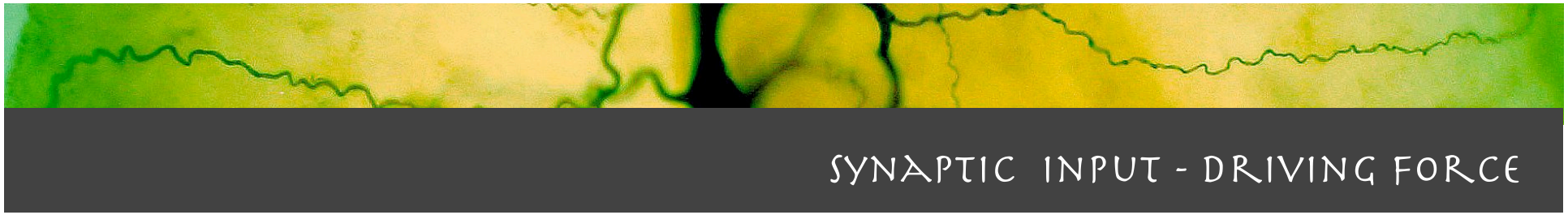


SYNAPTIC INPUT - DRIVING FORCE

$$I_{synaptic} = (E_{synaptic} - V_m)G_{synaptic}$$

PSC

$$C_m \frac{dV_m}{dt} = (E_{leak} - V_m(t))G_{leak} + (E_{syn} - V_m(t))G_{syn}(t) + I_{injected}$$

PSP

EPSC, IPSC, EPSP, IPSP are not good as measure of input

STATIONARITY APPROXIMATION

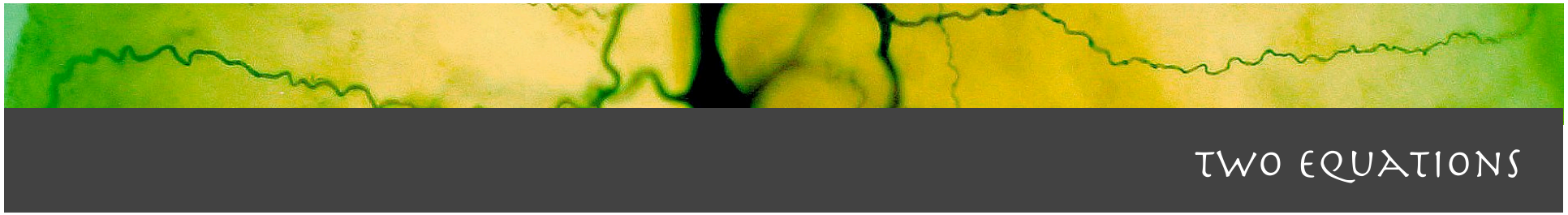
Intensity of synaptic input =>

average over a small window
where mean Vm don't change much

Thus,

$$C_m \frac{dV_m}{dt} \approx 0$$

How big a window? Small enough that stationarity is a good approximation and large enough to average out fluctuations. Typically 200-500 ms is appropriate.



TWO EQUATIONS

Two equations with two unknown:

$$G_{total} = G_e + G_i + G_{leak}$$

$$(E_{leak} - V_m)G_{leak} + (E_e - V_m)G_e + (E_i - V_m)G_i - I_{injected} = 0$$

