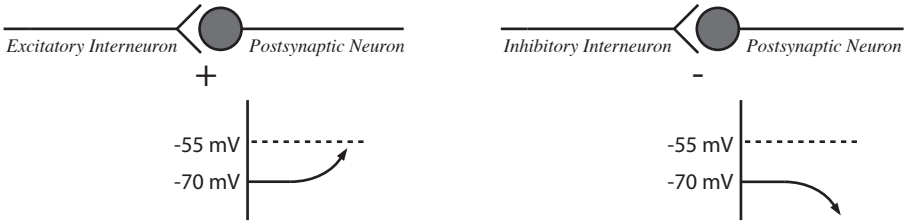
Interneurons

An Introduction to

Excitatory and Inhibitory Interneurons

and

Integration

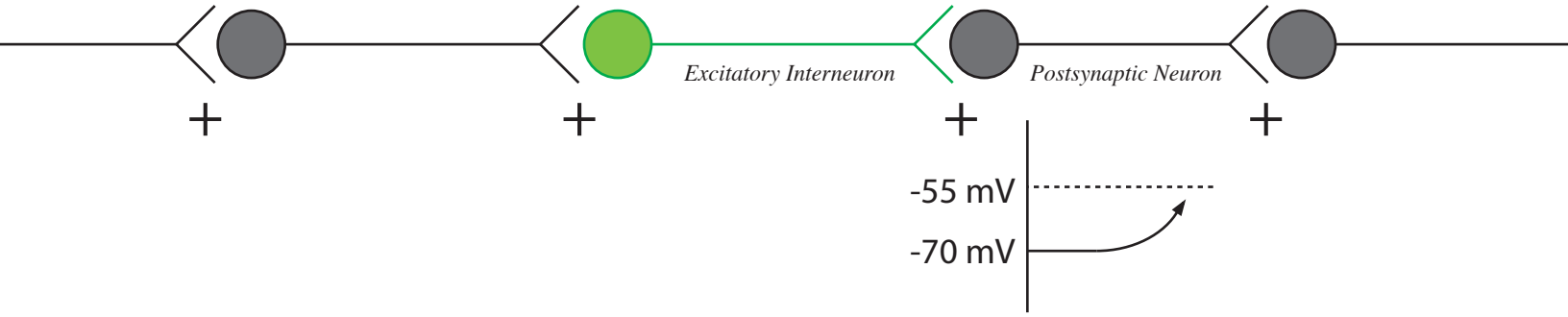


By Noel Ways

INHIBITORY AND EXCITATORY INTERNEURONS

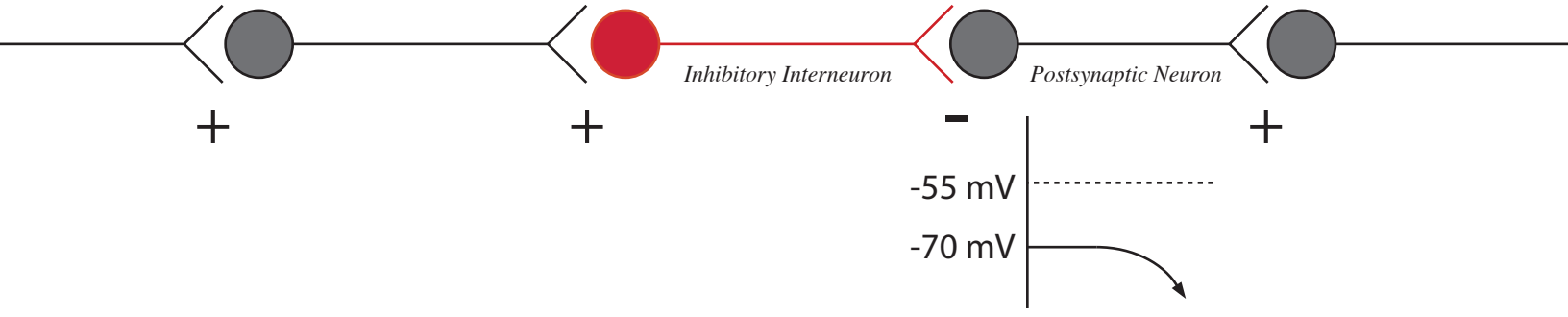
Inhibitory and excitatory interneurons play a crucial role in determining whether a postsynaptic neuron reaches the threshold. If the interneuron is excitatory, it will bring the postsynaptic neuron closer to threshold due to the influx of positively charged sodium ions (Na^+).

