# Threshold Tutorial Summary

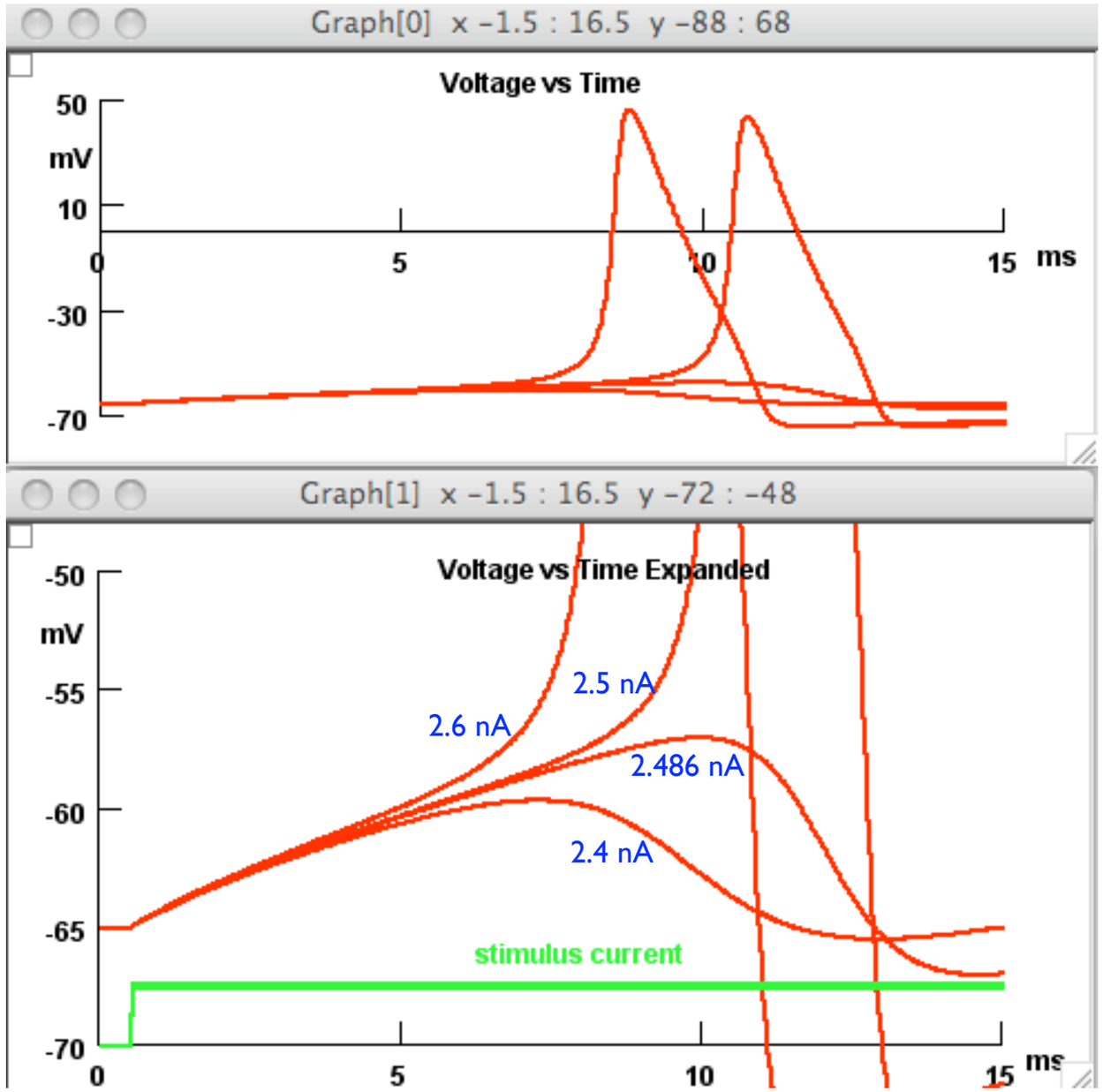
Josh Lucan

## Goals:

- To investigate whether threshold is at a fixed voltage in neurons.
- To understand how threshold depends on the duration of the stimulus and the importance of this relation for synaptic transmission.
- To explore the determinants of firing frequency in a train of action potentials generated by a sensory receptor potential.

# Highlights of Experiment 1: Threshold

•Threshold occurs at a fixed current rather than voltage.