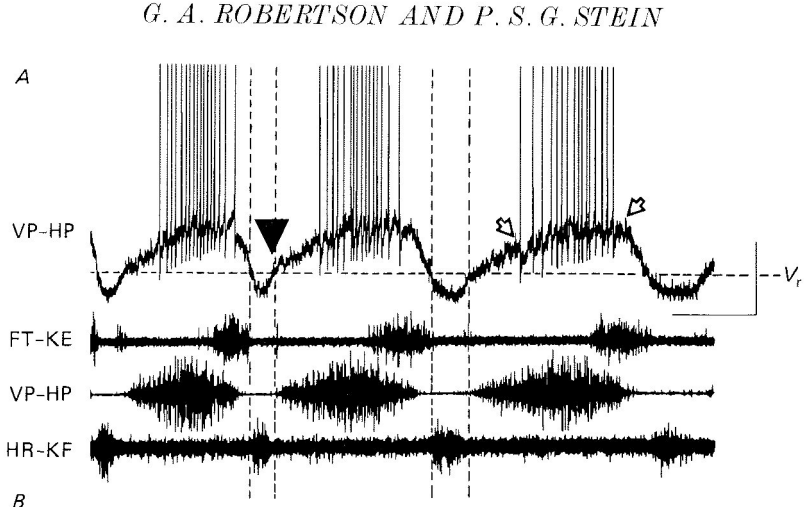
Now, solve for Gi and Ge…

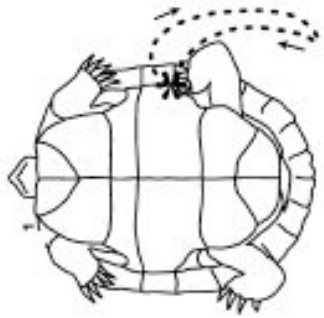
$$G_e = \frac{I_{injected} + G_{total}(V_m - E_i) + G_{leak}(E_i - E_{leak})}{E_e - E_i}$$

$$G_i = G_{total} - G_{leak} - G_e$$

Gleak is measured during quiescence. If only we could measure Gtot, we would have Ge and Gi….