Excitatory interneuron that produces an Excitatory post synaptic potentials (EPSP)

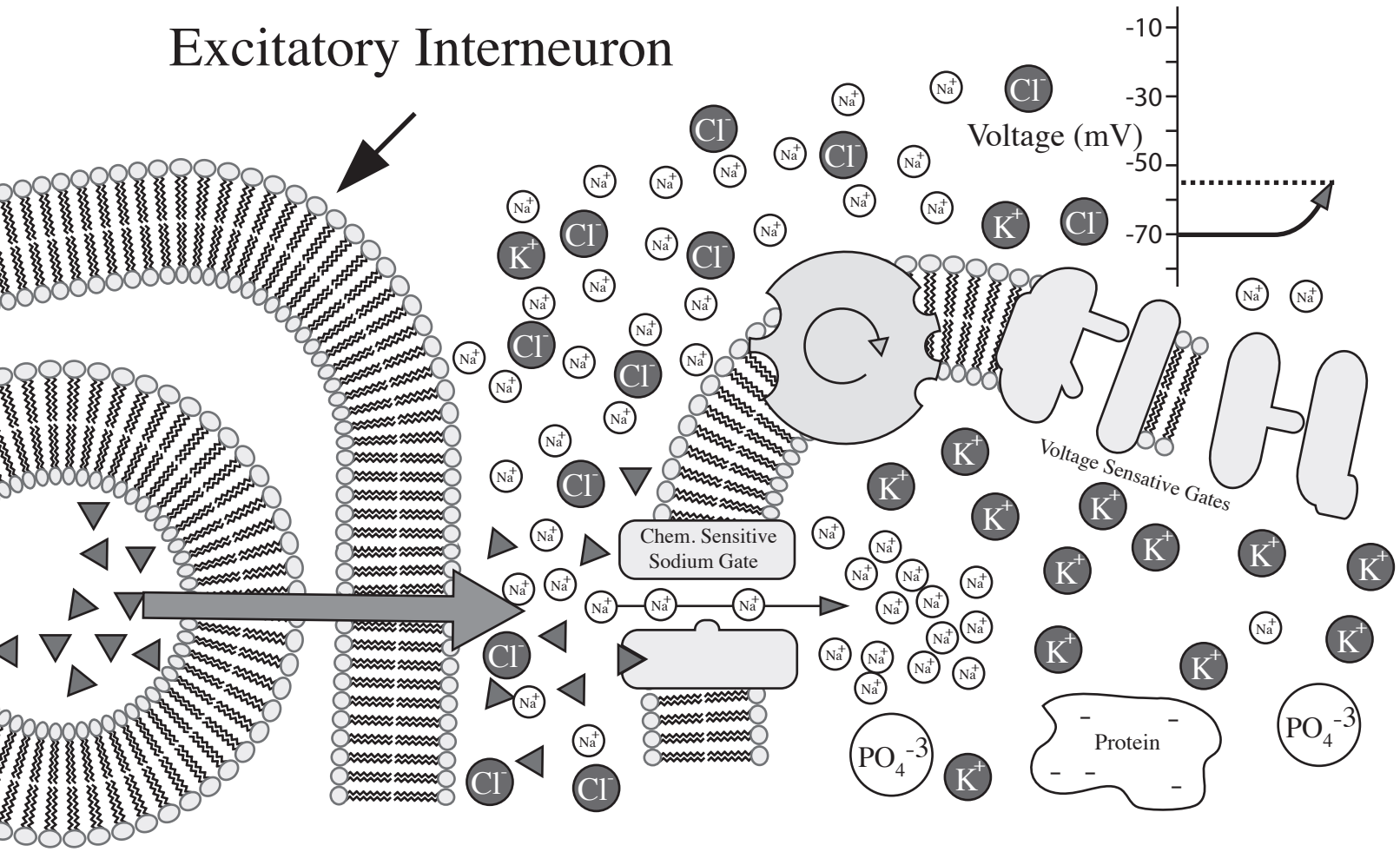


If the interneuron is inhibitory, it's effect will be to bring the postsynaptic neuron further away from threshold due to the influx of negatively charged calcium ions (Cl^-) into the neuron; and the efflux of positively charged potassium ions (K^+) out of that neuron.

