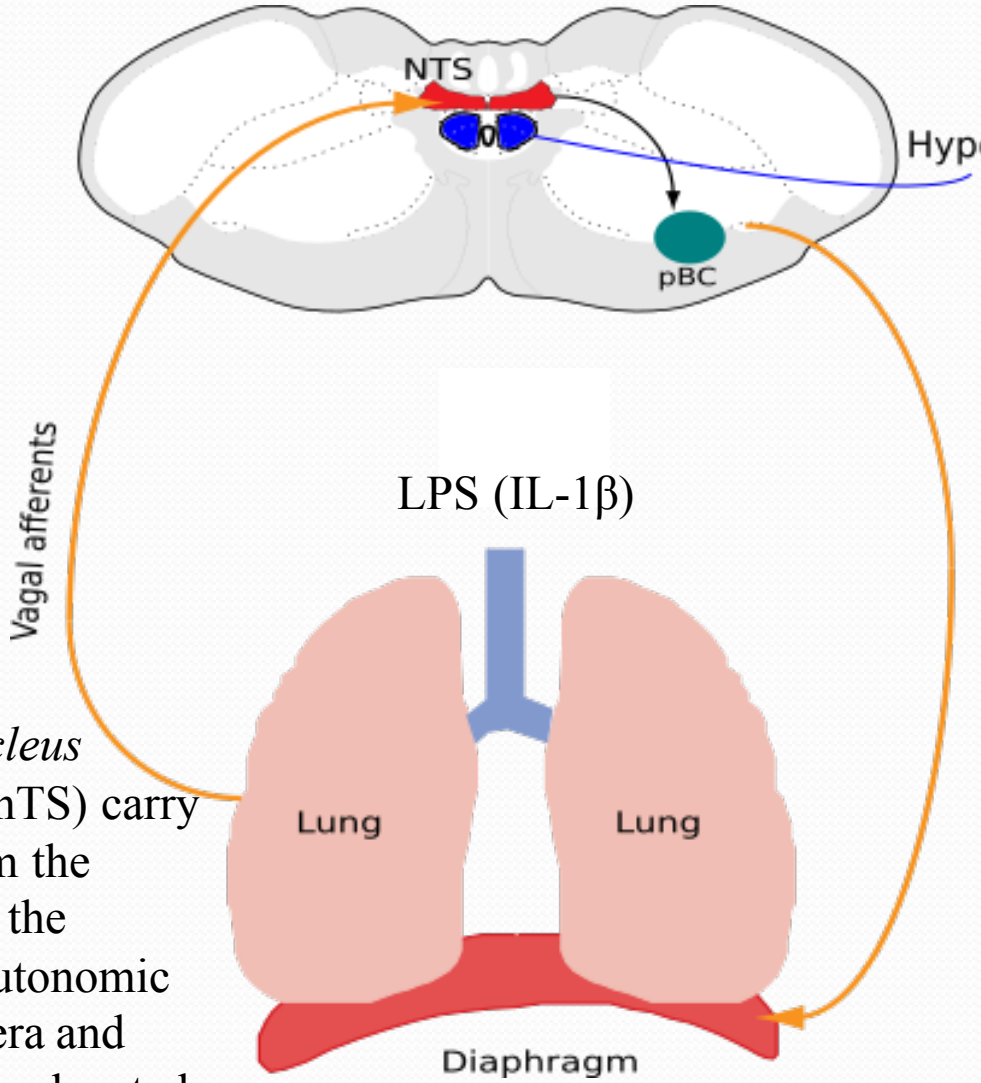
Inspiratory neuron from postnatal day 4 (P4) rat



Hypothesis/Objective

- We hypothesize that neurons in the nTS can alter breathing activity in the presence of the early pro-inflammatory cytokine, IL-1β.
  - This alters the effect of chemosensory inputs to the inspiratory rhythm generator (preBötzinger Complex).