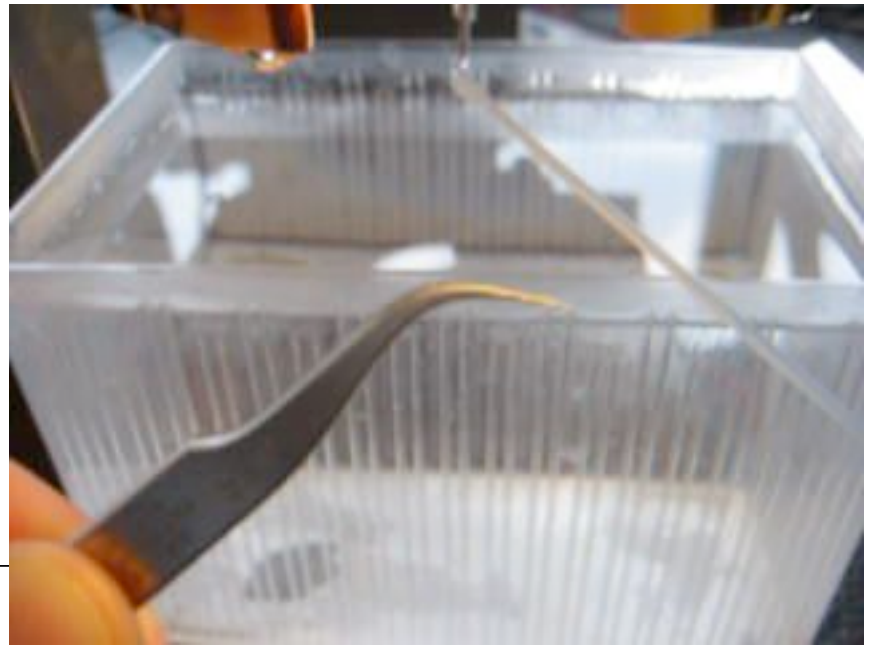
TURTLE SCRATCH REFLEX

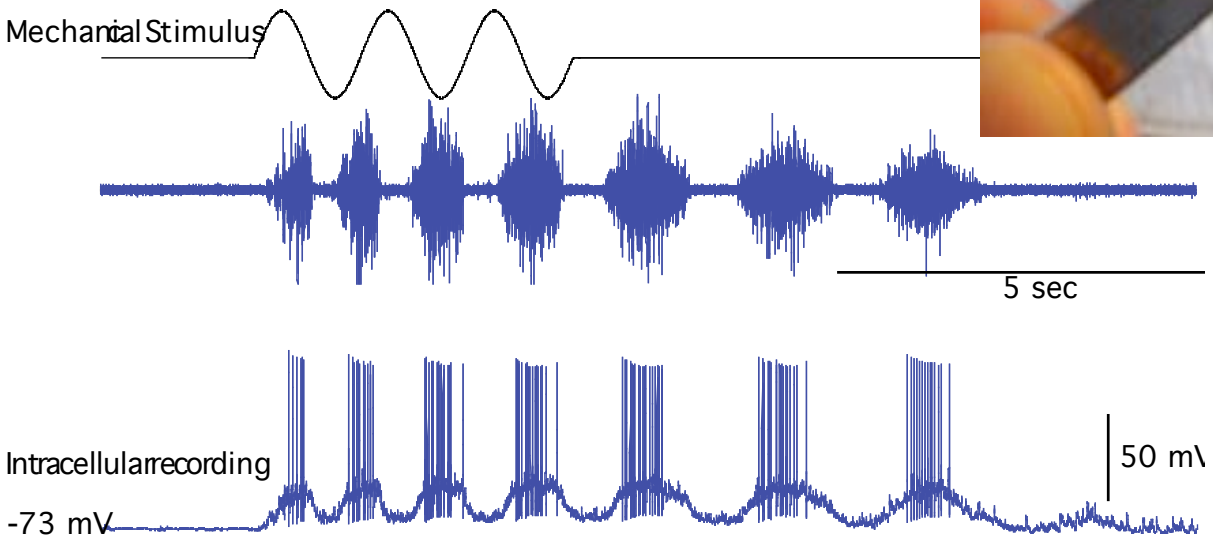




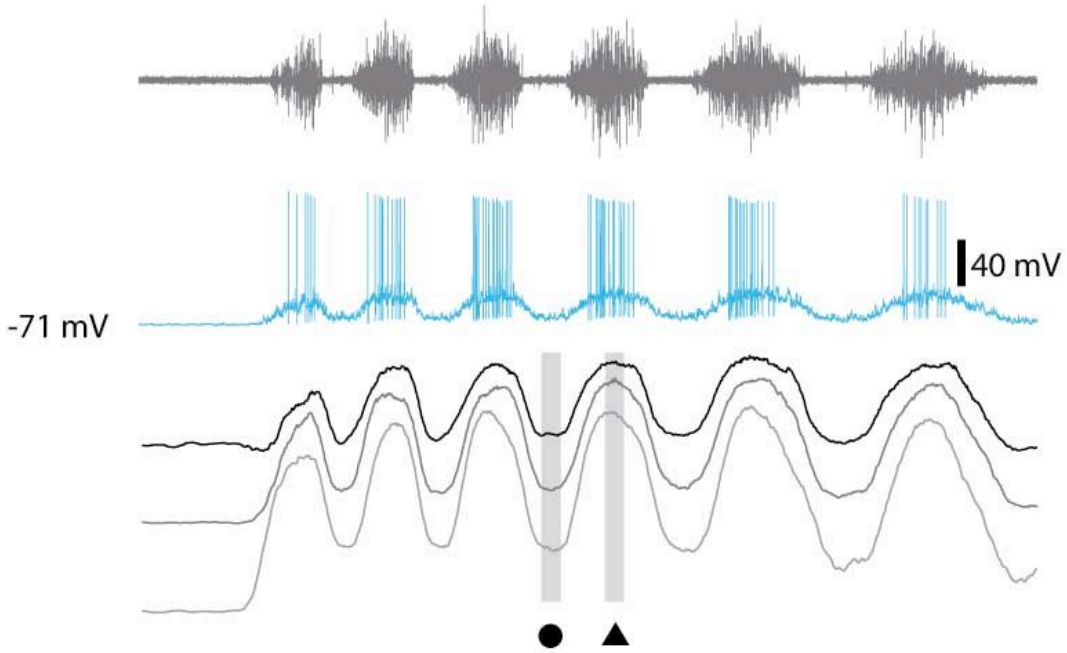