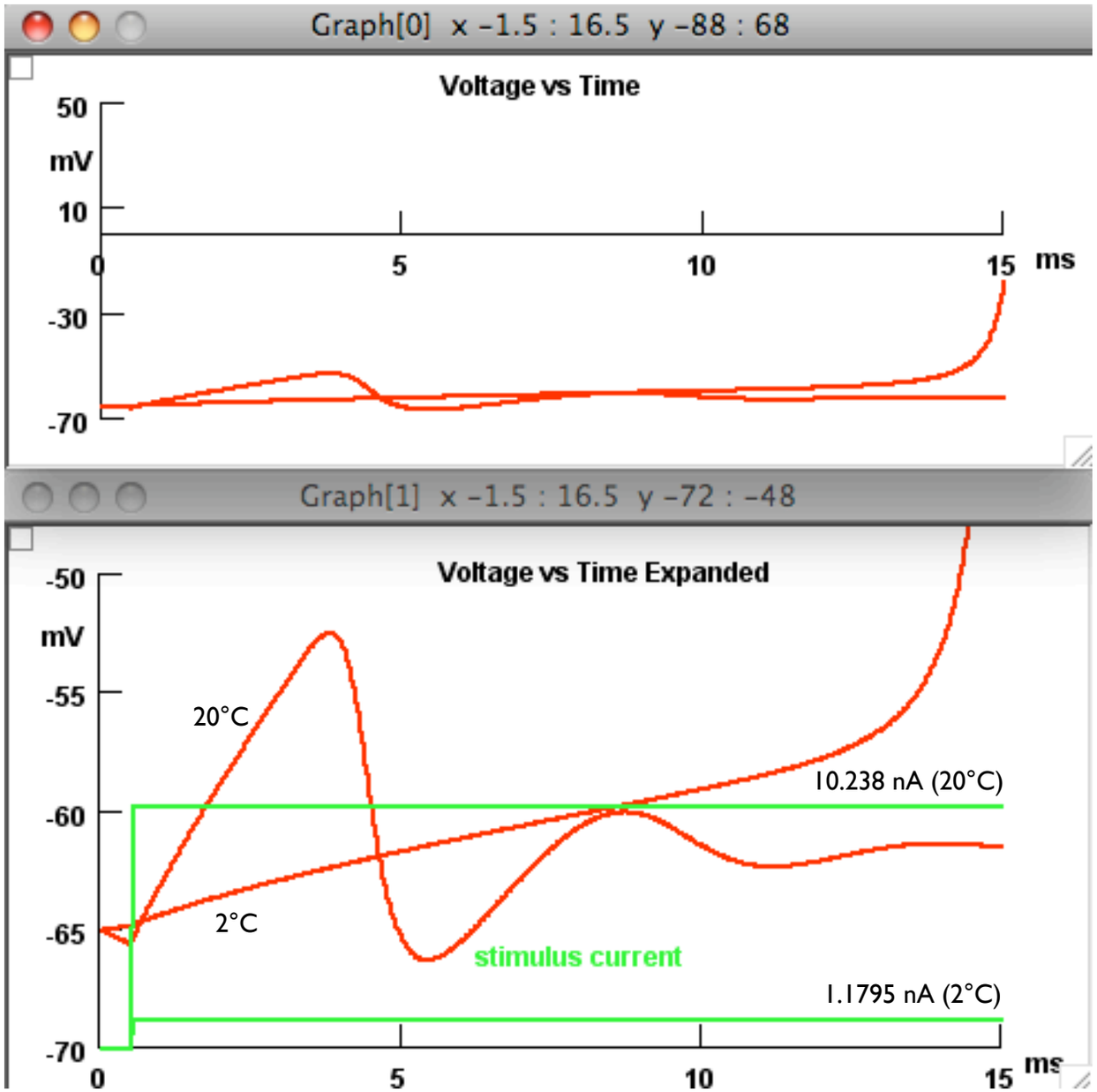

•Here the critical current threshold is between 2.486 and 2.5 nA.

•Note how the peak voltage of the 2.486 nA stimulus is actually higher than the voltages at which the 2.5 and 2.6 stimuli take off.

•Note also that threshold has more to do with the rate of change of the voltage.

# Highlights of Experiment 2: Temperature

•Higher temperatures lead to higher current thresholds.