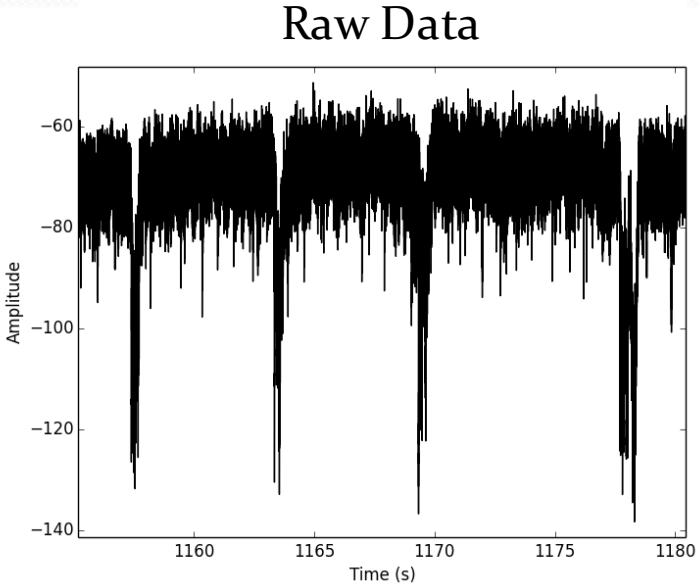
- We hypothesize that NMDA receptors are developmentally regulated, specifically NR2B containing NMDA receptors are present early in development and then are down-regulated.
  - This results in changes in breathing *regularity* and may be a substrate for apneas or periodic breathing in preterm infants!

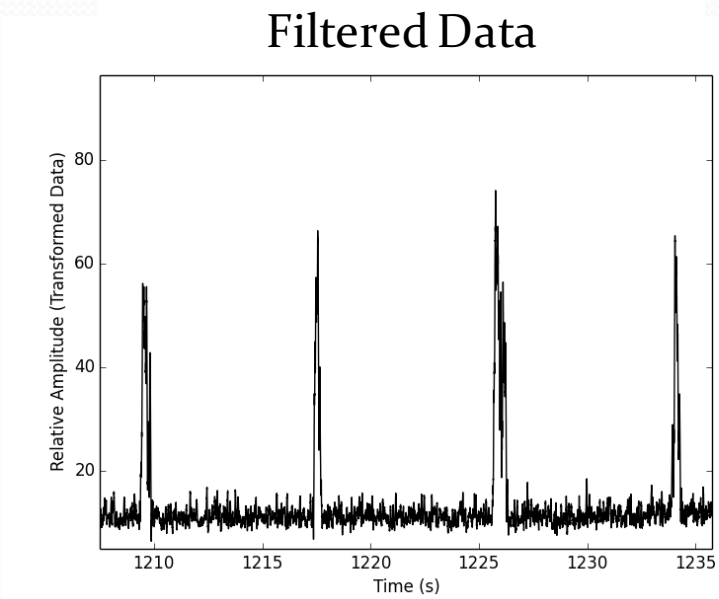


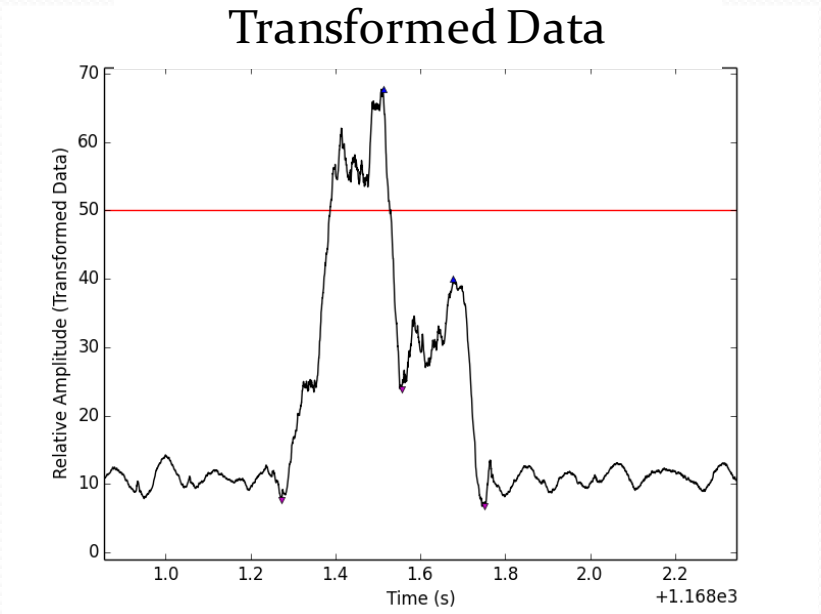
The hypoglossal nerve (XII) innervates the muscles of the tongue which is used in the articulation of speech and swallowing.

Neurons of the *nucleus tractus solitarius* (nTS) carry afferent traffic from the vagus nerve (X) to the brainstem where autonomic control of the viscera and thermoregulation are located.