Robertson & Stein J Physiol 1988

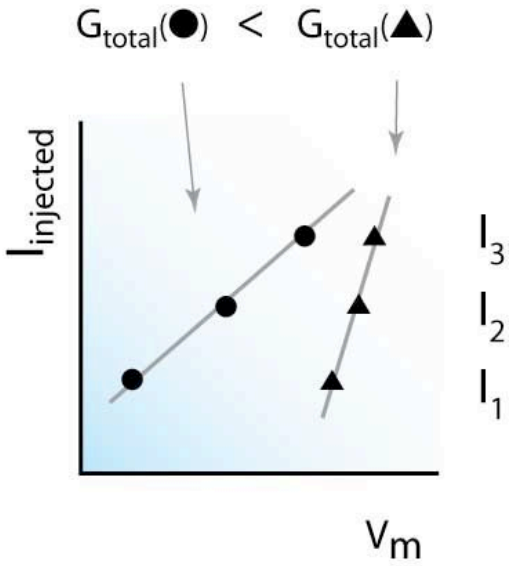
ACTIVATION OF NETWORK





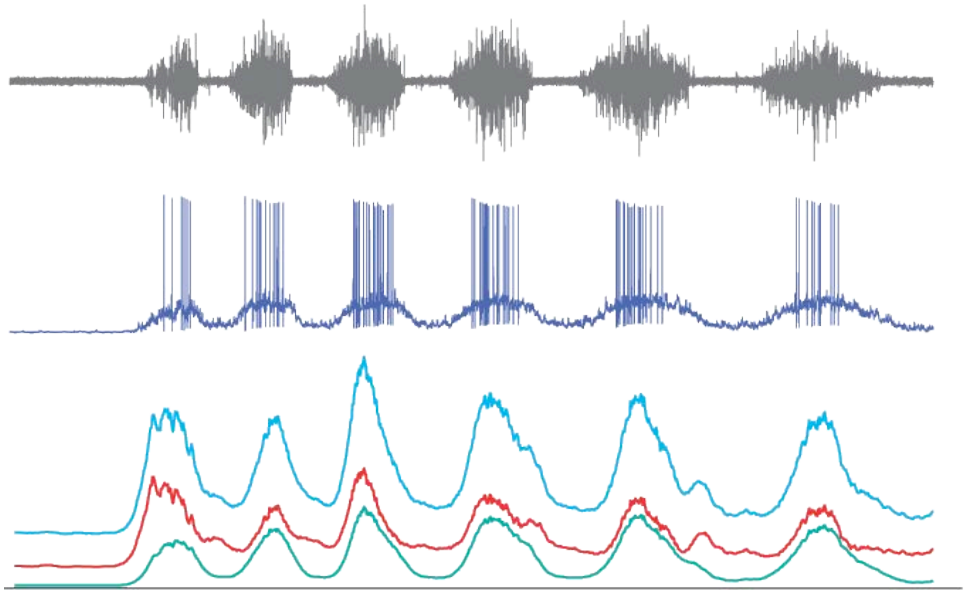
EXPERIMENT