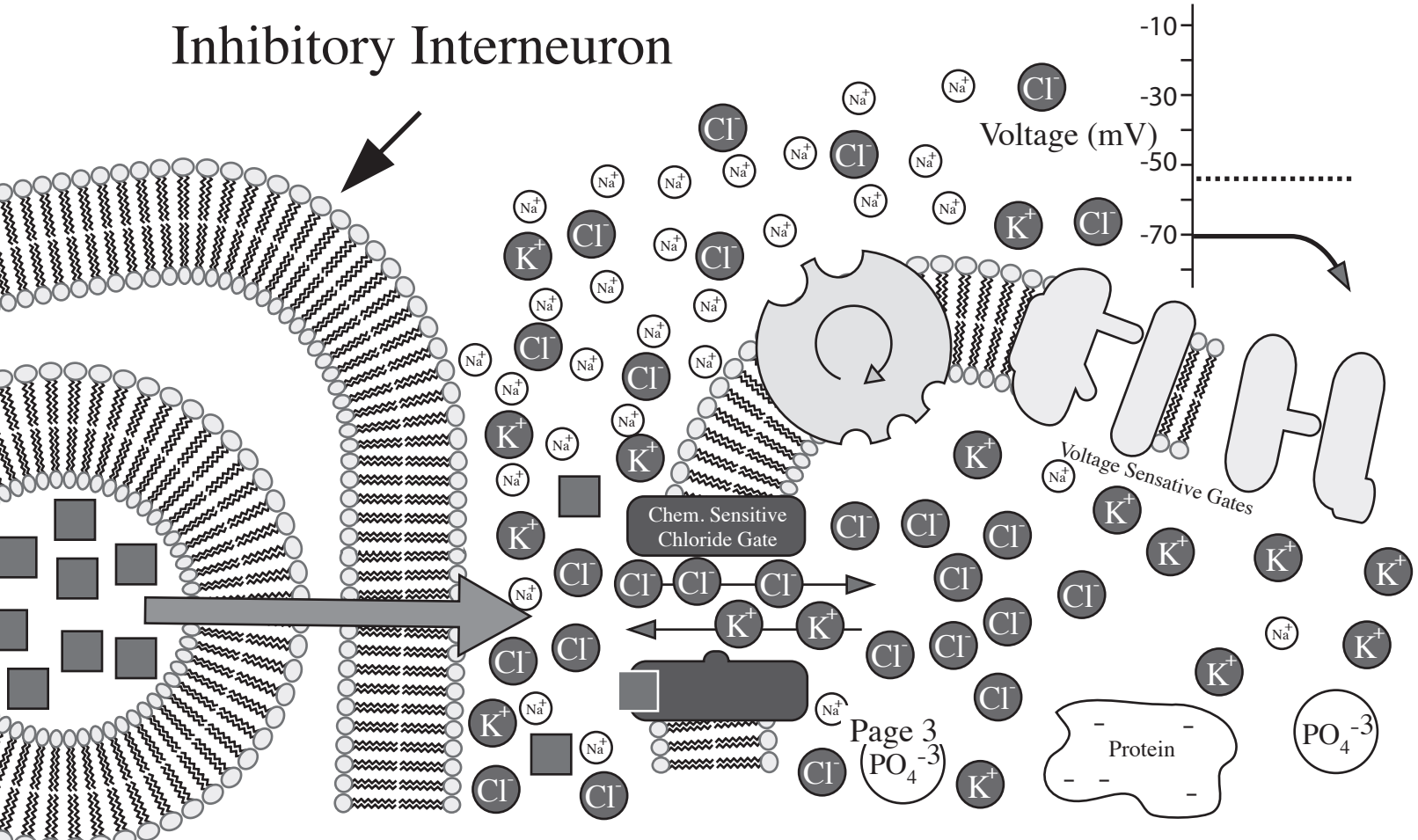
Inhibitory interneuron that produces an Inhibitory post synaptic potentials (IPSP)