Raw Data

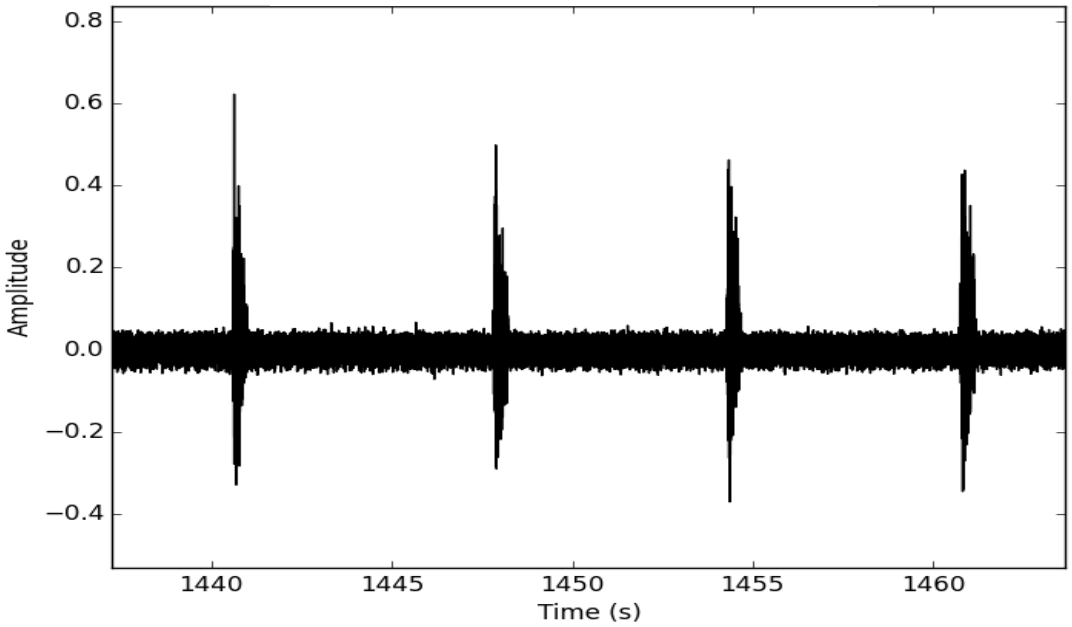

Raw Data
Amplitude
−60
−80
−100
−120
−140
1160
1165
1170
1175
1180
Time (s)


Filtered Data
Relative Amplitude (Transformed Data)
80
60
40
20
1210
1215
1220
1225
1230
1235
Time (s)

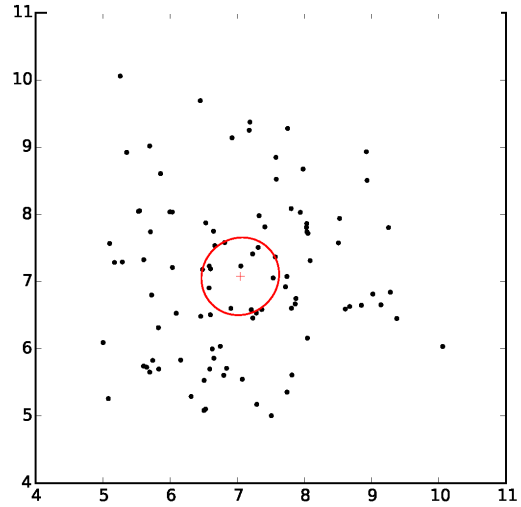

Transformed Data
Relative Amplitude (Transformed Data)
70
60
50
40
30
20
10
0
1.0
1.2
1.4
1.6
1.8
2.0
2.2
Time (s)
+1.168e3