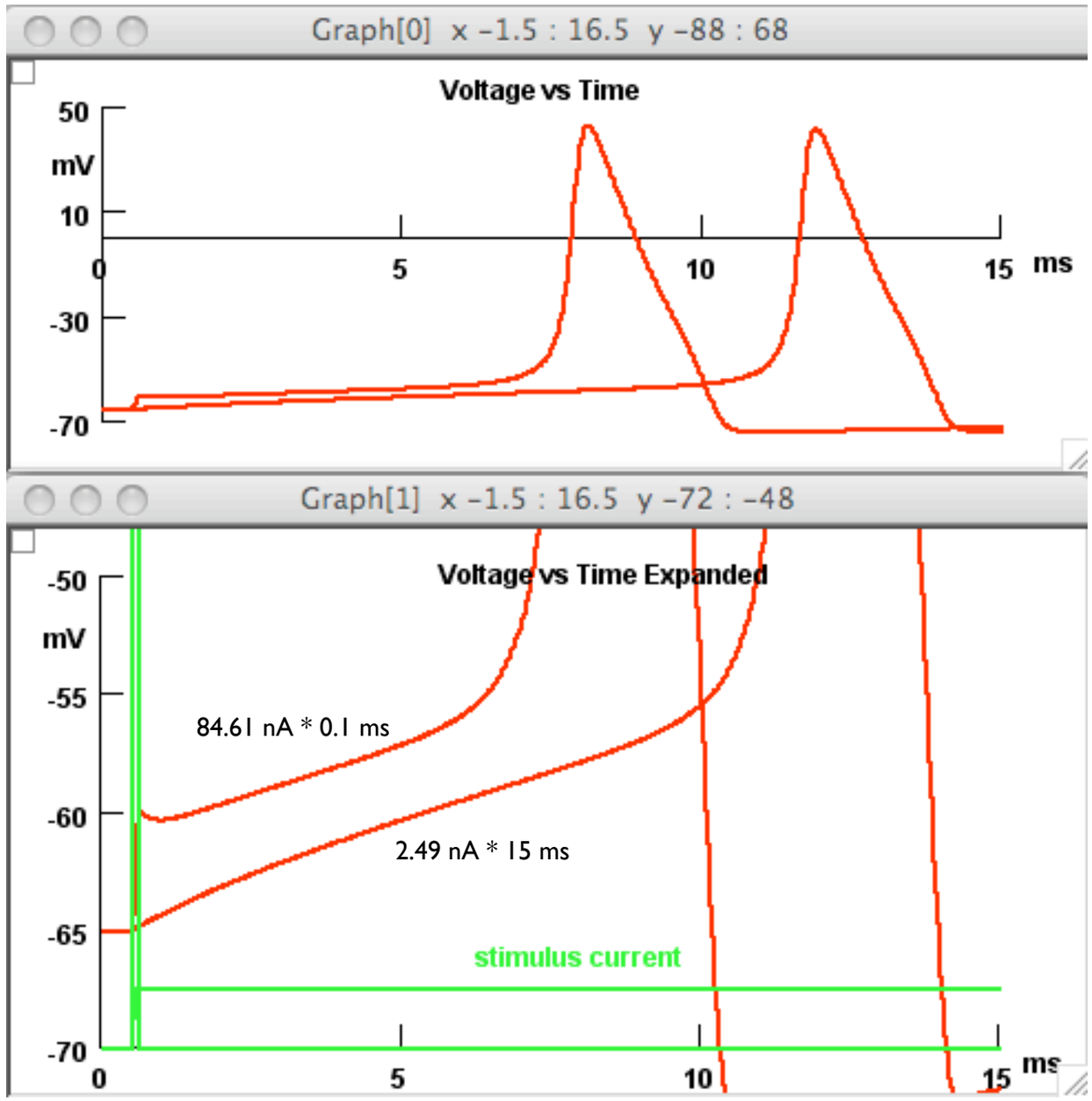



•Because higher a temperature speeds up the kinetics of the channels the rates of change of conductances and voltages will also be faster.

•With faster kinetics the Na current needs more injected current to overcome the K current.

# Highlights of Experiment 3: Duration

•Stimuli of shorter duration require a greater amplitude to reach threshold.

