

I Aradi, V Santhakumar, I Soltesz: Variability of GABAergic synaptic inputs regulates the excitability of hippocampal pyramidal cells: Combined dynamic clamp and modeling studies

GABAergic synaptic inputs to principal cells are heterogeneous in terms of their anatomical, molecular and physiological properties. Whether diversity in GABAergic synaptic inputs affects the efficacy of GABAergic inhibition is not understood.

Dynamic clamp recordings were carried out from CA1 and CA3 pyramidal cells in hippocampal slices to study if alterations in the variance of IPSC populations can modulate the excitability of hippocampal pyramidal cells. The effects of changes in the IPSC variability were also studied in biophysical models of CA1 and CA3 pyramidal cells.

In response to increases in the variability of the inhibitory synaptic peak conductances, CA1 neurons increased their tonic firing frequency, whereas CA3 cells produced burst firing. In addition, both computational models and dynamic clamp recordings of CA1 cells showed that increased variance in the populations of IPSCs affected the CA1 pyramidal cells' firing rate during theta – gamma oscillations.

These results indicate the functional importance of the diversity of interneurons in cortical and hippocampal circuits, and suggest that GABAergic synaptic variability is a key parameter of neural networks that can regulate neuronal excitability under both normal and pathological conditions.

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