Raw Data

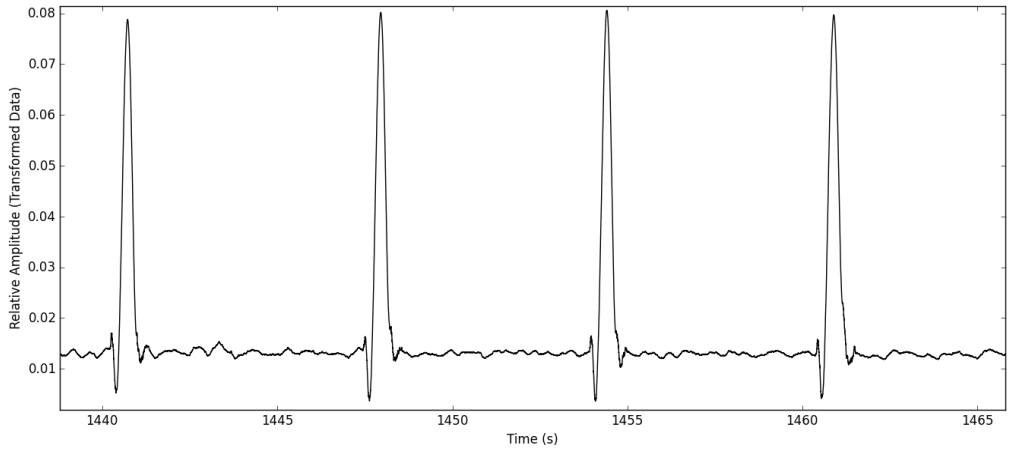
Raw Data



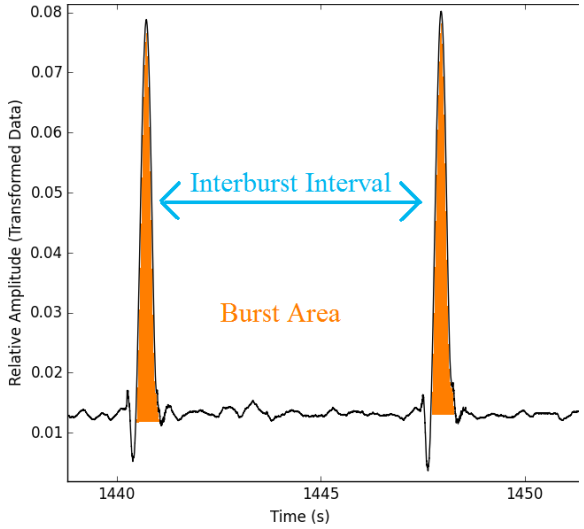
Poincare Plot



Filtered Data



Analysis



What is BASS used for?

- Biomedical Analysis Software Suite (BASS) is a program designed to analyze wave data.

- Event Measurements: Peak amplitude, Peak-Peak Intervals, Duration, Interburst interval, Total Cycle Time, Peaks per Burst, Intraburst Frequency, Burst Area, Attack, Decay.

- Event Detection: Peaks and boundaries (Bursts)

localhost:8888/notebooks/Desktop/bass-dev/bass-dev/Single%20Wave-%20Interactive.ipynb

IP[y]: Notebook Single Wave- Interactive Last Checkpoint: May 11 14:18 (autosaved)

File Edit View Insert Cell Kernel Help

Heading 1 Cell Toolbar: None

Welcome to BASS!

Version: Single Wave- Interactive Notebook.

```
BASS: Biomedical Analysis Software Suite for event detection and signal processing.
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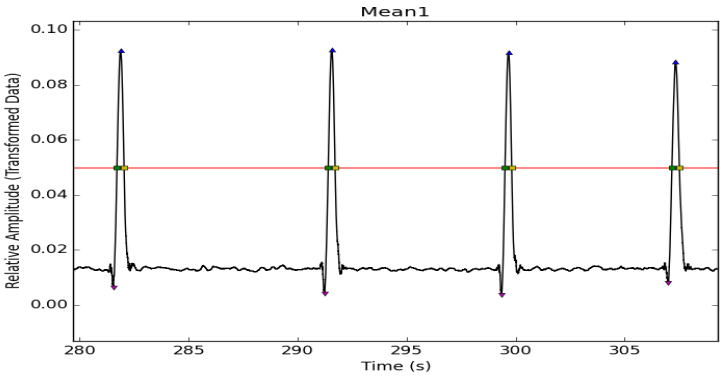

Initalize

Run the following code block to intialize the program. This notebook and bass.py file **must** be in the same folder.

In [1]:
```
from bass import *
```

```
BASS ready!
```

Begin User Input

For help, check out the wiki: Protocol

Or the video tutorial: Coming Soon!

Load Data File

Use the following block to change your settings. You **must** use this block.

Here are some helpful information about the loading settings:

Advantages of BASS

- Open Source/Free Software
- User friendly
- Consolidation of functions for statistical measurement
- Ease of generation of tables and figures
- Usable with many data sets
- Customizable with programming experience in Python

So why do all this?

- The purpose of this research is to use free tools to detect changes in breathing regularity and (*hopefully!*) increase the long-term health of preterm babies.

Acknowledgements

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