Shaping of STDP curve by interneuron and Ca^{2+} dynamics

Lynsey McCabe[1], Paolo Di Prodi[1], Bernd Porr[1], Florentin Wörgötter[2]
[1] Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland
[2] Bernstein Center for Computational Neuroscience, University of Göttingen, Bunsenstr. 10 (at the MPI), D-37073 Göttingen Germany

Email: lmc@elec.gla.ac.uk

Spike-timing-dependent-plasticity is a special form of Hebbian learning where the relative timing of post- and presynaptic activity determines the change in synaptic weight. Recent studies have shown that the shape of the postsynaptic potentials determine the shaping of the STDP curve. Consequently, interneurons change the shape of the postsynaptic potential thus affecting the overall shaping of the STDP weight-change curve. The weight change rule used is split into two parts: LTP is modelled by NMDA activity multiplied by the derivative of the calcium concentration and LTD is modelled using Ca^{2+} concentration only. The result of this is a STDP curve which depends on the Ca^{2+} dynamics but is changed by the presence of the attached interneuron. Reducing NMDA activity in the model also presents an opportunity to model deficits seen by schizophrenia patients by observing the transformed plasticity plots. Reducing the NMDA activity not only reduces plasticity in the pyramidal cell, but also reduces the activity of the input NMDA receptor of the GABAergic interneuron. Therefore NMDA hypofunction has two effects; as well as scaling down LTP, there will also be a disinhibition of the interneuron which will then cause an increase in LTD.