Natural firing patterns reduce sensitivity of synaptic plasticity to spike timing

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Induction of synaptic plasticity is sensitive to the rate and the timing of pre- and postsynaptic action potentials. In experimental protocols evoking plasticity, the imposed spike trains are typically regular and the relative timing between every pre- and postsynaptic spike is fixed. This is at odds with firing patterns observed in the cortex of intact animals, where cells fire irregularly and the timing between pre- and postsynaptic spikes varies. To investigate synaptic changes elicited by *in vivo*-like firing, we use numerical simulations and mathematical analysis of synaptic plasticity models. We concentrate on two very different classes of models : a spike-timing model based on spike-triplets (Pfister and Gerstner 2006), and a calcium-based model (Graupner and Brunel 2012). We show that the influence of spike-timing on plasticity is weaker than expected from regular stimulation protocols. Moreover, when neurons fire irregularly, synaptic changes induced by precise spike-timing can be equivalently induced by a modest firing-rate variation. The central result – that synaptic change from correlations can be attained by uncorrelated firing rate variations – holds for both plasticity models investigated. These findings bridge the gap between existing results on synaptic plasticity and plasticity occurring *in vivo*, and challenge the dominant role of spike-timing in plasticity.

References

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