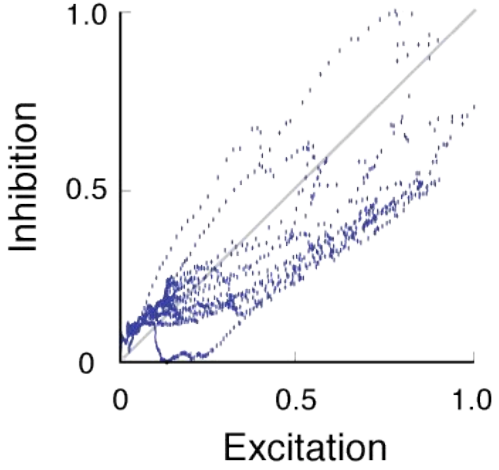




Berg, Alaburda, Hounsgaard Science 2007

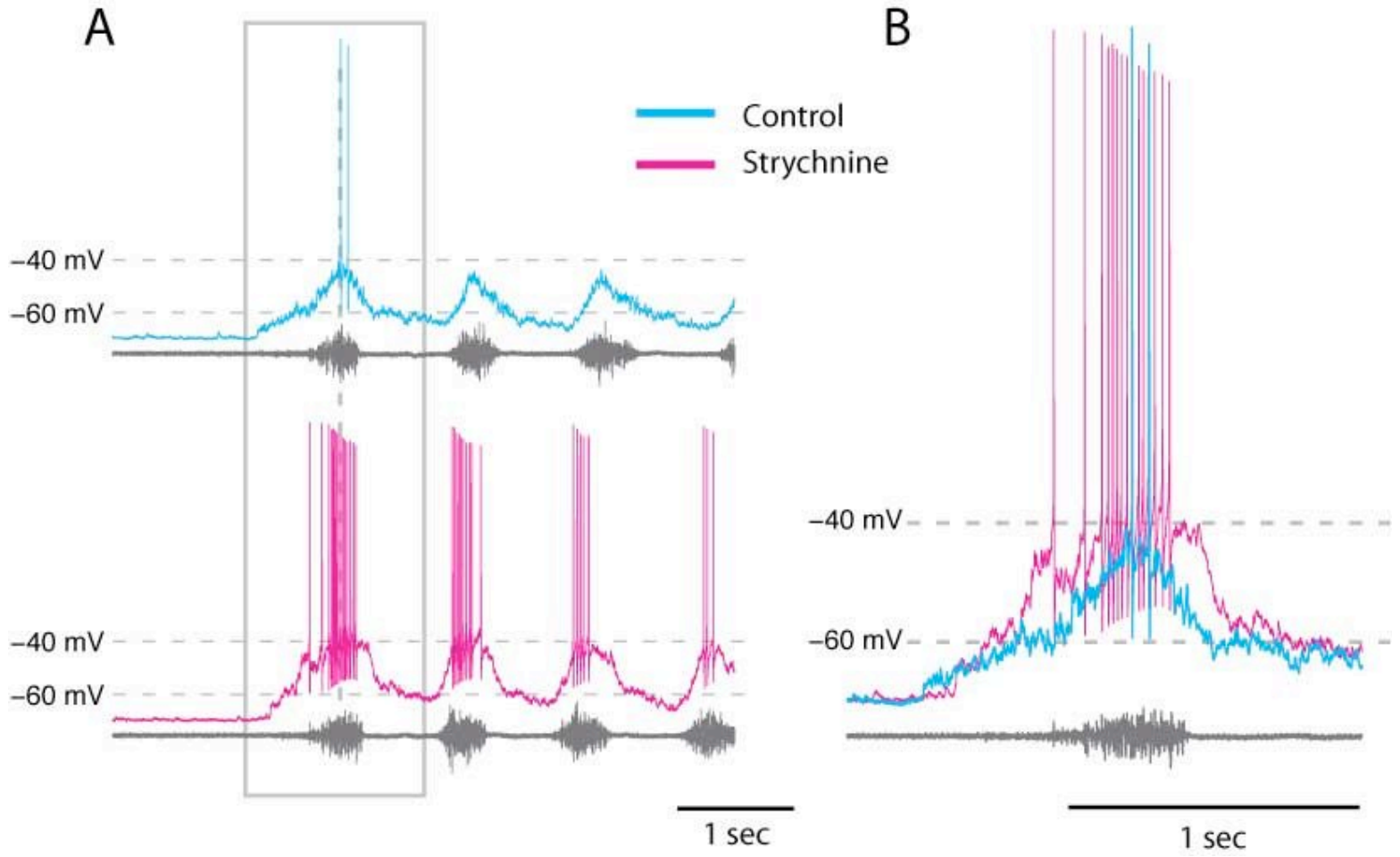
RESULT - BALANCED INHIBITION/EXCITATION