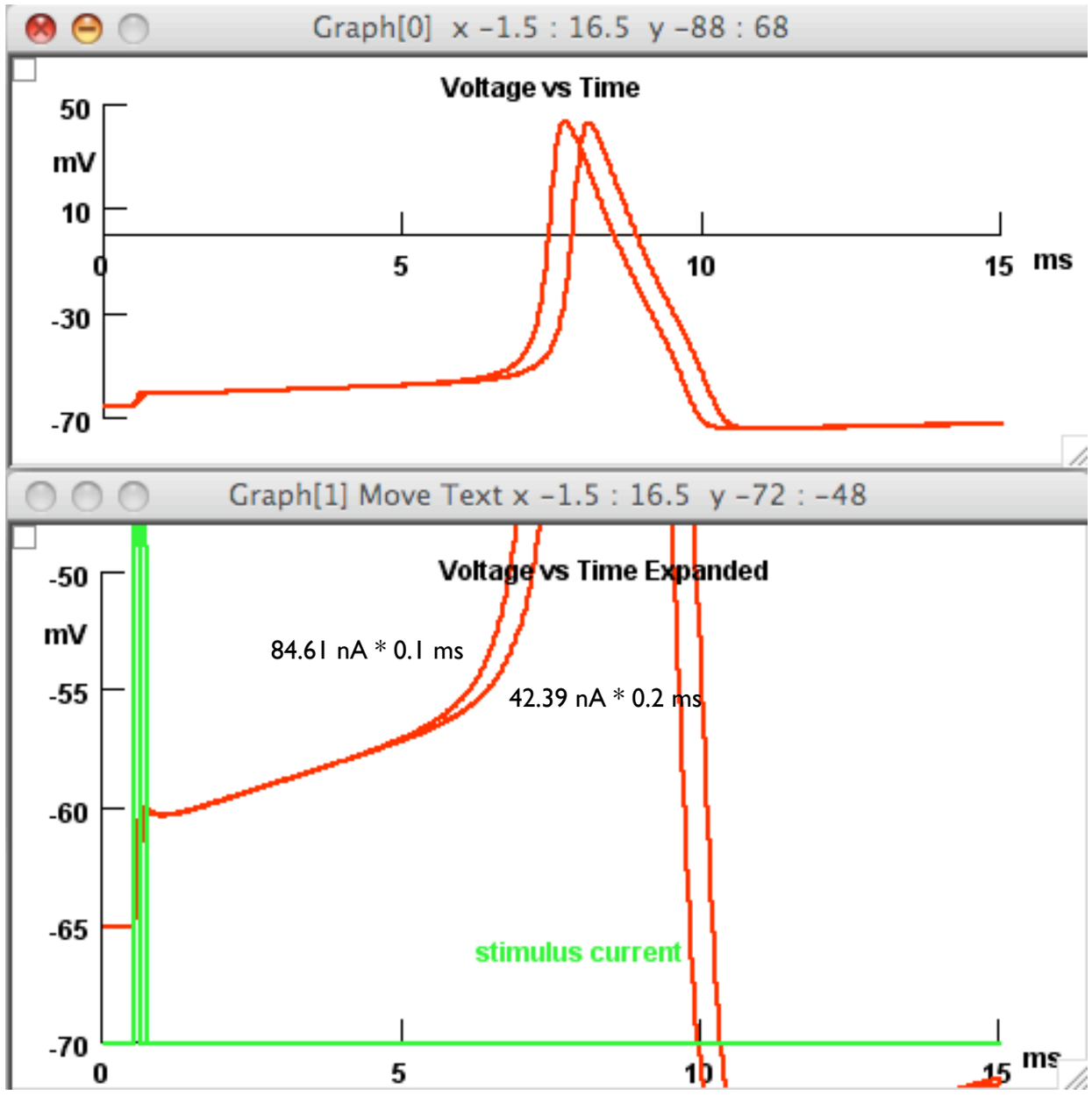



•Because the Na current turns on faster than the K current a brief but large current will provide the Na current the upper hand over the K current.

•Since NMJ depolarizations occur from large and brief currents such as this, small fluctuations in neurotransmitter quanta make little difference.

# Highlights of Experiment 3: Myasthenia Gravis

•Doubling the duration compensates for halving the current amplitude.

