Supplementary Methods

Notes on measuring inhibitory and excitatory conductances.

The current that we are recording under proper voltage clamp\(^6\) is:

\[
i(t)_{\text{measured}} = g_{\text{inhibitory}}(t) (V_m - E_{Cl}) + g_{\text{excitatory}}(t) (V_m - E_{\text{excitatory}}) + i_{\text{other}}(V_m).
\]

\(V_m\) = membrane voltage, \(E_{Cl}\) = chloride equilibrium potential, \(E_{\text{excitatory}}\) = excitatory neurotransmitter induced current’s equilibrium potential, \(g_{\text{inhibitory}}(t)\) = the inhibitory neurotransmitter controlled conductance, \(g_{\text{excitatory}}(t)\) = the excitatory neurotransmitter controlled conductance.

To measure inhibitory current we set \(V_m\) to be equal to \(E_{\text{excitatory}}\). Under this condition

\[
i(t)_{\text{measured}} = g_{\text{inhibitory}}(t) (V_m - E_{Cl}) + i_{\text{other}}(V_m).
\]

An important point here is that changing the “state of the cell” by changing the intracellular environment can have two effects:

1. It can change \(i_{\text{other}}(V_m)\) but that is a constant term because \(V_m\) is constant. (note that without sodium and potassium channel block that is not true)

2. It can scale \(g_{\text{inhibitory}}(t)\) to be \(k g_{\text{inhibitory}}(t)\) where \(k\) is an unknown constant, but the time course of the inhibitory conductance (in the scale of the synaptic events) is controlled from outside the cell by a neurotransmitter. The neurotransmitter is released from the presynaptic cell which is not affected by our electrode.
Taken together, $i(t)_{\text{measured}}$ can be written in the following form:

$$i(t)_{\text{measured}} = g_{\text{inhibitory}}(t) \ a + b$$

where $a$ and $b$ are constants. ($a = k (V_m - E_{Cl})$, $b = i_{\text{other}} (V_m)$).

Therefore our “inhibitory current” parameter is following $g_{\text{inhibitory}}(t)$.

A similar argument stands for the “excitatory current” parameter.