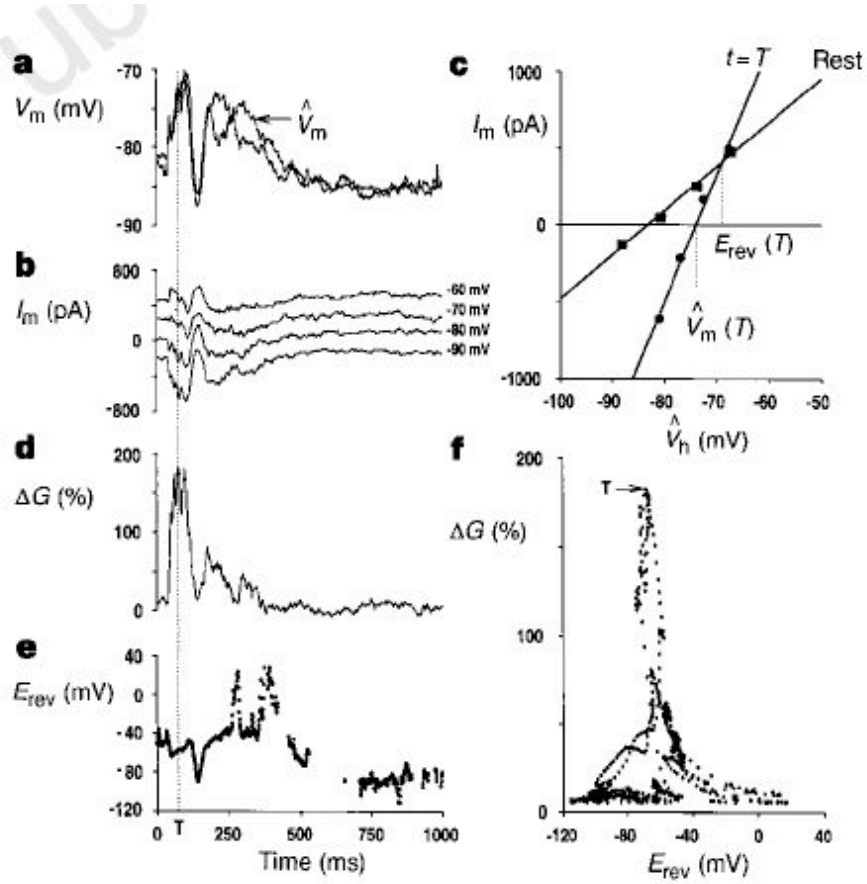
Berg, Alaburda, Hounsgaard Science 2007

VERIFICATION - SUPERFUSION



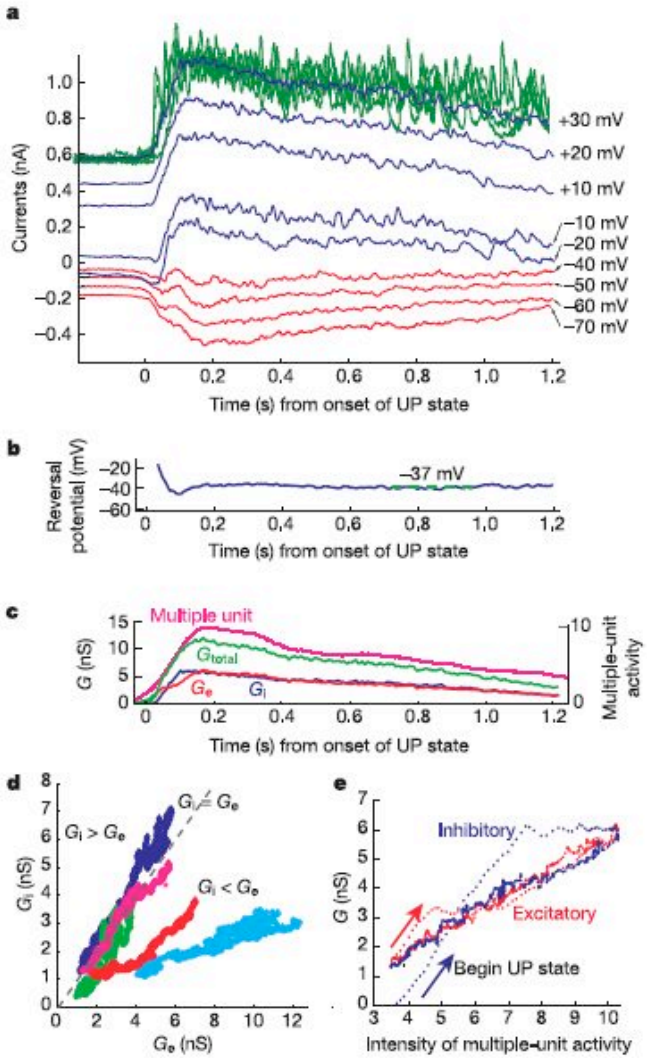
