Interplay between Multiple Plasticities and Activity Dependent rules: Data, Models and Possible Impact on Learning

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Presentation Abstract Summary Synaptic plasticity, the activity-dependent evolution neuronal connectivity, is admitted to underpin learning and memory. A paradigmatic plasticity depending on the spike timings of cells on both sides of the synapse (STDP), was experimentally evidenced through multiple repetitions of fixed pre- and post-synaptic spike patterns. Theoretical and experimental communities often implicitly admit that plasticity is gradually established as stimulus patterns are presented. Here, we evaluate this hypothesis experimentally and theoretically in the striatum, where (i) synapses may involve multiple pathways, or (ii) synaptic connections with multiple brain area exist. We will present models and experiments leading to reevaluate this hypothesis, showing that (i) multiple pathways may lead to non-monotonic establishments of plasticity where plasticity can be inverted depending on the number of stimulus presentations, and (ii) that multiple connections with in particular thalamus and cortex contribute to shaping their plasticities. We will propose a mathematical model building upon calcium transients to precisely dissect these complex interplays on resulting plasticities and reveal unexpected dependences on variables side variables (e.g. repetitions, frequency, temporal window). These results invite to reevaluate how plasticity is implemented as a global process, and to explore consequences on data processing capability and inspire new artificial intelligence techniques.

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