Excitatory Interneuron

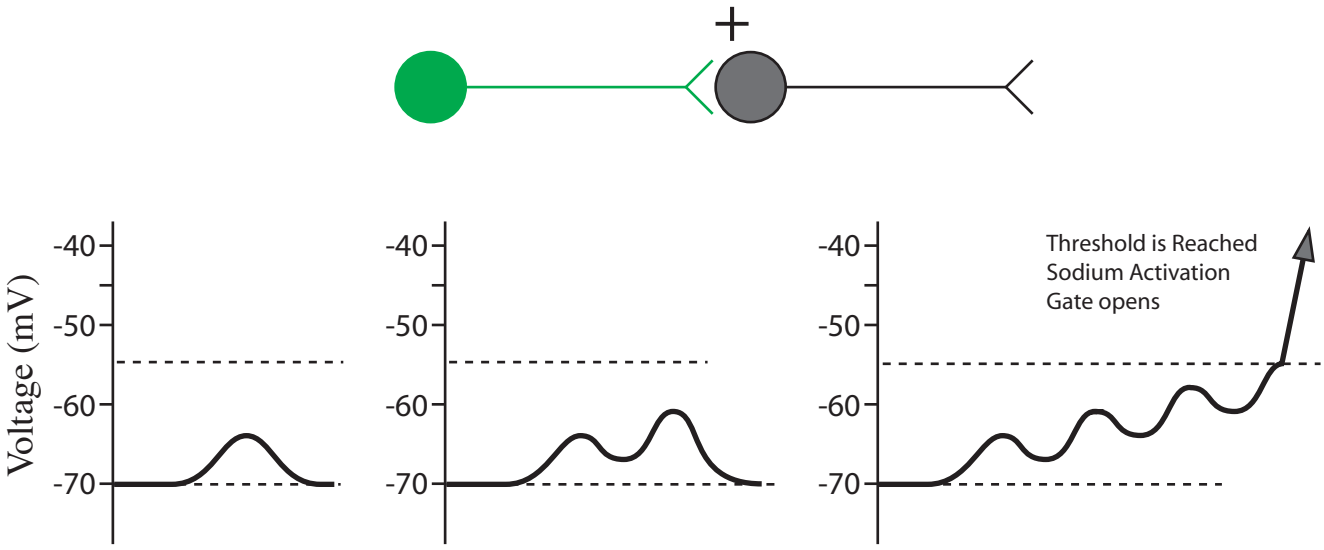


Inhibitory Interneuron

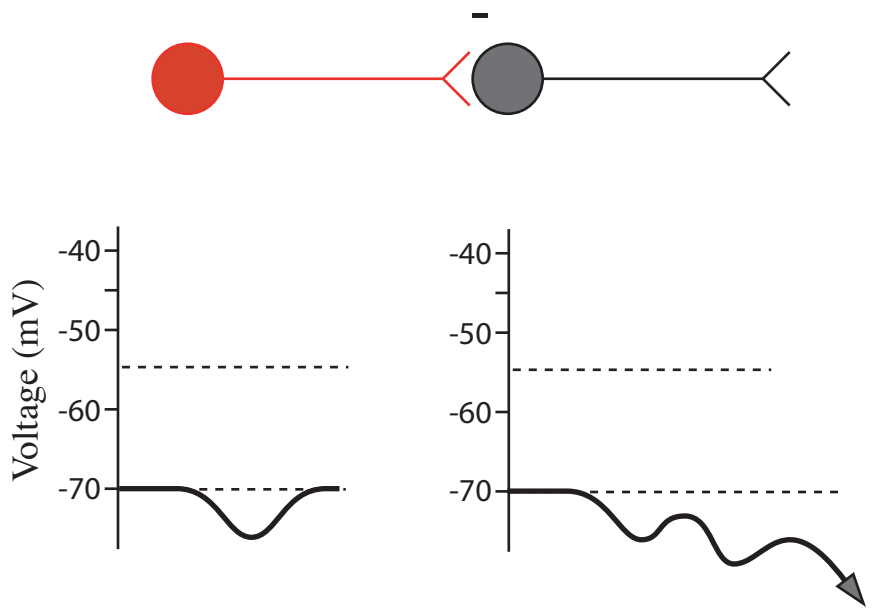


Temporal Summation

A single excitatory stimulation may not allow enough positively charged sodium (Na+) into the postsynaptic neuron enabling it to reach the threshold. However, repeated stimulation through time (temporal) may result in threshold due to the sum of all the sodium that accumulates.



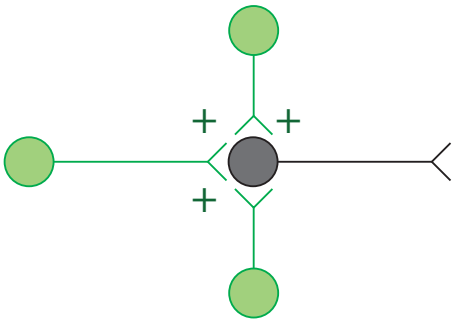
Likewise, repeated inhibitory stimulation can be summed up decreasing the likelihood of an action potential being generated as the membrane potential gets further and further away from threshold.