Berg, Alaburda, Hounsgaard Science 2007

BORG-GRAHAM, MONIER AND FREGNAC



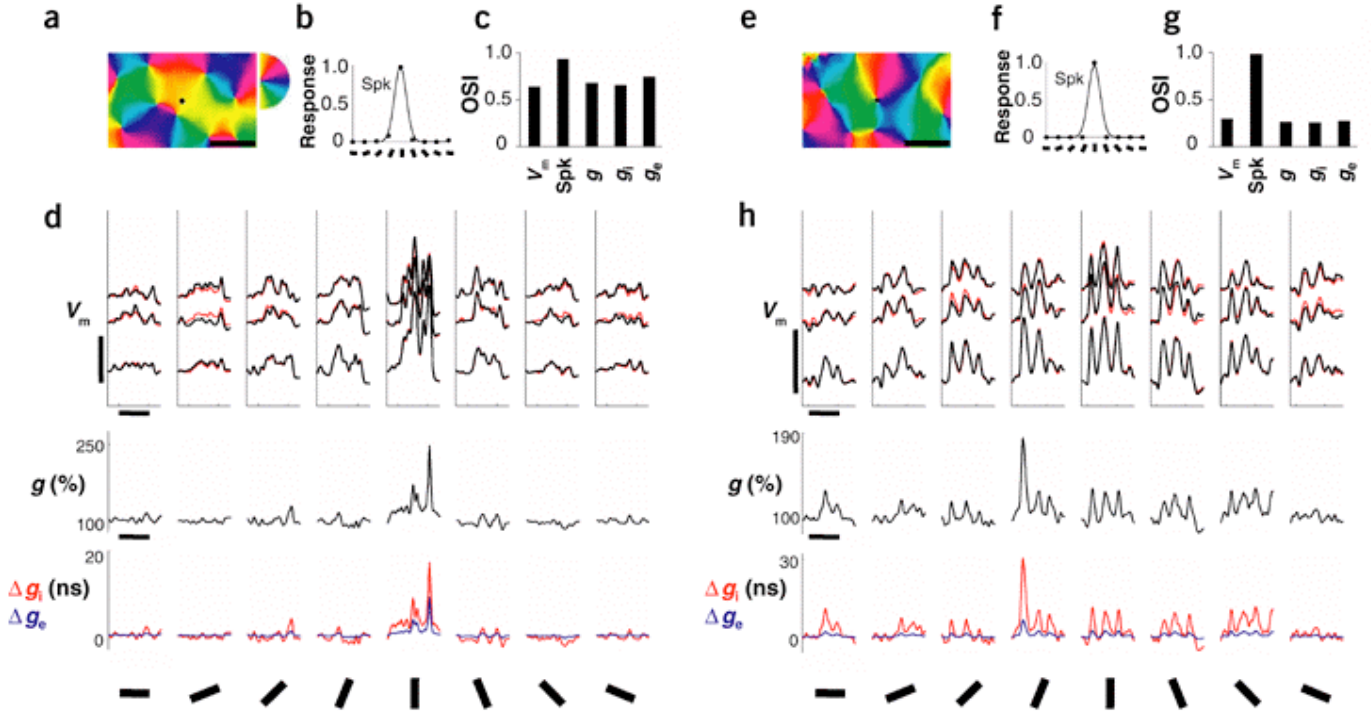
Borg-Graham, Monier, and Fregnac Nature 1998