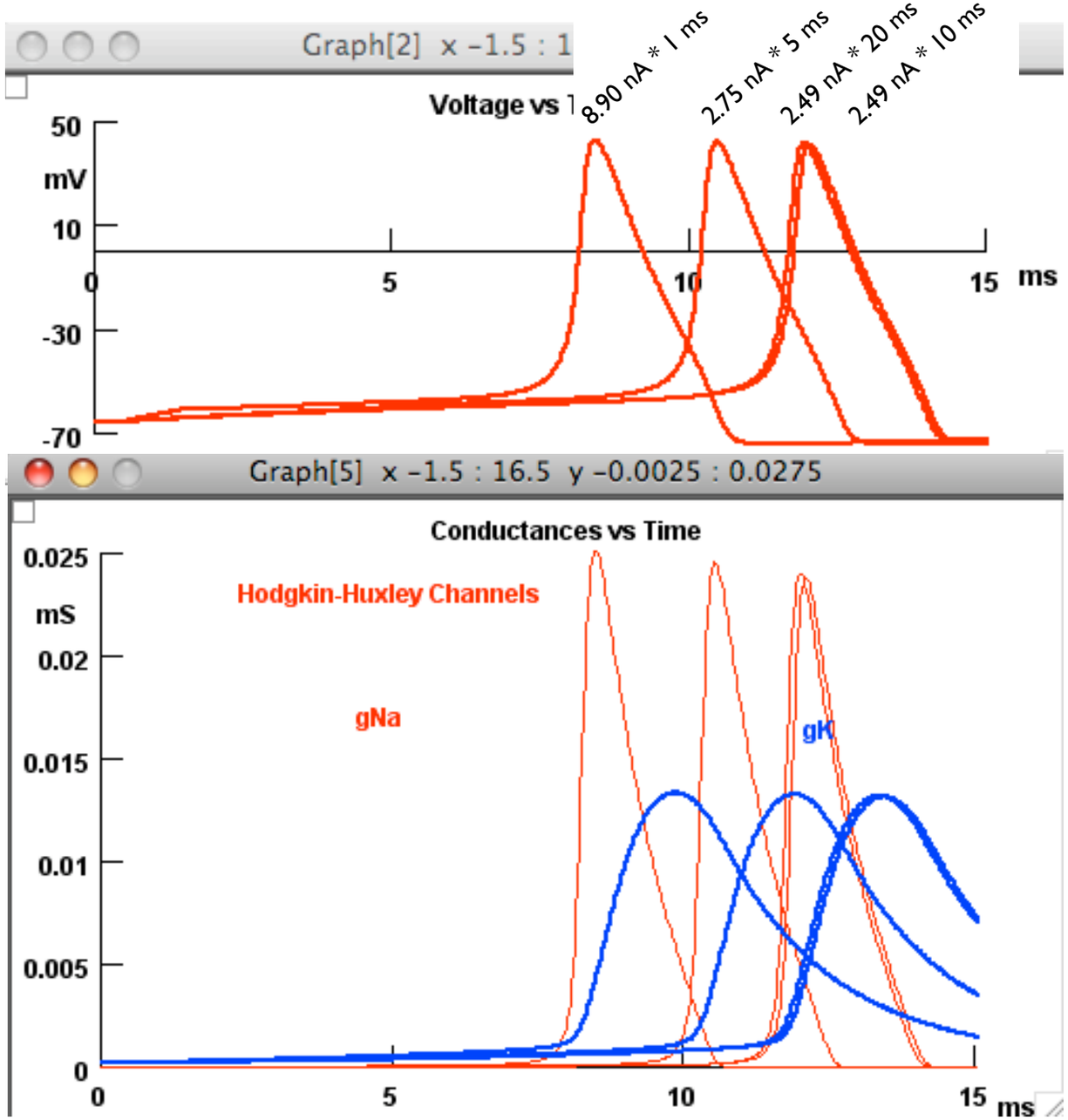



•Myasthenia Gravis is a condition in which fewer channels exist at the NMJ and thus thresholds for action potentials are more difficult to reach.

•Pharmacological agents which increase the duration of ACh presence at the synapse effectively treat the condition.

# Highlights of Experiment 4: Long synaptic currents

•The membrane's time constant is a limiting factor in the effectiveness of current duration on threshold.

