On physical processes controlling biological neural networks

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A hypothesis of fixation of information processing patterns and of learning in biological neural networks (BNN) is formulated: Short-range communication of neurons due to the ephaptic coupling ("cross-talk") via extracellular tissue (ECT), which is responsible for information processing, is enhanced by directed growth of dendrites controlled by galvanotaxis. This biophysical mechanism together with closed network topology, which are essentially different from those used in artificial neural networks, accounts for appreciable higher performance of BNNs despite they work at about million times lower frequencies. The hypothesis is based on our recent research into the ionic quantum diffusive transport of action potential through nerve fibre [1] and into the effect of ECT for the maintaining of homeostasis of nervous system and into the ephaptic coupling among vicinal neurons [2].

[1] J. J. Mareš, P. Hubík, V. Špička: *Diffusive propagation of nervous signals and their quantum control*. Eur. Phys. J. Spec. Top. **227** (2019) 2329–2347.

[2] J. J. Mareš, V. Špička, P. Hubík: *Possible role of extracellular tissue in biological neural networks*. Eur. Phys. J. Spec. Top. **230** (2021) 1089–1098.