Shu, Hasenstaub and McCormick



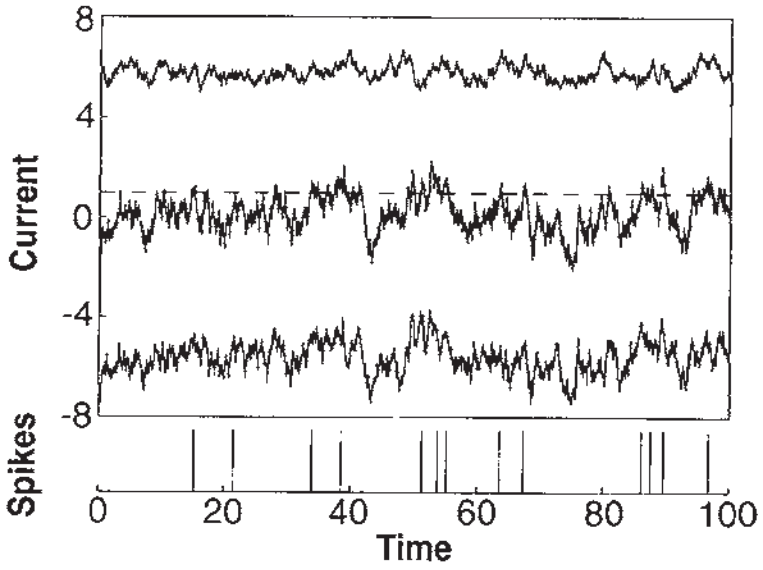
Shu, Hasenstaub, and McCormick Nature 2003

MARINO ET AL



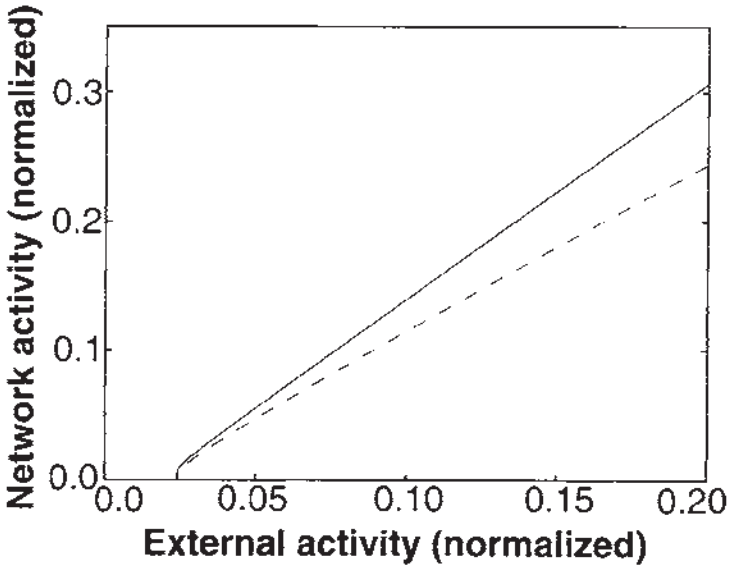
Marino et al Nature neuroscience 2005

Chaos in neuronal networks with balanced excitatory and inhibitory activity.



Temporal structure of the inputs and activity of a single excitatory unit. The upper panel shows the total excitatory input (consisting of external input and excitatory feedback) (upper trace) and the total inhibitory input (lower trace), as well as the net input (middle trace). The currents are shown in units of the threshold (dashed line).

Below, the times when the cell switched to the active state are indicated.



The mean activity of the excitatory neurons (solid line) and the inhibitory ones (dashed line) as functions of the activity of the external units . The activ ities correspond to firing rates divided by their maximum value.

van Vreeswijk and Sompolinsky (1996, 1998)