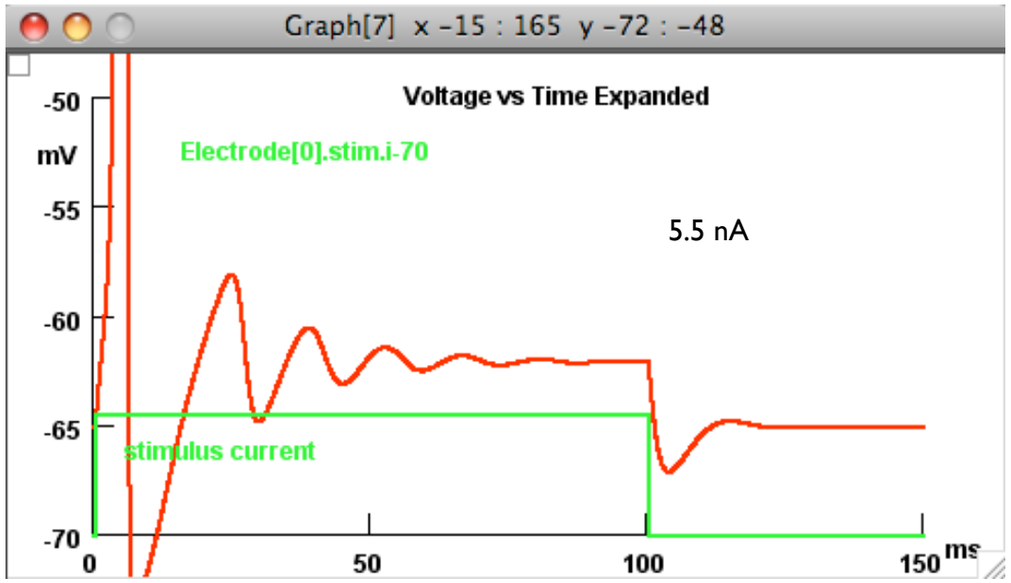


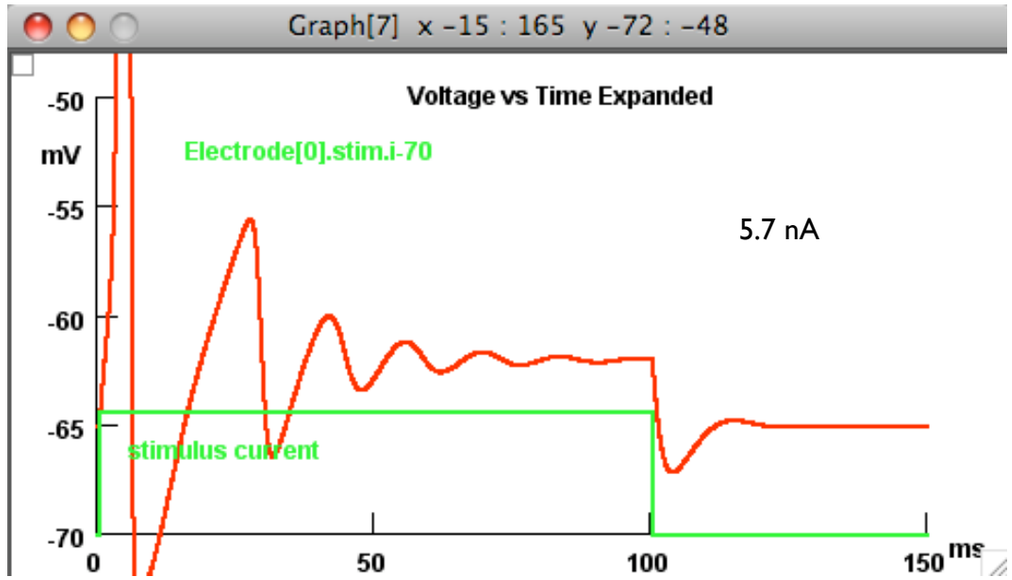

•The time courses of the conductances determine whether stimulus duration is a factor for a neuron to reach threshold.

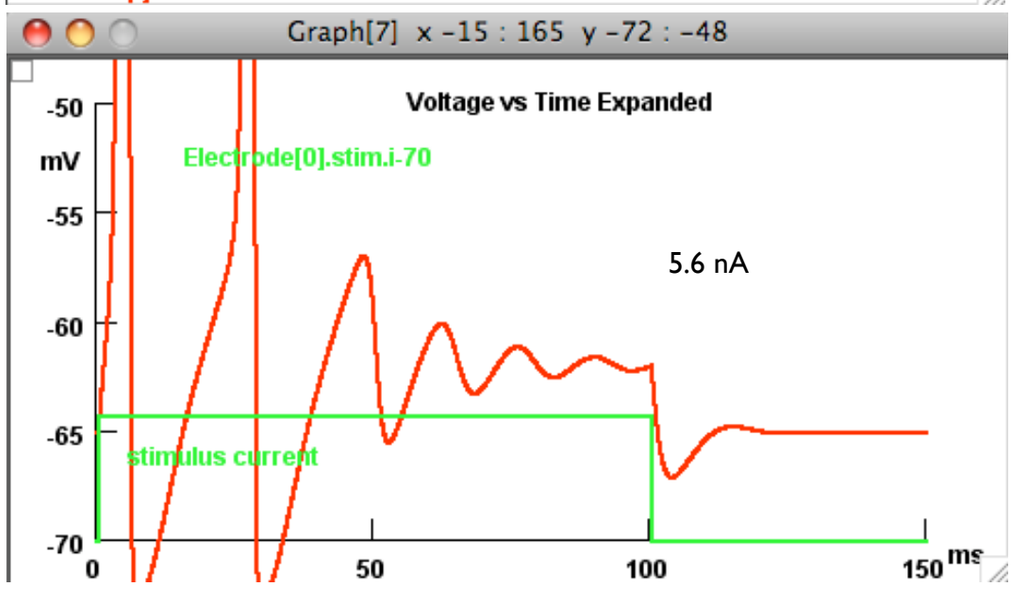
•For durations beyond 10 ms the stimulus duration exceeds the natural time courses of the Na and K conductances.

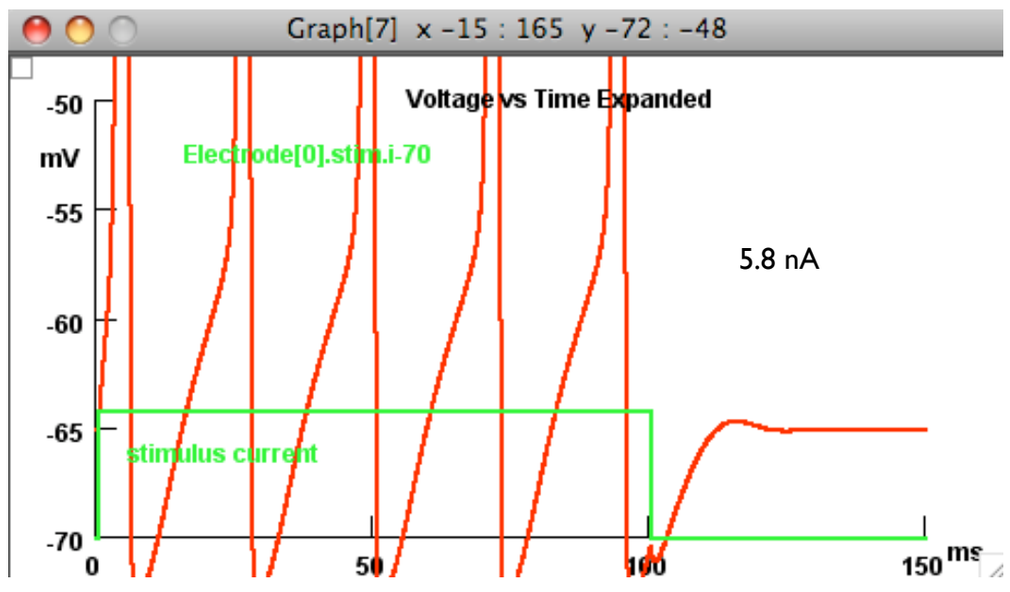
# Highlights of Experiment 5: Mechanosensory receptors

•Increasing the current amplitude over long durations starts as subthreshold oscillations and becomes a spike train.