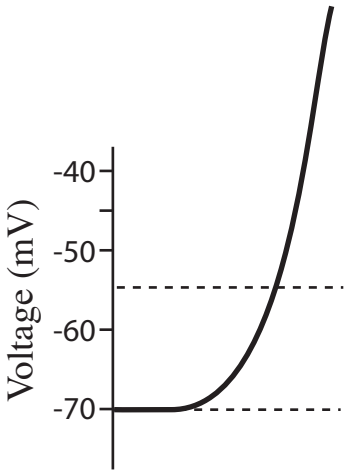


Remember, these effects are on the postsynaptic neuron, NOT the interneuron.

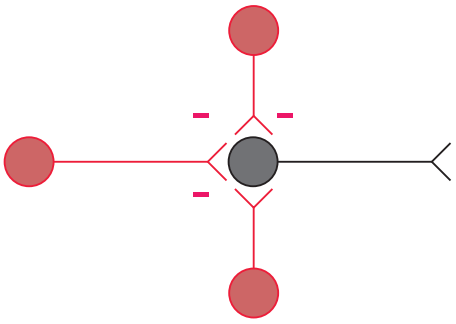
Spatial Summation

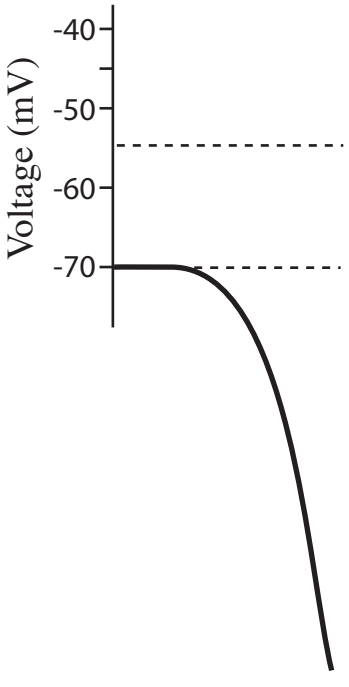
The summation can also be spatial (over the space or the area of the postsynaptic neuron). In the convergent circuit illustrated below, if all the presynaptic neurons simultaneously excite the postsynaptic neuron, this may result in it quickly reaching the threshold, followed by an action potential.





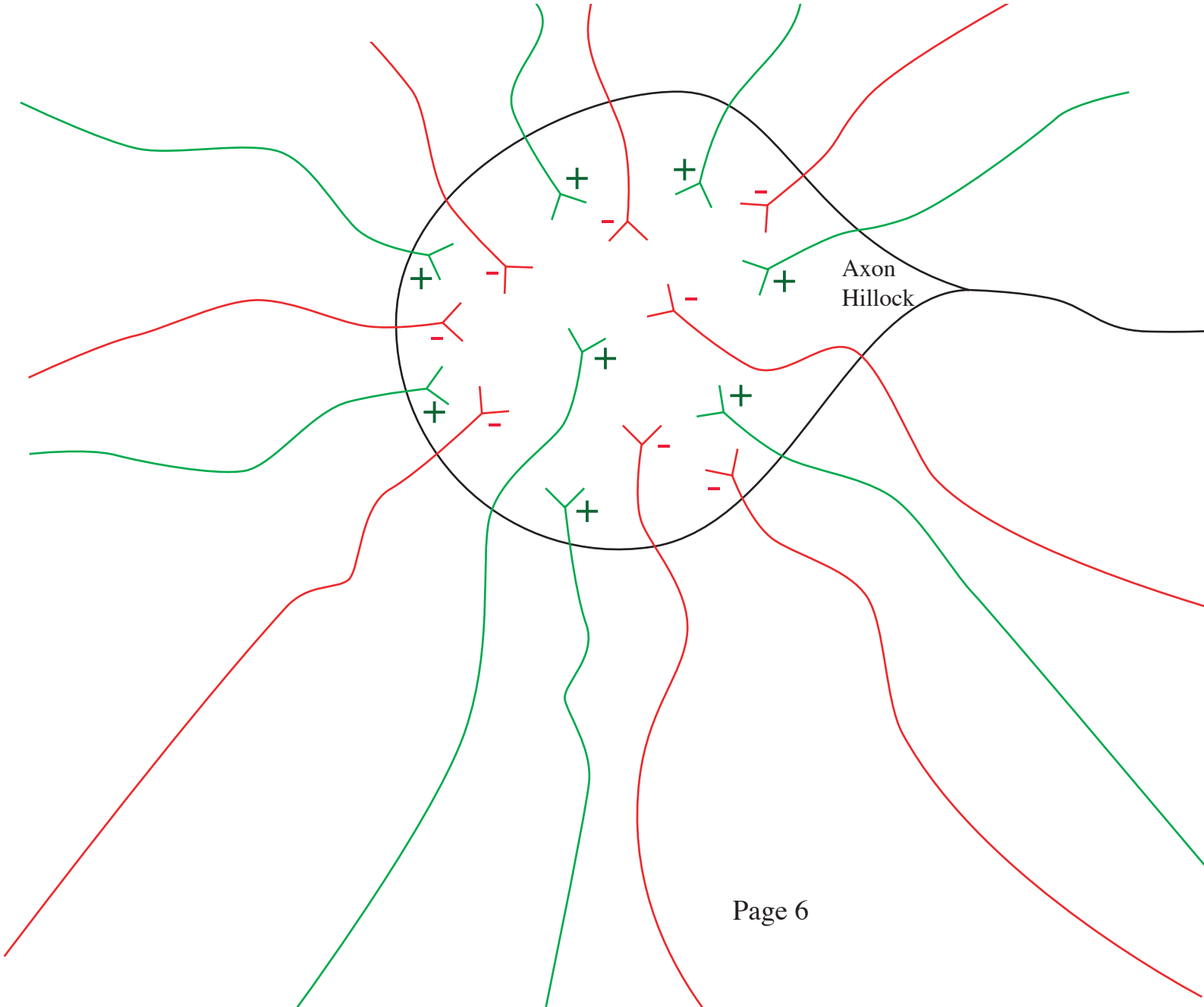
Spatial Summation may also occur with inhibitory neurons, and of course, the generation of an action potential is most unlikely (not shown).





Integration

A postsynaptic neuron is frequently a point of integration for both inhibitory and excitatory stimulation, where both spatial and temporal summation may occur concurrently. The determining factor, however, is the state of the axon hillock, where the electrical potential of the hillock will reflect the sum of effects "upstream". One can view this as a sort of "tug of war" between inhibitory and excitatory stimulation. regardless, no action potential will be generated until the threshold is reached. For the postsynaptic neuron, this is an all or nothing principle.



Application: Respiratory Rhythmicity Center
(A hypothetical / Simplistic Model)