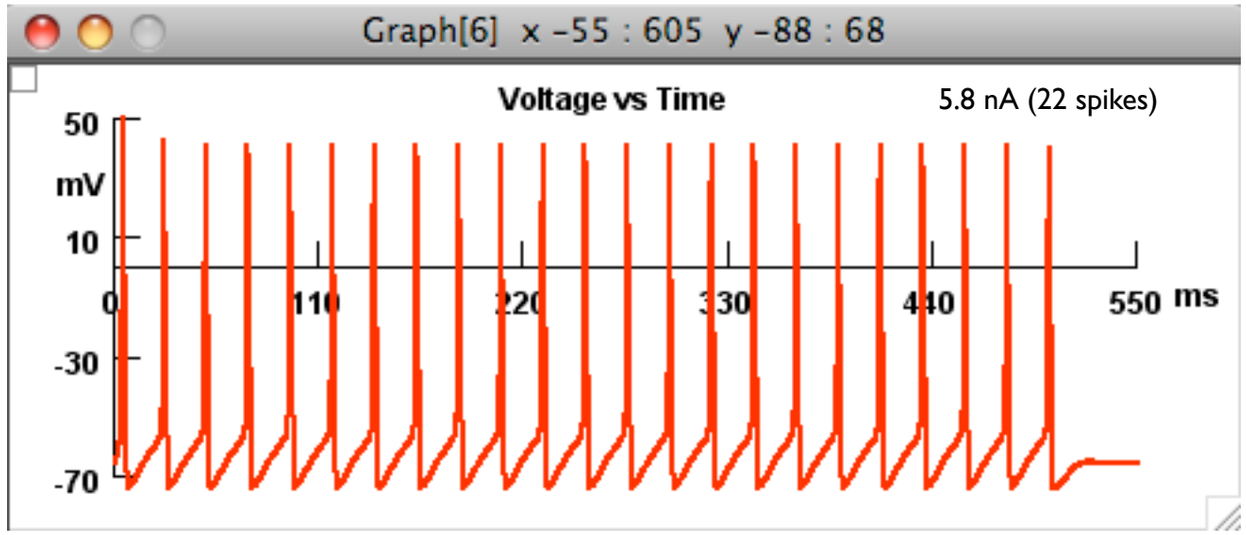



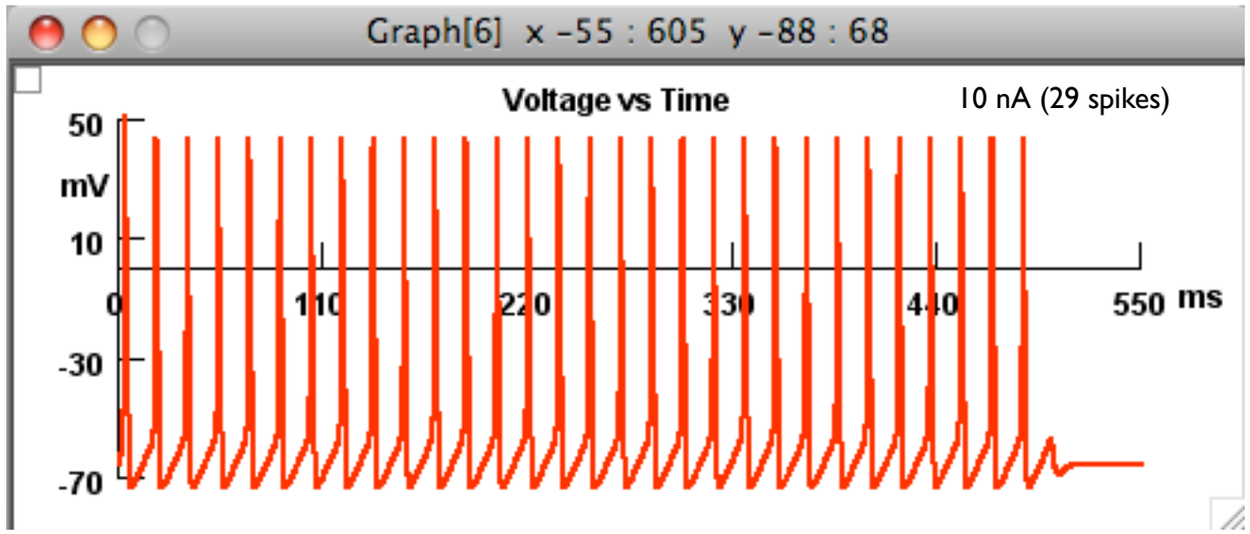



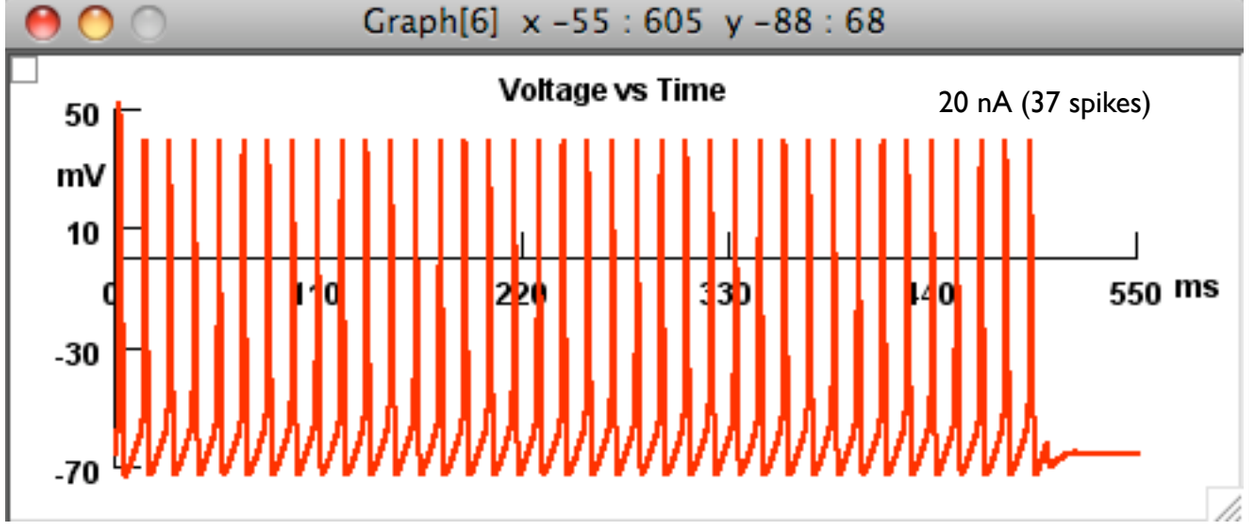

•A large enough input current will allow the Na current to repetitively overcome the competing K current.

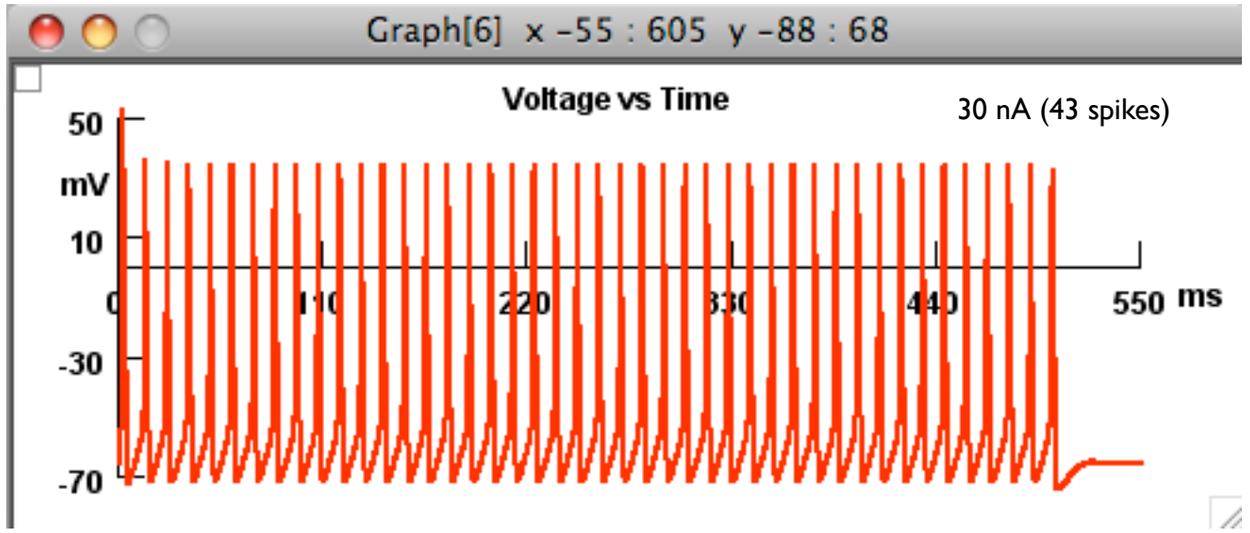
# Highlights of Experiment 6: Rate Code

•Larger currents lead to faster spike trains.




•Question: Does the relationship between the current amplitude and the rate code appear linear?

# Highlights of Experiment 7: Peak Amplitude

- Increasing the input current increases the peak amplitude of the AP.